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U.S. Department of Health & Human Services

Food and Drug Administration

SAVE REQUEST

USER:	(ixg)
FOLDER:	K120087 - 624 pages
COMPANY:	RESPIRATORY MOTION, INC. (RESPMOTI)
PRODUCT:	SPIROMETER, MONITORING (W/WO ALARM) (BZK)
SUMMARY:	Product: EXSPIRON
DATE REQUESTED:	Aug 21, 2014
DATE PRINTED:	Aug 21, 2014
Note:	Printed

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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K120087

SEP 26 2012

510(k) Summary

510(k) Owner:	Respiratory Motion, Inc.
Address:	305 Second Avenue, Suite B Waltham, Massachusetts 02451
Phone:	781-373-1636
Fax:	781-373-1653
Contact person:	Jenny Freeman, MD
Date 510(k) Summary prepared:	September 20, 2012
Trade name:	ExSpiron™
Common name:	Respiratory Monitor
Classifications:	Monitoring spirometer Product code: BZK Regulation: 21 CFR 868.1850 Breathing frequency monitor Product code BZQ Regulation: 21 CFR 868.2375
Predicate devices:	For product code BZK, nSpire Wright/Haloscale Respirometer, marketed by nSpire Health, Inc. of Longmont, CO 510(k) K091853 For product code BZQ, Philips MPn0 Intellivue Patient Monitors, marketed by Philips Healthcare 510(k) K060541
Device Description:	The ExSpiron™ consists of: • **Bioimpedance measurement system**: A stabilized high frequency current generator is connected to two outer electrodes. The inner four electrodes are connected to an adaptive circuit that conditions the resulting voltage signal and converts it to digital form. Firmware performs signal acquisition and relays data to the panel PC. • **Panel PC**: A Windows 7 PC performs signal processing and calibration, and runs the graphical user interface (GUI). The PC takes user input from a touch screen through a virtual keyboard and mouse. The GUI is used for recording patient data and displaying the respiratory trace as well as scalar values and trends for minute volume, tidal volume, and respiratory rate. • **Single Patient Use ExSpiron™ Electrode Lead Set:** An electrode lead set containing six electrodes to be placed on the torso. It delivers current and records impedance measurements. The electrode lead set is also used to perform subsystem checks prior to patient measurements.

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Intended use:	ExSpiron™ is indicated for use by healthcare professionals in healthcare facilities, such as post-operative care and critical care units, to monitor breathing in adult (at least 21 years old) patients. ExSpiron™ is a non-invasive system that graphically displays lung volume against time and reports an approximate value of: • Tidal volume, • Respiratory rate, and • Minute ventilation ExSpiron™ measurements are used as an adjunct to other clinical information sources.
Comparison of technological characteristics:	

Characteristic	ExSpiron™	nSpire	Philips Intellivue Monitor	Comment
Intended Use	See above.	See K091853	See K060541	The clinical application of the ExSpiron™ is equivalent to that of the nSpire. The comparison to the intended use of the Philips monitor is restricted to monitoring of respiration rate. ExSpiron™ has no alarm function. All devices are used by healthcare professionals.
Technology	Measurement is by thoracic bioimpedance.	Measurement is by in-line turbine flow meter.	Measurement is by bioimpedance.	
Volume Measurements	Tidal volume Minute volume Volume vs. time chart	Tidal volume Minute volume	None	The time function for the minute volume measurement of the nSpire is provided by a user's stopwatch.
Rate Measurements	Respiratory rate (breaths/min)	None	Respiratory rate	
Safety	IEC 60601-1, including electrical and mechanical safety	Mechanical only. Safety specifications are not given in the user manual or 510(k) summary.	IEC 60601-1, etc.	

Nonclinical performance testing:	Performance testing confirmed essential performance by IEC 60601-1 and IEC 60601-1-2 tests and confirmed usability by simulated use by physicians and nurses representative of intended users.

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Clinical performance testing:

A clinical study compared simultaneous measurements from the ExSpiron and the predicate, Wright spirometer. (Respiratory rate was calculated using a stop watch.) Twenty subjects representing a broad range of intended patients participated in the study. (Age range: 20-84, BMI range: 19.9-43.2, 11 female, 9 male) The study involved two sessions for each subject, an initial session in which electrodes were applied, the ExSpiron was calibrated to the individual, and each subject performed ten 60-second breathing tests. Tidal volume, minute ventilation, and respiratory rate were measured simultaneously by the ExSpiron and the Wright spirometer. Each subject returned twenty-four hours after the first session with the original electrodes still attached. Using the same individual calibration values, a second set of ten 60-second breathing tests was performed.

The results of ExSpiron-Wright study were:

ExSpiron-Wright		Minute Ventilation	Tidal Volume	Respiratory Rate
Bias	**Overall**	**-2.1%**	**-1.9%**	**-0.2%**
	Day 1	-2.3%	-1.7%	-0.6%
	Day 2	-1.9%	-2.0%	0.2%
Precision	**Overall**	**10.5 %**	**10.3 %**	**2.0 %**
	Day 1	10.2%	9.7%	2.3%
	Day 2	10.8%	10.8%	1.6%
Accuracy	**Overall**	**10.7 %**	**10.4 %**	**2.0 %**
	Day 1	10.4%	9.8%	2.4%
	Day 2	10.9%	11.0%	1.6%

The results indicate that the individual calibration is stable over a 24-hour period.

A similar study was performed comparing the Wright spirometer to the Morgan SpiroAir LT diagnostic spirometer. (The closed cell construction of the Morgan spirometer limits the breathing test time to 30 seconds. A direct comparison of the ExSpiron to the Morgan spirometer is suboptimal.) A different set of twenty subjects participated. (Age range: 20-60, BMI range: 19.0-28.0, 9 female, 11 male) Each subject participated in one session performing twenty 30-second breathing tests with volume measurements made simultaneously with the Wright spirometer and the Morgan diagnostic spirometer.

The Morgan-Wright study results were:

Wright-Morgan	Minute Ventilation	Tidal Volume
Bias	**0.4%**	**0.4%**
Accuracy	**3.9%**	**3.9%**

Continued on next page.

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<table>
<tr><td>Clinical performance testing:
Continued from previous page</td><td>Combining the results of the ExSpiron-Wright study and the Wright-Morgan study provided calculated estimates of ExSpiron bias and accuracy with respect to the Morgan diagnostic spirometer:
<table>
<tr><th>ExSpiron-Morgan</th><th>Minute Ventilation</th><th>Tidal Volume</th></tr>
<tr><td>Bias</td><td>-1.7%</td><td>-1.5%</td></tr>
<tr><td>Accuracy</td><td>9.9%</td><td>9.6%</td></tr>
</table></td></tr>
<tr><td>Conclusions regarding safety and effectiveness:</td><td>Based on the comparisons of intended use, and results of nonclinical and clinical testing, the ExSpiron™ is substantially equivalent in intended use, safety, and effectiveness to the nSpire Respirometer and to the breathing frequency monitor function of the Philips Intellivue Patient Monitors.</td></tr>
</table>

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DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Food and Drug Administration
10903 New Hampshire Avenue
Document Control Room –WO66-G609
Silver Spring, MD 20993-0002

SEP 26 2012

Respiratory Motion, Incorporated
C/O Mr. Chas Burr
Chas Burr QR Services
11 Mystic Avenue
Winchester, Massachusetts 01890

Re: K120087
Trade/Device Name: ExSpiron™
Regulation Number: 21 CFR 868.2375
Regulation Name: Breathing Frequency Monitor
Regulatory Class: II
Product Code: BZQ, BZK
Dated: September 20, 2012
Received: September 21, 2012

Dear Mr. Burr:

We have reviewed your Section 510(k) premarket notification of intent to market the device referenced above and have determined the device is substantially equivalent (for the indications for use stated in the enclosure) to legally marketed predicate devices marketed in interstate commerce prior to May 28, 1976, the enactment date of the Medical Device Amendments, or to devices that have been reclassified in accordance with the provisions of the Federal Food, Drug, and Cosmetic Act (Act) that do not require approval of a premarket approval application (PMA). You may, therefore, market the device, subject to the general controls provisions of the Act. The general controls provisions of the Act include requirements for annual registration, listing of devices, good manufacturing practice, labeling, and prohibitions against misbranding and adulteration. Please note: CDRH does not evaluate information related to contract liability warranties. We remind you, however, that device labeling must be truthful and not misleading.

If your device is classified (see above) into either class II (Special Controls) or class III (PMA), it may be subject to additional controls. Existing major regulations affecting your device can be found in the Code of Federal Regulations, Title 21, Parts 800 to 898. In addition, FDA may publish further announcements concerning your device in the Federal Register.

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Please be advised that FDA's issuance of a substantial equivalence determination does not mean that FDA has made a determination that your device complies with other requirements of the Act or any Federal statutes and regulations administered by other Federal agencies. You must comply with all the Act's requirements, including, but not limited to: registration and listing (21 CFR Part 807); labeling (21 CFR Part 801); medical device reporting (reporting of medical device-related adverse events) (21 CFR 803); good manufacturing practice requirements as set forth in the quality systems (QS) regulation (21 CFR Part 820); and if applicable, the electronic product radiation control provisions (Sections 531-542 of the Act); 21 CFR 1000-1050.

If you desire specific advice for your device on our labeling regulation (21 CFR Part 801), please go to http://www.fda.gov/AboutFDA/CentersOffices/CDRH/CDRHOffices/ucm115809.htm for the Center for Devices and Radiological Health's (CDRH's) Office of Compliance. Also, please note the regulation entitled, "Misbranding by reference to premarket notification" (21CFR Part 807.97). For questions regarding the reporting of adverse events under the MDR regulation (21 CFR Part 803), please go to http://www.fda.gov/MedicalDevices/Safety/ReportaProblem/default.htm for the CDRH's Office of Surveillance and Biometrics/Division of Postmarket Surveillance.

You may obtain other general information on your responsibilities under the Act from the Division of Small Manufacturers, International and Consumer Assistance at its toll-free number (800) 638-2041 or (301) 796-7100 or at its Internet address http://www.fda.gov/MedicalDevices/ResourcesforYou/Industry/default.htm.

Sincerely yours,

Anthony D. Watson, B.S., M.S., M.B.A.
Director
Division of Anesthesiology, General Hospital,
Infection Control and Dental Devices
Office of Device Evaluation
Center for Devices and
Radiological Health

Enclosure

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Indications For Use

510(k) Number (if known): K120087
Device Name: ExSpiron
Indications for Use:

ExSpiron is indicated for use by healthcare professionals in healthcare facilities, such as post-operative care and critical care units, to monitor breathing in adult (at least 21 years of age) patients.

ExSpiron is a non-invasive system that graphically displays lung volume against time and reports an approximate value of:

- Tidal volume,
- Respiratory rate, and
- Minute ventilation.

ExSpiron measurements are used as an adjunct to other clinical information sources.

Prescription Use ___X____ AND/OR Over-The-Counter Use_____
(Part 21 CFR 801 Subpart D) (Part 21 CFR 801 Subpart C)

(PLEASE DO NOT WRITE BELOW THIS LINE-CONTINUE ON ANOTHER PAGE IF NEEDED)

Concurrence of CDRH, Office of Device Evaluation (ODE)

(Division Sign-Off)
Division of Anesthesiology, General Hospital
Infection Control, Dental Devices

510(k) Number: K120087

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K120087/S1
AN/SAGRD

FDA CDRH DMC
K55 MAY 29 2012
Received

Respiratory Motion, Inc.
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U.S. Food and Drug Administration
Center for Devices and Radiological Health
Document Mail Center – WO66-G609
10903 New Hampshire Avenue
Silver Spring, MD 20993-0002
May 24, 2012

Office of Device Evaluation:

Subject: Response to Request for Additional Information for 510(k) 120087
Change from Traditional 510(k) to Abbreviated 510(k)

Respiratory Motion, Inc. (RMI) is submitting this response to FDA's request for additional information, dated March 30, 2012. The response in the enclosed pages includes concise answers and attachments for detailed information.

In response to the second question, regarding RMI's promise to comply with FDA Recognized Standards before shipment, RMI is converting the submittal from a Traditional 510(k) to an Abbreviated 510(k). RMI has rewritten Chapter 9 to include information for an Abbreviated 510(k).

RMI is enclosing a CD with a pdf file containing this cover letter, the response, and its attachments. The paper copies are printed from this pdf file. The contents of the paper copy and the pdf file are identical.

Respectfully,

Chas Burr
510(k) Correspondent for Respiratory Motion, Inc.

cc: Jenny Freeman, MD, President Respiratory Motion, Inc.
Encl: Response to Request for Additional Information, with attachments
CD with pdf file

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Respectfully,

Signed on hard copy

Chas Burr
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Response to Request for Additional Information
510(k) K120087 ExSpiron Respiratory Monitor
Respiratory Motion, Inc. (RMI)

FDA's questions are shown in *italics*.

1. *You provided Indications For Use statement page in Section 4. However, you did not indicate whether your proposed device is prescription use or over-the-counter use. Please clarify and provide an updated Indications For Use statement page.*

   RMI unintentionally omitted indicating that the ExSpiron is intended for prescription use. A corrected Indications for Use Statement is in Appendix 1-1.

2. *In Section 9 and 17, you stated that your proposed device will conform to standards and validation testing. Please be advised that we expect all testing to be completed prior to 510(k) clearance. Therefore, please provide completed test report and data on your proposed device in its final finished form.*

   RMI's development plan is based on 510(k) clearance with a promise to comply with standards prior to shipment. The reviewer clarified that the option of promised compliance is allowed by FDA with an Abbreviated 510(k). RMI is converting this 510(k) from a Traditional to an Abbreviated format. A revised Chapter 9, Reliance on Standards, is in Appendix 2-1.

3. *In Section 15, you stated that* B4 [redacted]

a. *Please specify the* B4 [redacted].

   B4 [redacted].

b. *Please clarify whether you made any modifications to the electrodes identified above.*

   No modifications were made to the electrodes per se. Relative positioning is provided by an overlay. The patient contacting part of the overlay is medical grade polyethylene foam tape, coated on one side with non-sensitizing acrylic adhesive B4 [redacted] states that the tape has been tested for cytotoxicity, irritation, and sensitization.

c. *If you made any modifications to the electrodes in the predicate device, then please provide detailed description of all modifications. In addition, please provide biocompatibility testing.*

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There was no modification to the electrodes. The biocompatibility information provided by B4 [redacted] also appears in the 510(k) summary for the electrodes, "The device was subjected to biocompatibility testing as recommended in the May 1, 1995 FDA memorandum entitled: *Use of International Standard ISO-10993, "Biological Evaluation of Medical Devices Part 1: Evaluation and Testing.* The device was found to be non-irritating, non-cytotoxic, and non-sensitizing."

4. *In Section 18, you stated that "Bench performance testing has focused on usability." However, you did not provide human factors study data. Please provide human factor study on your final finished product according to FDA recognized standard "AAMI / ANSI HE75:2009, Human factors engineering - Design of medical devices". Please provide all labeling and training programs for your proposed device.*

At the time of the original 510(k), the usability testing had been used to determine usability requirements. Usability requirements were included in the System Requirements. User Error hazards were included in the Risk Management Plan (pages 16-7 and 16-8 of the original submission). The usability requirements and user error hazards were reviewed to develop the usability validation protocol and test record form in Appendix 4-1.

Technical usability content is found in the User Manual (Appendix 4-2). The Training Outline (Appendix 4-3) describes the training performed by RMI authorized personnel.

Final usability validation was performed at RMI's clinical test facility. Test users, who did not have previous experience with ExSpiron, included:

- 5 Anesthesiologists
- 1 Cardiothoracic surgeon
- 1 Critical care physician
- 2 ICU nurses
- 1 ER nurse

Test results showed no difficulties or failures with the final ExSpiron device and training. The ease of use results from use similarities with other common monitoring devices, a user interface designed to match typical user workflow, and documentation and training that address unique ExSpiron features. The ten test reports are provided in Appendix 4-4.

Promotional claims are listed in Appendix 4-5.

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Clinical

5. *You have not provided sufficient information to evaluate potential limitations to the use or accuracy of the device with respect to clinical conditions or the presence of other equipment. Please address how issues of device function that may occur in the presence of very high or very low respiratory rates, morbid obesity, dehydration, anasarca, hypotension, and implanted or temporary neurostimulators or pacers. If there are other conditions or devices that may affect the performance of the device, please include them as well in your discussion. Please be aware that the adequacy of the clinical trial population cannot be assessed without such information.*

Very low and very high respiratory rates

The ExSpiron's bioimpedance-determined measurements provide accuracy for a broader range of respiratory rates than the measurements of the predicate device. Conventional spirometers respond to the mechanical properties of expired air, i.e., pressure, flow rate, mass, or volume, which vary with respiratory rate. ExSpiron's bioimpedance measurement is not subject to these changes. RMI in its work with the predicate device has found that the range of ExSpiron measurements is at least equivalent to that possible with the predicate device.

At low respiratory rates, e.g., four breaths per minute, airflow is so low that the predicate device mechanical spirometer was not responsive through a large portion of each breath. According to the predicate's specification sheet, the spirometer begins to register flow at 2.5 L/min, a flow rate not generally sustained at four breaths per minute. A comparison to the predicate device is therefore not feasible at this rate.

Data from the study presented in the original 510(k) suggest that the ExSpiron measurement performance is insensitive to respiratory rate. Figure 5-1 shows accuracy and precision for each of the three measurements (TV, MV, and RR) plotted against RR. Accuracy and precision are within specifications and show no significant correlation in the range of RR from 7 to 23 breaths per minute. Each circle represents measurement performance data for each RR value. These data indicate that ExSpiron's measurement performance is not sensitive to RR. Measurement performance is within specification for the whole tested range, 7 to 23 breaths per minute. There is no correlation between RR and the accuracy or precision of three measurements ($p>0.2$ in all six cases.

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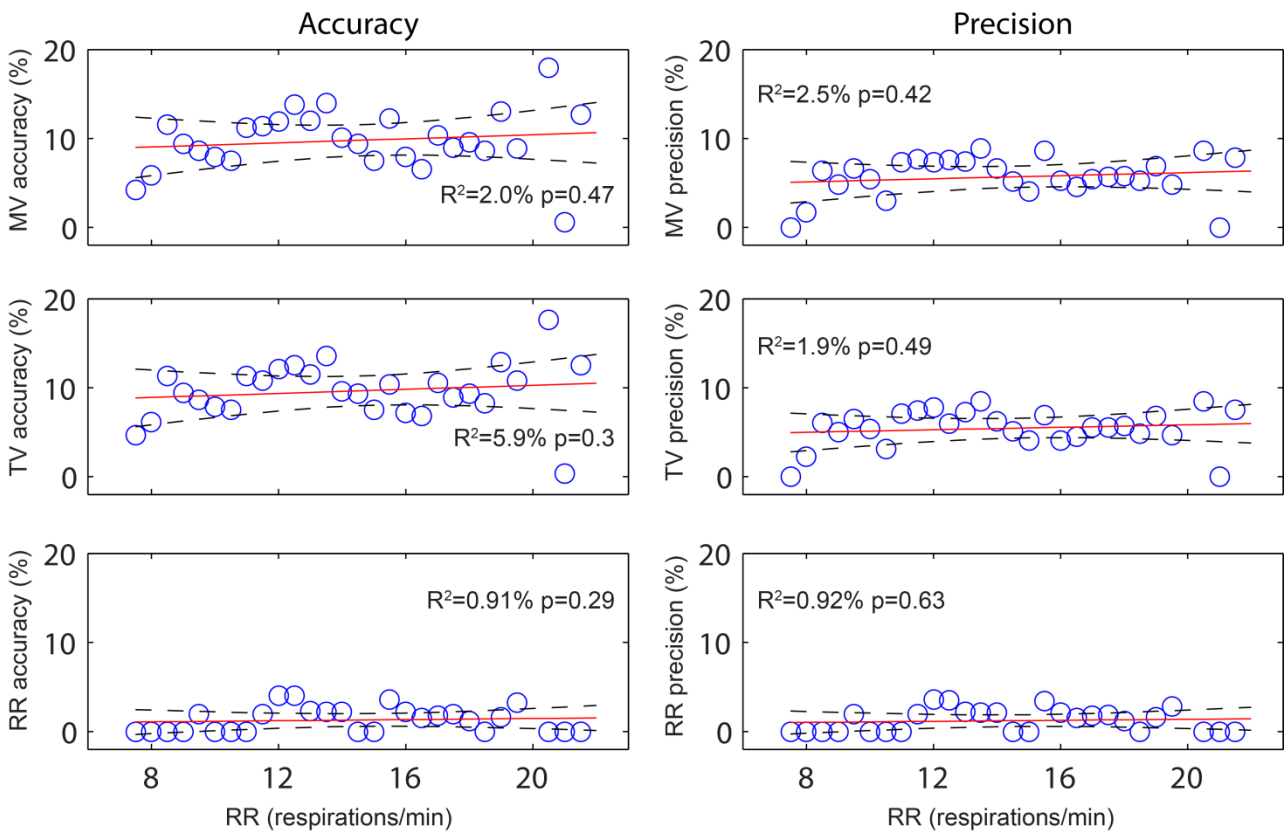
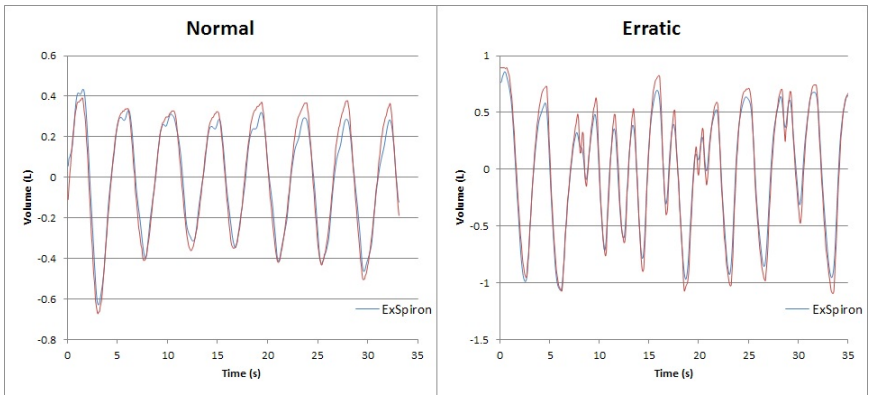


Figure 5-1 ExSpiron Measurement Performance plotted against Respiratory Rate

In the comparison of graphic displays of the ExSpiron and the Spiro Air-LT diagnostic spirometer, subjects were asked to breathe erratically. The results included samples of high frequency breathing and of large and small breaths. The original 510(k) described tests for three subjects. Figure 5-2 shows the three overlays of ExSpiron volume measurements over Spiro Air-LT measurements. The data suggest that ExSpiron responds equivalently to the diagnostic spirometer over a broad range of frequencies.



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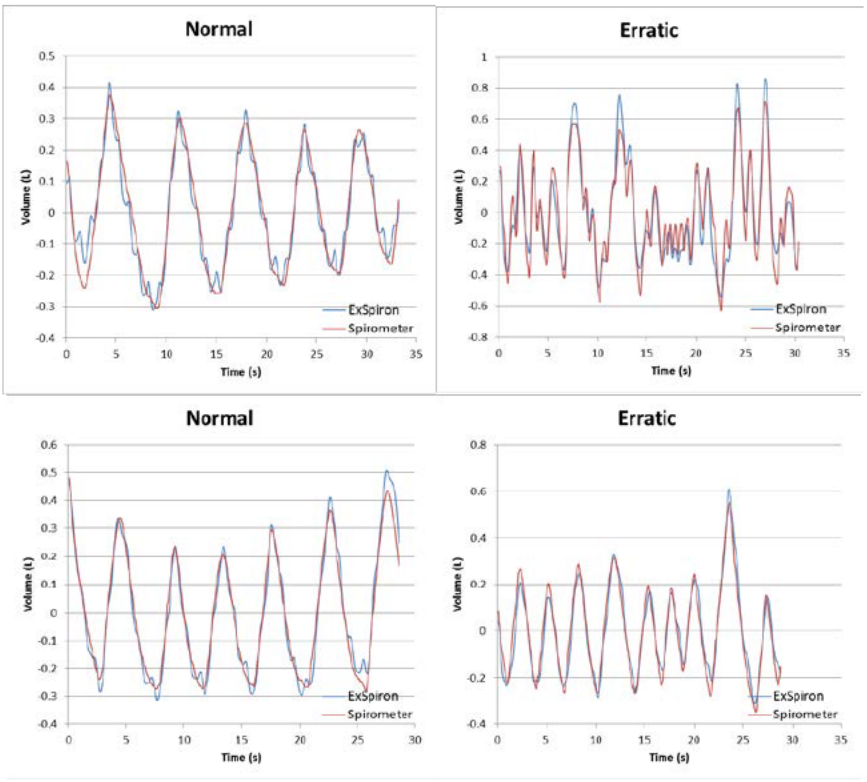

Figure 5-2 Overlays of Graphic Displays
ExSpiron and Spiro Air-LT
(Figure spans two pages)

B4 [redacted]

ExSpiron provides information to help assess respiratory distress. Because the existence of very low or very high respiratory rates is a sign of respiratory distress, RMI is adding this Caution to the User Manual:

> *The accuracy of ExSpiron volume measurements has not been confirmed at very high (> 30 breaths per minute) or very low (≤ 5 breaths per minute) respiratory rates. If a patient has a very high or very low respiratory rate, confirm respiratory status with other clinical information sources.*

Morbid obesity

Obesity and other body conditions affecting body composition are expected to shift baseline impedance. B4 [redacted]

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Results from the study presented in the original 510(k) demonstrate ExSpiron's measurement performance is not affected by obesity.

Data from the study presented in the original 510(k) indicate that the ExSpiron measurement performance is insensitive to BMI. Figure 5-3 shows accuracy and precision of ExSpiron measurement plotted against BMI. Each circle represents a single subject's average accuracy or precision. The red lines are the best linear regression fits to each data set with corresponding coefficients of determination and p-values listed within each panel. The charts show lack of correlation of ExSpiron measurement performance over the range of BMI's in the study (p>0.2) in all cases. Note that, reflecting the unfortunate trend in body type found in the US, five subjects in the study are obese (BMI>30) and two subjects are morbidly obese (BMI > 40).

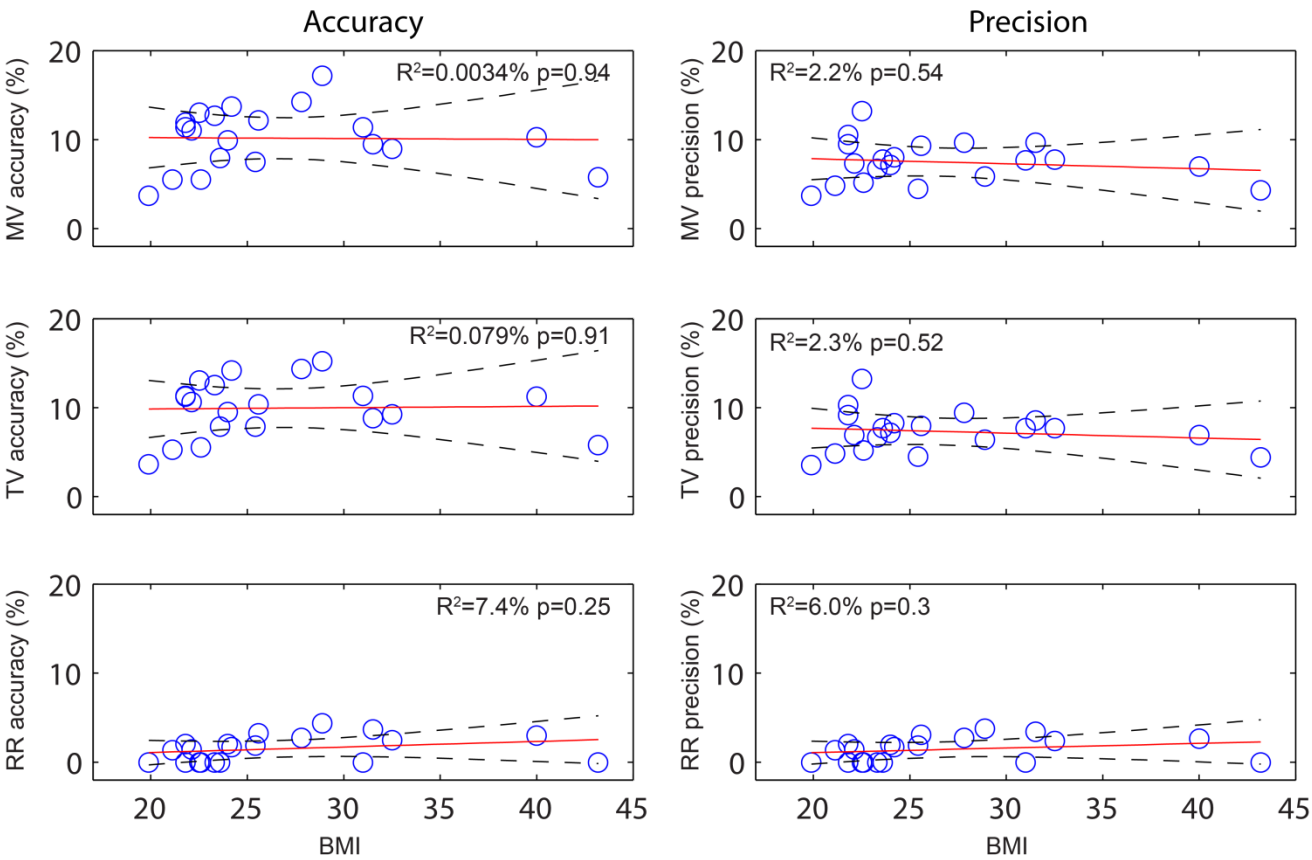

Figure 5-3 ExSpiron Measurement Performance data plotted against BMI

Dehydration and Anasarca

As with obesity, the state of hydration is expected to shift baseline impedance. This shift in baseline impedance does not affect ExSpiron lung volume measurements because ExSpiron lung volume measurements are associated with the volume of air in the thorax during the excursion of

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each breath and are based on the difference between minimum and maximum impedance around the impedance baseline.

The state of hydration was not measured or controlled during the study. As noted, the primary impact of the state of hydration is on the baseline impedance. ExSpiron measures, but does not display baseline impedance. Figure 5-4 shows measurement performance versus baseline impedance. Each circle represents an individual subject's averaged data. The analysis demonstrates that measurement performance does not correlate with baseline impedance (p>0.2 in all cases). Accuracy and precision hold across the range of baseline impedance.

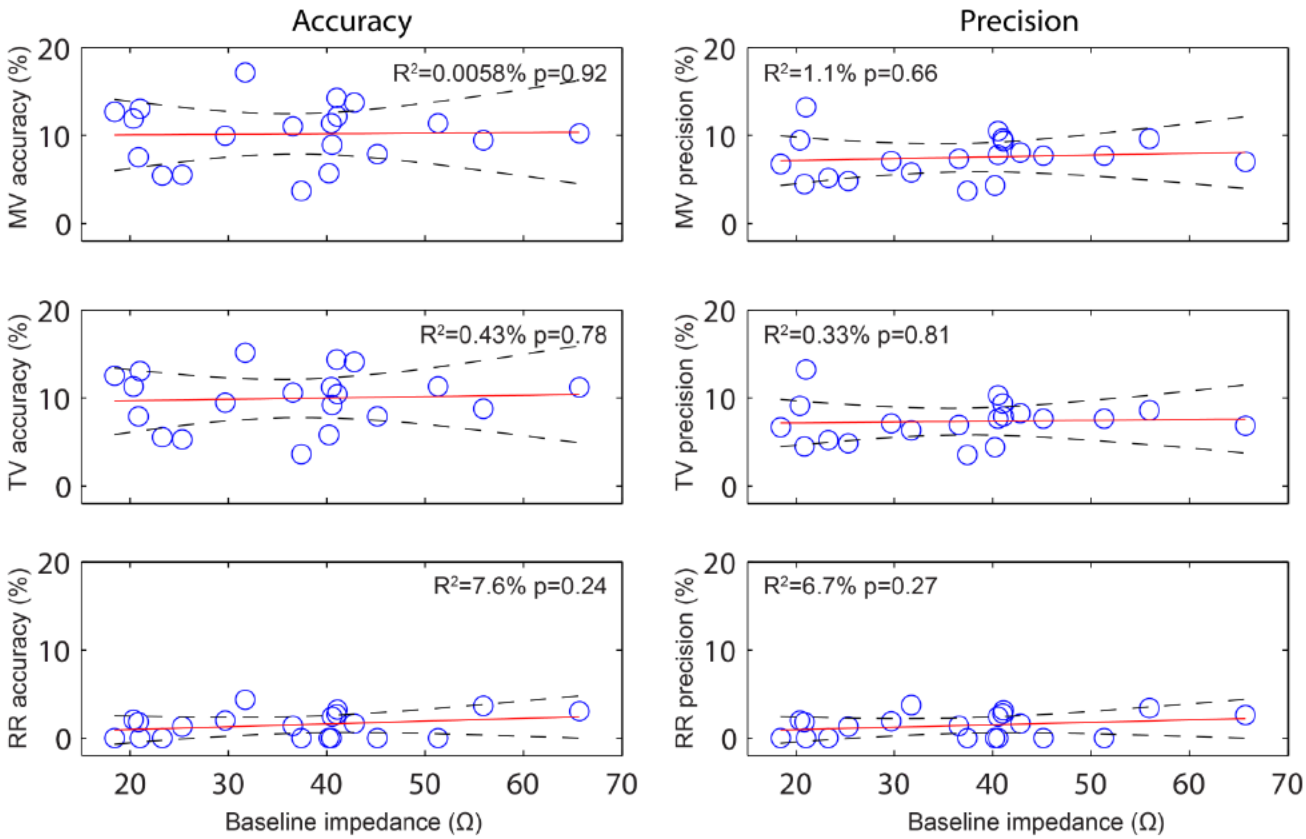

Figure 5-4 Measurement Performance plotted against Baseline Impedance

B4 [redacted]

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ExSpiron does not rely on baseline impedance, and ExSpiron measurement performance is not significantly affected by hydration. RMI cannot rule out minor changes in measurement performance associated with a large change in hydration within the 24-hour period after a calibration, due to potential changes in impedance "gain". To ensure proper use, a Caution will be added to the User Manual:

> *A very large change in patient hydration may affect the calibration. If a patient experiences a large change in hydration, recalibrate the ExSpiron monitor.*

Hypotension

Hypotension should have a negligible effect on ExSpiron's measurement performance. Hypotension and low cardiac output may influence the small signals measured by cardiac impedance devices. However, because ExSpiron's measurements are based on the larger impedance differences between air and body tissue, they should be immune to cardiac output or hypotension.

Note that blood pressure was neither measured nor controlled in the ExSpiron studies.

Implanted or Temporary Neurostimulators or Pacers

ExSpiron measures bioimpedance using a 50 kHz stimulation current. B4 [redacted]

Note: Another bioimpedance device with stimulating current in the 50 kHz frequency range may affect ExSpiron's measurement. The User Manual contains the Caution:

> *Do not use the ExSpiron™ monitor with another bioimpedance measurement system, such as an impedance cardiograph. Such devices may cause functional interference among the bioimpedance systems.*

6. *Please provide clinical and statistical justification as to how your patient inclusion and exclusion criteria are representative of the entire intended patient population.*

The purpose of this study is based on the ExSpiron intended use:

> *ExSpiron is a non-invasive system that graphically displays lung volume against time and reports an approximate value of:*
> - *Tidal volume,*
> - *Respiratory rate, and*
> - *Minute ventilation.*
>
> *ExSpiron measurements are used as an adjunct to other clinical information sources to determine respiratory status and appropriate therapy.*

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Because ExSpiron is intended to monitor, not to diagnose, the study's purpose is to demonstrate that ExSpiron's measurement performance is comparable to a clinically viable predicate device. The inclusion/exclusion criteria provide a broad sampling of subjects over which to demonstrate measurement performance.

The inclusion criterion for the study was:

- Males and females 18 to 90 years of age, of varying racial origins and body types, and with or without chronic respiratory diseases.

The exclusion criteria were:

- Lactating or pregnant females
- Subjects that have been hospitalized for asthma or COPD in the past 30 days

The justification for the inclusion criterion is the demonstration of clinically useful accuracy across a broad spectrum of adult subjects. The justification for the exclusion criteria is the reduction of risk to vulnerable subject populations.

There is no reason to believe that the respiratory bioimpedance changes in lactating or pregnant females would be different from the general adult population. Exclusion of lactating or pregnant females is a common practice in clinical trials because it reduces risk to infants and fetuses.

Individuals who had been recently hospitalized with asthma or COPD (chronic obstructive pulmonary disease) subjects were excluded from the study to reduce the risk of respiratory distress caused by the effort of breathing through the predicate spirometer device. B4 [redacted] Note that because the ExSpiron monitor does not add to the breathing workload, it is not considered a hazard to these subjects. Inclusion of asthma and COPD subjects who had not been hospitalized in the last 30 days provided confidence in the measurement performance in such subjects. Among the twenty subjects in the ExSpiron study, seven were smokers; two had a history of asthma, and one had a history of COPD.

7. *The clinical trial studied the device over a 24 hour period, but the device description does not provide information about the upper limits of duration of use of the electrode pads. Because testing should be done over the expected duration of use, please provide information about the upper limit of use of the electrode pads.*

RMI chose the 24-hour period as a conservatively short estimate of the duration for which the function of the ExSpiron system remains stable. The estimate is based primarily on the possibility of changes in electrode contact. Drift in ExSpiron calibration is not expected to be significant within twenty-four hours. Daily electrode replacement ensures optimal function. The clinical trial confirmed that measurement performance remains stable over 24 hours. Information on the 24-hour re-calibration appears in the User Manual in the first Caution in the

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Safety Measures section, the Clinical Procedure, and the Signal Quality section. See Appendix 4-2.

B4 [redacted]

8. *The Indications for Use statement does not specify an age range for intended use, but the clinical trial was conducted in subjects 20 years of age and older. Please modify the Indications for Use statement to indicate the age ranges for which the device may be used. If the age range is greater than that provided in the clinical testing, please be aware that additional testing may be needed to support the claim.*

The Indications for Use statement has been modified to indicate "adult patients". The subjects in the clinical trial ranged from 20 to 84 years of age. Please see the tabular data in appendices 9-1 and 9-2 for age distribution. See Appendix 1-1 for the modified Indications for Use.

9. *The 20 patients were selected to represent various ethnicity, disease states, and BMI values, but you have not provided specific information. Please provide line data in tabular form for each subject with respect to the selection variables.*

A table of selection variables data for each subject is in Appendix 9-1. Tables showing the distribution of these data across all subjects are in Appendix 9-2.

10. *You have not provided a sample size justification for the 20 patient trial. Please provide a sample size justification.*

The intended use for the ExSpiron is monitoring of respiratory measurements: TV, MV, and RR. RMI's clinical study was to demonstrate that ExSpiron's measurement performance is comparable to a clinically viable predicate device.
Sample size can be justified indirectly by the use of descriptive statistics and figures such as Figure 5.1 or by setting up an appropriate hypothesis test and then calculating the statistical power for the test. RMI chose the size of the subject group to be 20 to demonstrate (with 90% power) that the accuracy and precision of ExSpiron is within 20% of the predicate device. In fact, with 20 subjects the study demonstrates (by the equivalence test described below) that the measurements from the two devices are within 15% of each other.

Overview of sample size justification
The sample size justification is based on a power calculation for an equivalence test. The calculation is done for both the familiar definition of relative error (RE) and the log(accuracy) that closely approximates RE for values of RE near zero. The twenty repeated measures per subject are autocorrelated and not independent. Thus, to calculate power, we need to compute the variance inflation factor (VIF) for autocorrelated data. For the 20 subjects studied, each with

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20 autocorrelated repeated measures, the 400 = 20*20 observations are equivalent to 57 independent observations.

B4

[redacted]

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From formula 3.19 in Chow et al. ('Sample Size Calculations in Clinical Research' by Shein-Chung Chow, Hansheng Wang,), Jun Shao, Chapman & Hall/CRC Biostatistics Series,2003, the paired-difference equivalence test power formula is:

B4

[redacted]

11. The analyses of percentage accuracy, precision, and bias of an unusually derived metric (natural log of the ratio of the device to the predicate measurements) are difficult to interpret clinically. Please provide an analysis of the results in terms of sensitivity, specificity, positive predictive values, and negative predictive value.

Questions 11 and 15 are closely related. Please see question 15 for the justification of the natural log calculation and an analysis of accuracy, precision, and bias based on the Bland-Altman formulas.

Sensitivity, specificity, positive predictive value, and negative predictive value are meaningful in terms of diagnosis. The ExSpiron's intended use is monitoring of respiratory measurements to be used as an adjunct to other clinical information. An analysis of diagnostic power is not consistent with the intended use.

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Statistical

12. On page 20-13, you stated that the factor day had no effect on the intra-class correlation coefficient. One of the limitations with the intra-class correlation coefficient is that "estimates (as with all correlation coefficients) are dependent on the range of the measuring scale; the wider the range, the better the result." (from Müller and Büttner Stat. in Med., Vol. 13, 2465-2476 (1994)). FDA conducted its own analysis using bootstrap of the absolute difference for minute ventilation and tidal volume. Numerical results from tables 6 and 7 on page 20-9 were used for the calculations. FDA analyses incorporated results at the subject level. Below are the results, all of which are statistically significant.

    - Accuracy between days 1 and 2 for minute ventilation: average absolute difference of 4.12%, with a 95% confidence interval of [3.10%, 5.55%]
    - Precision between days 1 and 2 for minute ventilation: 2.9% for the average absolute difference of precision with 95% confidence interval of [1.99%, 3.76%]
    - Accuracy between days 1 and 2 for tidal volume: average absolute difference of 4.105%, with 95% confidence interval of [2.73%, 5.63%]
    - Precision between days 1 and 2 for tidal volume: average absolute difference of 2.91%, with 95% confidence interval of [2.05%, 3.87%]

    In light of these results, it is unclear that the device performs comparably on different days, especially with respect to minute ventilation and tidal volume. Please comment on these results.

Regarding the FDA analyses presented in this question: RMI respectfully disagrees with the conclusions and points out an issue in the analyses. Two analyses are presented below, one that illustrates that the more appropriate day measure is average difference and one that shows that the factor day is unrelated to accuracy.

B4 [redacted]

[redacted]

B4 [redacted]

[redacted]

[redacted]

[redacted]

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B4

B4

B4

Testing the Factor DAY as a Predictor of Accuracy

RMI has directly modeled accuracy from the 400 pairs, each pair consisting of the two measurements, one for each device. The outcome y is then the paired difference divided by the predicate measurement. RMI repeated the analysis with the log(ratio) definition of y. Previously RMI had modeled the raw data, including device as a factor, and reported the intra-class correlation coefficient, ICC, as a summary measure of accuracy. RMI never claimed that day was not a factor in predicting raw values, but only that any such day-difference had no effect on accuracy. In particular, RMI showed that raw-data models including or excluding the factor DAY had negligible effect on the estimate of the ICC. RMI made no major assertions about whether or not the factor DAY was significant.

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The basic model has outcome variable RE and one predictor variable, day. The two measurements of interest were MV and TV because, as shown above, the standard deviation of RE for the variable, RR, was very small, 0.02, and accuracy is very high. B4 [redacted]

REFERENCE

(Kenward, M. G. and Roger, J. H. (1997), "Small Sample Inference for Fixed Effects from Restricted Maximum Likelihood," *Biometrics* 53: 983-997 and Littell, R. C., Milliken, G. A., Stroup, W. W., and Wolfinger, R. D.(1996), *SAS System for Mixed Models.* SAS Institute Inc.: New York).

To check the results we reran the models using the 'empirical option' that invokes the sandwich estimator that to obtain more robust estimates.

REFERENCE

(Linear Mixed Models for Longitudinal Data by Geert Verbeke and Geert Molenbergs Springer 2000 NY section 6.2.4).

Sample SAS code appears in Appendix 12-2 SAS Code for Mixed Model.

Relative error is unrelated to the factor 'day'. For the outcome RE(MV) the unadjusted analysis, Kenward-Rogers analysis, and empirical-option analyses assigned p-values to the factor 'day' from 0.71 to 0.79. For RE(TV) the analogous p-values were 0.96 to 0.98. For the outcome log(accuracy) for MV the p-values ranged from 0.75 to 0.82 and for TV from 0.90 to 0.92.

13. On page 20-7, a three subject study is described which the ExSpiron is compared to the SpiroAir-LT in order to determine whether the graphical display can track respiratory curves accurately. Using only three subjects is a small sample size, rendering any generalizations to the entire intended use population questionable. Also, the SpiroAir-LT was used to calibrate the ExSpiron, which may introduce bias. It is also unclear that only the SpiroAir-LT will be used for calibration in routine clinical practice. In addition to addressing these concerns, please provide plots which superimpose the tracings from the SpiroAir-LT and ExSpiron on the same graph, with clear legends that clearly depict the device producing each tracing.

The short study's purpose is only to provide a reasonable validation that ExSpiron's graphical display of time plots works appropriately.

The clinical study with the predicate device demonstrated ExSpiron's measurement performance across a broad subject population for single measurements. Time plots of a collection of single measurements typically do not need a confirmation of accuracy separate from the accuracy of individual measurements.

RMI performed the time plot confirmation with the SpiroAir-LT, a diagnostic spirometer, which is not a predicate for the ExSpiron, but which has a graphic display function. The three-subject

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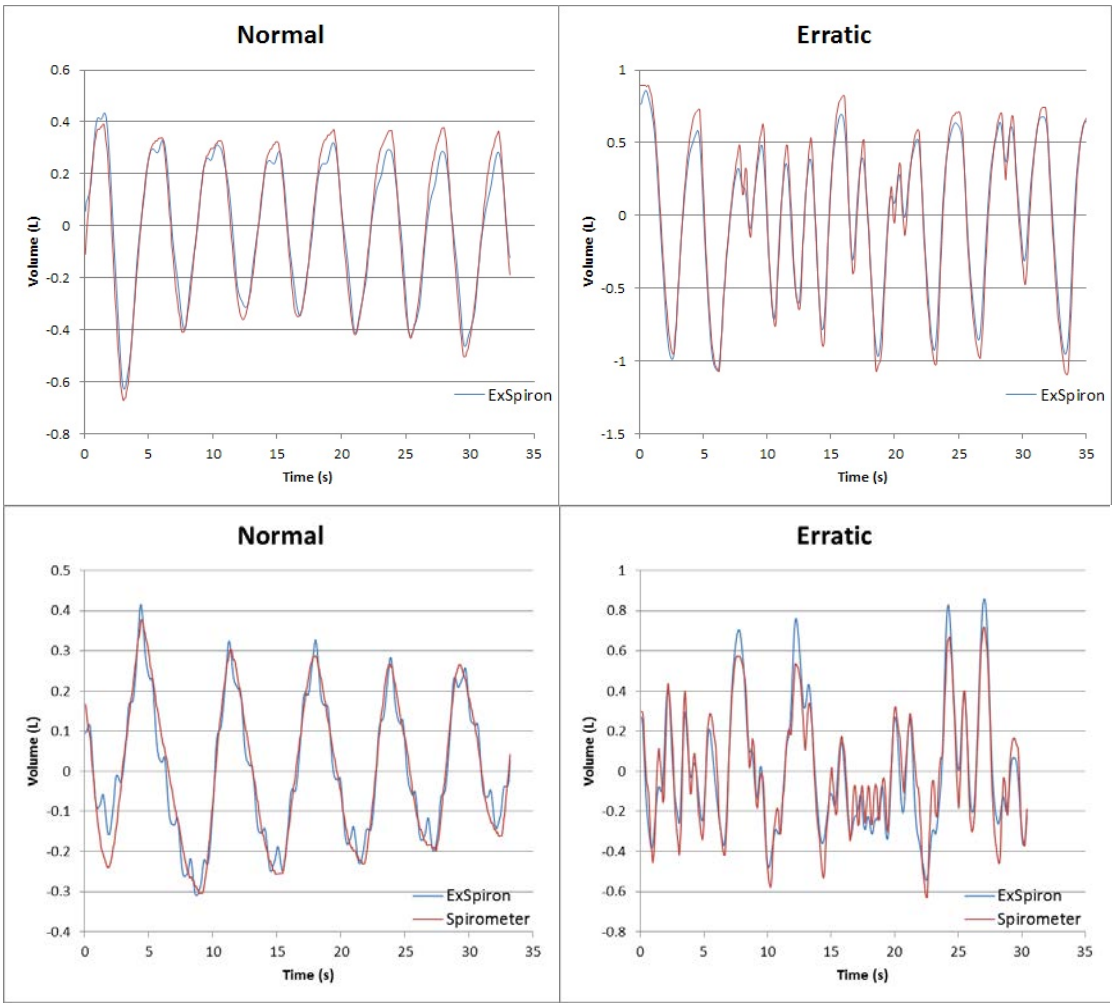
test provided a reasonable validation of a function for which proper performance can be argued based on engineering principles.

Individual patient calibration of the ExSpiron to the SpiroAir-LT is equivalent to the individual patient calibration performed with a spirometer per the User Manual. The validation relies on a visual comparison of the waveforms of produced by the SpiroAir-LT and by the ExSpiron. The comparison shows the expected result, the waveforms are virtually identical. See an example chart in Figure 13-1.



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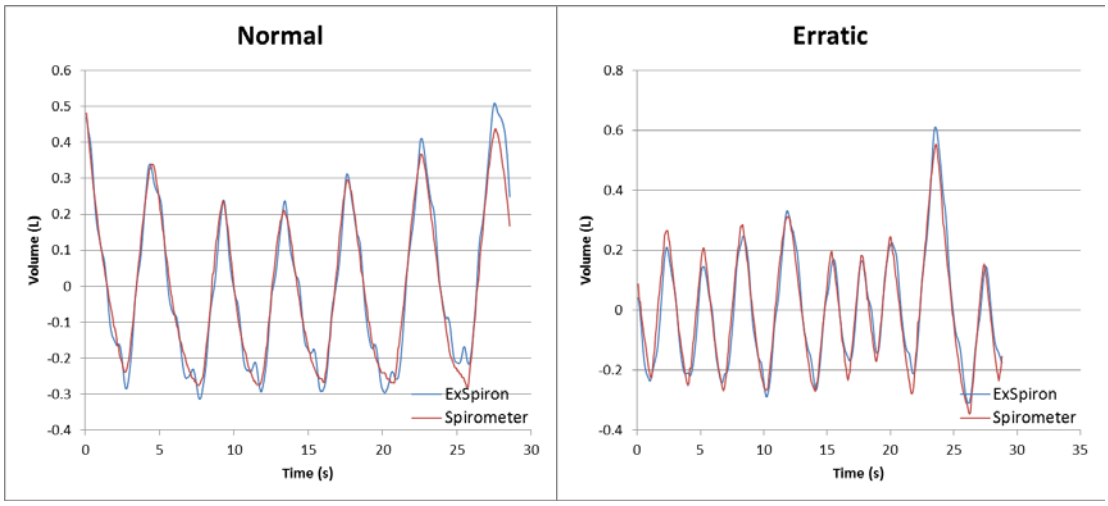

Figure 13-1
Overlays of an ExSpiron and a Spiro-Air LT waveform
(Note: Figure 13-1 spans two pages.)

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14. Please provide Bland-Altman plots comparing the ExSpiron against the Wright Respirometer, separately for each subject and combined. Please see Bland and Altman The Lancet Volume 327, Issue 8476, 8 February 1986, Pages 307–310 for more information about Bland-Altman plots.

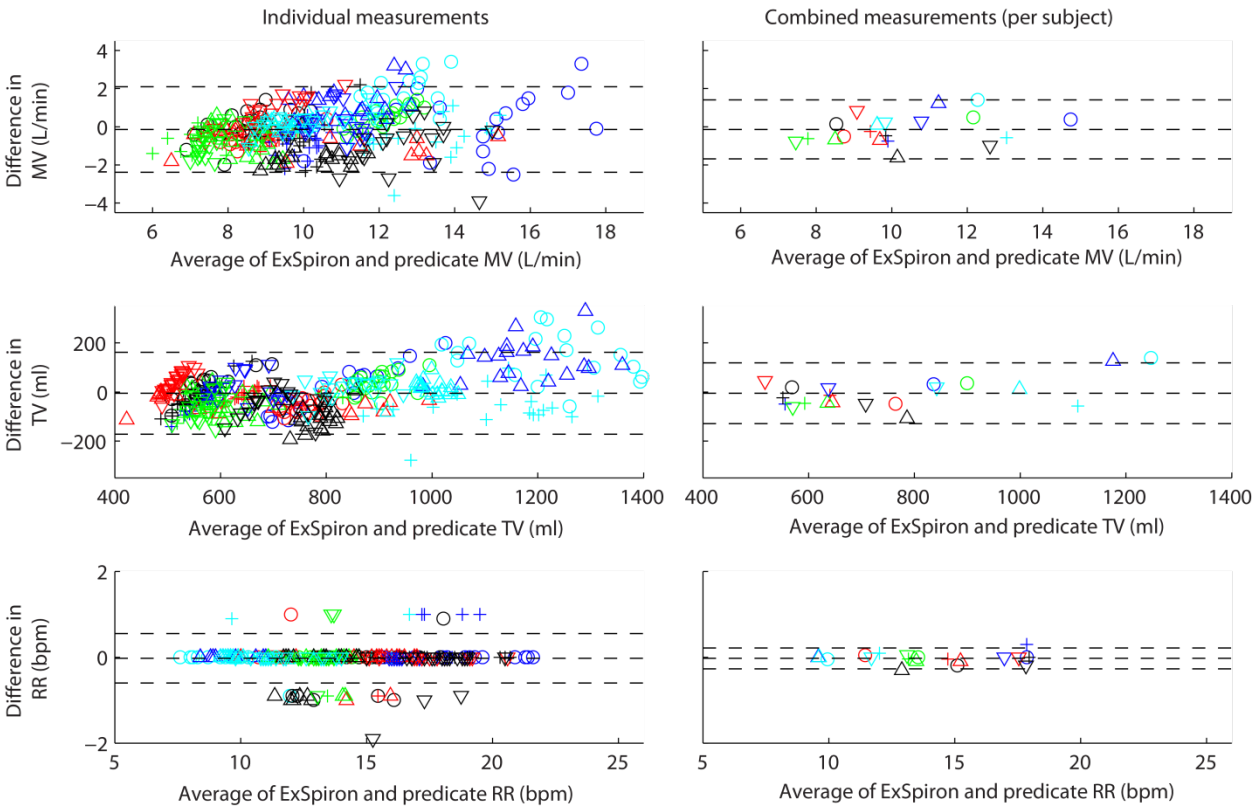

Figure 14-1 Bland-Altman Plots

RMI performed a Bland-Altman analysis of the clinical trial data in the standard fashion, following the guidelines in the Lancet 1986 article. The analyses confirmed that for all three measures the differences between the predicate and ExSpiron are small. The Bland-Altman analyses are consistent with the original analysis in section 20 of RMI's 510 (k). The average disparity between ExSpiron and the predicate device was confirmed to be small and clinically irrelevant (differences of -0.2 bmp, -5ml and -0.14 L/min for RR, TV, and MV, respectively).

RMI calculated the difference between ExSpiron and the predicate device for each measure (MV, TV, and RR) and the average of ExSpiron and the predicate for each measure. Figure 14-1 shows the resulting plots. Data from different subjects are depicted with a different color/symbol combination (i.e. blue plus sign is one subject, cyan plus sign in another subject, blue circle is a third subject, etc.). The left column shows individual data from all subjects and from all trials whereas the right column shows each subject's averaged data. The middle black dashed line on each plot depicts the average difference and the upper and lower black dashed lines indicate the 95% confidence intervals (±2 SD from the mean). Note that the mean differences between devices in all six plots are essentially zero.

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The bottom row shows the measurement difference in respiratory rate (RR). The left chart shows that the majority of the readings are perfectly accurate (difference of 0) and in only 1 trial out of 400 there is a difference between devices of 2 breaths/min. The right chart shows that the averaged measurements are even more similar between the two devices. 95% of the measurement differences are within the range of (-0.27 and 0.22) breaths/min.

The middle row shows the differences in tidal volume (TV) between ExSpiron and the predicate. On the left the individual differences are, on average, off by -5.0 ml (ExSpiron overestimates TV by 5 ml). Note that the 95% of the differences are in the range of (-172 and 162) ml and that this range is enlarged by the relatively larger disparities measured at large TV (greater than 1000ml). While the reported ExSpiron tidal volume measurements are within the clinically acceptable range, in fact, for the more clinically relevant portion of data, 550 ml to 1050 ml (see Lugo G, Casstaneda-Hernandez G. Critical care medicine 1997:25 (5) 806-811), the 95% range is even better (-151 and 114 ml). This range is further improved in the averaged data (right middle panel), showing that 95% of the differences measured are within (-129 and 119 ml). Once again, the largest differences occur at the largest TVs. It is likely that these unusually large tidal volumes were the result of the subject being asked to breathe into the predicate device spirometer for the test.

The top row shows the differences in minute ventilation (MV), which is the product of TV and RR. As such, it is not surprising that the MV disparity is somewhat larger than the RR and TV (the error in MV is affected by errors in both RR and TV). Nevertheless, on average ExSpiron underestimates MV by only 0.14 L/min (140 ml/min) Note that the largest errors are seen at large minute volumes (12-18 L/min) associated with the unusually large tidal volumes described above.

15. The calculation method used for quantifying the bias, precision, and accuracy (shown on page 20-5) is not a standard statistical method. Rather than using the logarithm scale, which could be difficult to interpret, please provide the bias, precision, and accuracy on the original raw measurement scale. If there are important medical or clinical decision points that are used in clinical practice, please incorporate these clinical decision points into the analysis of the ExSpiron against the predicate. These points can be incorporated by calculating sensitivity and false positive rate for the clinical study. To incorporate the correlated measurements (i.e. multiple measurements made on the same subject), please consider using bootstrap. For more information about bootstrap, please see Davison and Hinkley (1997) Bootstrap Methods and Their Application.

As requested, the statistical analysis has been repeated using a Bland-Altman difference error measure, not the logarithm scale. See Appendix 15-1 Statistical analysis of bias, precision, and accuracy.

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Figure 15-1 shows a summary comparison of measurement performance as determined by the Bland-Altman analysis and by the logarithm-based analysis in the original submittal. The results and conclusions of the studies, with the Bland-Altman error variable and with logarithm variable error are virtually identical.

	Log based analysis			Bland-Altman analysis		
	Absolute bias	Precision	Accuracy	Absolute bias	Precision	Accuracy
MV	6.4	7.5	10.2	6.4	7.5	10.1
TV	6.3	7.3	9.9	6.4	7.2	9.9
RR	0.5	1.4	1.5	0.5	1.4	1.5

Figure 15-1
Summary Comparison of Log-based analysis and Bland-Altman analysis

B4 [redacted]

[redacted]

B4 [redacted]

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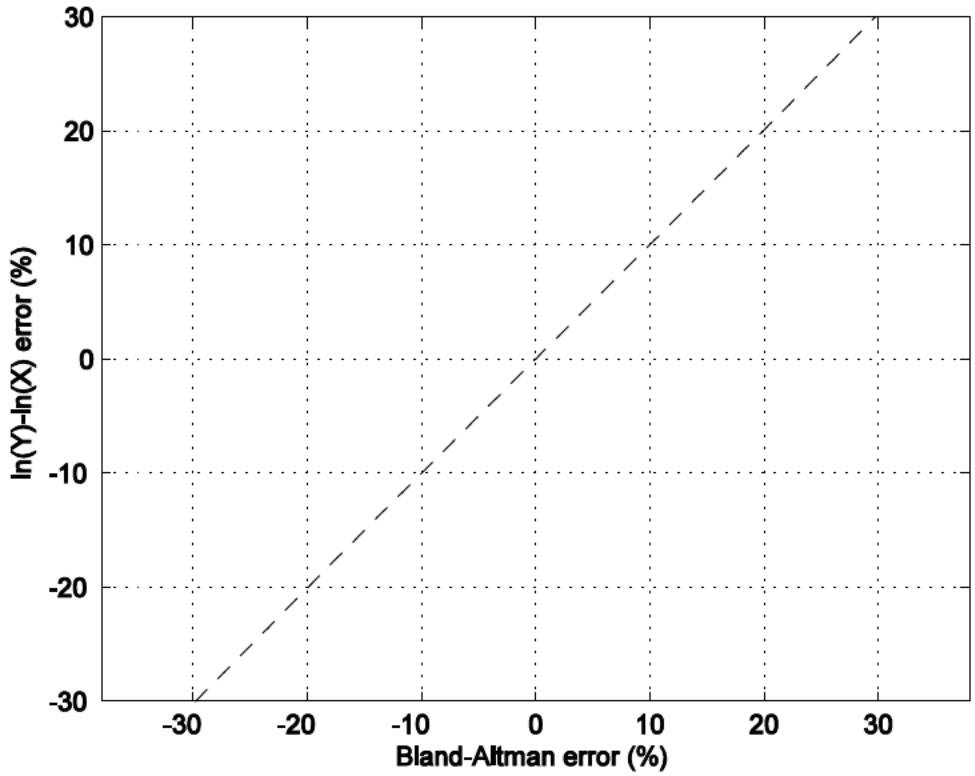
B4

[redacted]

Thus, RMI's log-based error measure is the same as the Bland-Altman error measure to the first order. Plotting the two error measures within the range of 30% error, shows a nearly straight line of equality.



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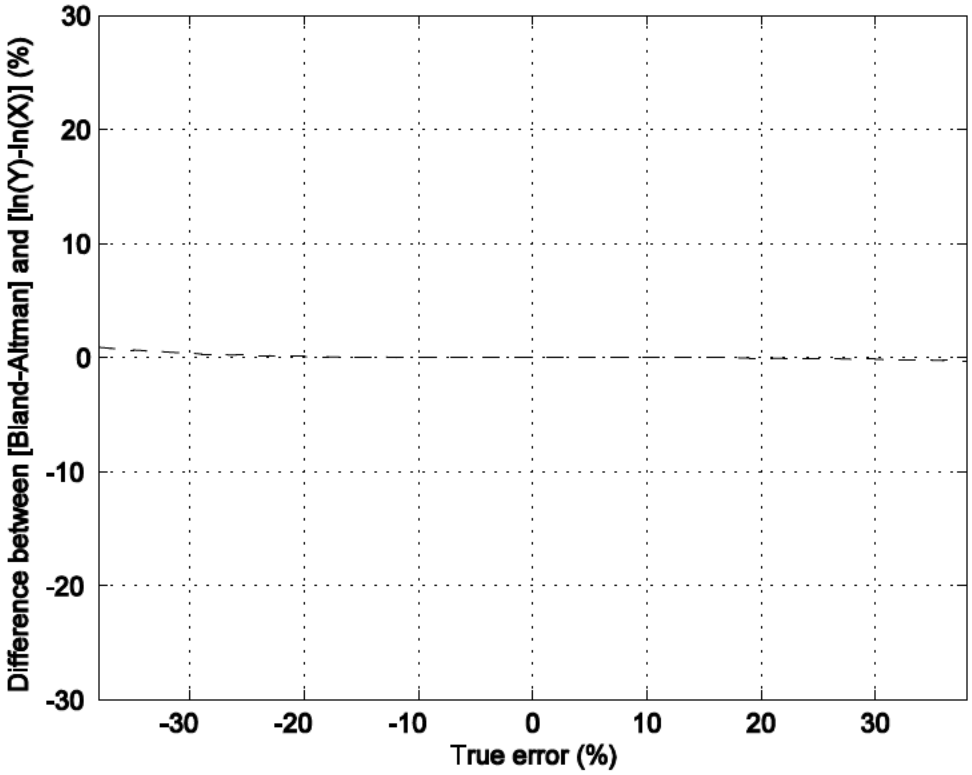
Another way to look at the relationship is a graph of the difference between the log-based error measure and the Bland-Altman error message. The difference is less than 1% for actual errors up to 30%.

Within the range of errors seen in the RMS clinical study, the log-based error measure is virtually identical to the Bland-Altman error measure.



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ExSpiron's intended use is described in the Indications for Use statement:

> *ExSpiron is a non-invasive system that graphically displays lung volume against time and reports an approximate value of:*
> - *Tidal volume,*
> - *Respiratory rate, and*
> - *Minute ventilation.*
>
> *ExSpiron measurements are used as an adjunct to other clinical information sources to determine respiratory status and appropriate therapy.*

There are no medical or clinical decision points implied by this intended use. ExSpiron provides measurement information to be used as an adjunct to other clinical information sources. As a measurement device, ExSpiron is evaluated based on measurement performance, accuracy and precision. Evaluation of diagnosis-specific performance, such as sensitivity and specificity, is inconsistent with the intended use.

16. On page 20-3, you stated that 20 subjects were used for the clinical study. Please provide justification for this sample size From a statistical perspective, it is difficult to understand why this is sufficient.

Questions 10 and 16 both ask for justification of the sample size. Please refer to the response to question 10 above for the justification.

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Appendixes

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2-1	Revised Chapter 9, Reliance on Standards
4-1	Usability Test Record Format
4-2	Revised User Manual
4-3	Training Outline
4-4	Usability Test Results
4-5	Promotional Claims
7-1	MediTrace 850 Foam ECG Radiolucetn Electrodes instruction sheet.
9-1	Subject selection data for each subject
9-2	Subject selection data across all subjects.
10-1	Derivation of the Variance Inflation Factor (VIF)
12-1	Details of bootstrap analysis
12-2	SAS Code for Mixed Model
15-1	Statistical analysis of bias, precision, and accuracy

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Appendix 1-1
Revised Indications for Use Statement

The revised Indications for Use statement is on the next page.

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Indications For Use

510(k) Number (if known): K120087
Device Name: ExSpiron
Indications for Use:

ExSpiron is indicated for use by healthcare professionals in healthcare facilities, such as post-operative care and critical care units, to monitor breathing in adult patients with potential respiratory compromise.

ExSpiron is a non-invasive system that graphically displays lung volume against time and reports an approximate value of:

- Tidal volume,
- Respiratory rate, and
- Minute ventilation.

ExSpiron measurements are used as an adjunct to other clinical information sources to determine respiratory status and appropriate therapy.

Prescription Use ___X____ AND/OR Over-The-Counter Use_____
(Part 21 CFR 801 Subpart D) (Part 21 CFR 801 Subpart C)

(PLEASE DO NOT WRITE BELOW THIS LINE-CONTINUE ON ANOTHER PAGE IF NEEDED)

Concurrence of CDRH, Office of Device Evaluation (ODE)

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Appendix 2-1
Revised Chapter 9, Reliance on Standards

9. Statement Regarding Reliance on Standards

Before ExSpiron is released for commercial shipment, the system will have completed testing to demonstrate conformance to:

> AAMI/ANSI ES 60601-1:2005 Medical electrical equipment – Part 1: General requirement for basic safety and essential performance, (General)
> FDA Recognition Number 5-52
>
> IEC 60601-1-2:2001 with Amendment 1:2004 Medical Electrical Equipment - Part 1-2: General Requirements for Safety - Collateral standard: Electromagnetic Compatibility - Requirements and Tests
> FDA Recognition Number 5-28

AAMI/ANSI ES 60601-1:2005 (USA version of IEC 60601-1 (Third edition))
In particular:

- Class 1 protection against electric shock, operating from a specified supply.
- IPX2 protection against fluid
- Type BF applied part, defibrillator proof
- Continuous duty cycle
- Not suitable for use with flammable anesthetics
- No use of risk management processes in lieu of prespecified performance requirements

IEC 60601-1-2
ExSpiron will comply with Class A emissions and to non-life-supporting levels for immunity.
EMC Standards:

- CISPR 11 / EN 55011 Radiated Emissions
- CISPR 11 / EN 55011 Conducted Emissions
- IEC 61000-4-3 Radiated Immunity
- IEC 61000-4-6 Conducted Immunity
- IEC 61000-4-4 EFT Immunity
- IEC 61000-4-5 Surge Immunity
- IEC 61000-4-2 ESD Immunity
- IEC 61000-4-11 Voltage Dips and Drops
- IEC 61000-4-8 Magnetic Immunity
- IEC 61000-3-2 Voltage Harmonics
- IEC 61000-3-3 Voltage Flicker

Essential performance is the functionality described in the User Manual. This essential performance definition appears in Appendix B Specifications in the User Manual. (See the revised User Manual is Appendix 4-2 of this Additional Information Response.)

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The patient cable and patient leads will conform to FDA's Performance Standard for Electrode Lead Wires and Patient Cables, 21 CFR 898, and to ANSI/AAMI EC53: 1995/(R)2008 – ECG Cables and Wires

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Appendix 4-1 B4 [redacted] **Test Record**

B4 [redacted]

B4 [redacted] **Test Record**

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B4 Test Data

B4 Test Data

B4 Test Data

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Appendix 4-2 Revised User Manual

Changes:	Page in this response
• Revised Indications for Use	39
• Additional Cautions	46
o Extreme respiratory rates	
o Extreme changes in hydration	
• Technical Specifications	56
o Standards	
▪ IEC 60601-1	
▪ IEC 60601-1-2	

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User Manual

ExSpiron™
Respiratory Variation Monitor™ (RVM)

© Respiratory Motion, Inc.

305 Second Avenue, Suite B

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Waltham, MA 02451-1122

General Warning:

DO NOT use this monitor

- for any purpose other than specified in this manual
- if parts are broken or missing
- without reading this user manual

ONLY qualified personnel should use the ***ExSpiron™*** Monitor.

The ***ExSpiron™*** Monitor is NOT a diagnostic monitor. The ExSpiron should be used as an adjunct to other clinical information to determine respiratory status and appropriate therapy.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Contact Information

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Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Table of Contents

To be added.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Introduction

Intended Use

ExSpiron™ is indicated for use by healthcare professionals in healthcare facilities, such as post-operative care and critical care units, to monitor breathing in adult patients with potential respiratory compromise.

ExSpiron™ is a non-invasive monitor that graphically displays lung volume against time and reports an approximate value of:

- Tidal volume,
- Respiratory rate, and
- Minute ventilation.

ExSpiron™ measurements are used as an adjunct to other clinical information sources to determine respiratory status and appropriate therapy.

NOTE: United States regulation restricts this device to sale by or on the order of licensed medical practitioners.

Intended Operators

***ExSpiron*™** is intended to be operated by trained technicians and clinical professionals.

Brief Description of Device

The system includes:

- **ExSpiron™** Data Acquisition System, including patient cable with leads
- Touch screen panel computer (Windows 7® Operating System)
- PC Power Supply
- **ExSpiron™** Disposable Electrode Pads

The ***ExSpiron*™** Disposable Electrode Pads should always be used with the ExSpiron monitor.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Safety Measures

Warnings

WARNING: Electric shock hazard. The ***ExSpiron*™** monitor is to be opened only by Respiratory Motion personnel, their designees, or qualified service engineers. There are no user-serviceable parts inside.

WARNING: Do not autoclave, gas-sterilize, or immerse any portion of the ***ExSpiron*™** monitor. This may create an electric shock hazard or damage internal components.

Cautions

CAUTION: ***ExSpiron*™** disposable electrode sets are designed for single use only and should not be re-used. Reuse may interfere with monitor function. An electrode pad should not be used for more than 24 hours. Recalibrate the ***Exspiron™*** after changing electrode pads. Dispose of electrode pads s per requirements for biohazard waste.

CAUTION: Use only Respiratory Motion ***ExSpiron*™** electrode pad sets with the ***ExSpiron*™** monitor. Use of other electrodes may interfere with monitor function.

CAUTION: Do not use the ***ExSpiron™*** monitor with another bioimpedance measurement system, such as an impedance cardiograph. Such devices may cause functional interference among the bioimpedance systems.

CAUTION: Do not mount or store the ***ExSpiron*™** monitor under an IV bag or other liquids. Fluid leaking onto the monitor may interfere with monitor function and may create an electric shock hazard. (ExSpiron is resistant to the ingress of fluids, with an IPX2 rating. However ExSpiron is not waterproof.)

CAUTION: Before attaching the ***ExSpiron™*** monitor to a medical monitoring pole, ensure that the pole is specified to carry the weight of the ***ExSpiron™*** monitor.

CAUTION: The accuracy of ***ExSpiron*** volume measurements has not been confirmed at very high (> 30 breaths per minute) or very low ($\leq$ 5 breaths per minute) respiratory rates. If a patient has a very high or very low respiratory rate, confirm respiratory status with other clinical information sources.

CAUTION: A very large change in patient hydration may affect the calibration. If a patient experiences a large change in hydration, recalibrate the ***ExSpiron*** monitor.

Precautions

The ***ExSpiron*™** monitor should not be used as the sole basis for diagnosis or therapy. Healthcare professionals should use ***ExSpiron*™** measurements as an adjunct to other clinical information sources to help determine regulatory status and appropriate therapy.

The ***ExSpiron*™** monitor should not be used as an apnea monitoring system.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Cleaning and disinfection

Clean external surfaces of the ***ExSpiron™*** monitor with a cloth dampened with warm water. Cleaning with a mild disinfectant is recommended.

Disposal

Dispose of used electrodes as biohazard waste.

Dispose of used batteries per local or national waste regulations.

At the end of its life, dispose of or recycle the ***ExSpiron™*** monitor per local or national regulations.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Operation

Principles of Operation

Various types of bodily tissue have varying levels of electrical impedance. Impedance is the measure of an object's opposition to carrying an alternate current. Air has far more impedance than any bodily tissue. As an individual inhales and exhales, the movement of air in and out of the lungs sequentially increases and decreases the level of electrical impedance within the thorax. Similar to standard leads that measure respiratory rate, the ***ExSpiron*™** measures changes in impedance by passing a low level alternating constant current through the thorax. Respiratory Motion algorithms are able to correlate directly these changes in impedance with lung volumes. Analysis of the respiratory curve yields three important parameters: tidal volume of each breath, respiratory rate and minute ventilation.

Features of Design

Device Design

The ***ExSpiron*™** monitor is comprised of a set of electronics and standard computer functionality, which collects and analyzes pertinent patient information. ***ExSpiron*™** leads originating from the device connect to ***ExSpiron*™** electrodes placed in predetermined configurations on the patient's skin. Electrode configuration and the monitor user interface are detailed in Sections 2 and 3.

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Electrode Configuration

Electrode configuration is detailed in Figure 1. There are two electrode pads, designated 1 and 2 (Fig. 1). Routine skin preparation following standard hospital procedures should be undertaken before electrode pad placement. The patient's skin should be thoroughly cleansed and failure to do so could interference with the integrity of the ***ExSpiron™*** readings.

Electrode pad 1 should be placed over the sternal notch and extend to the xiphoid process. If necessary, the bottom electrode pad can be torn along the perforated edge to allow for further extension.

Electrode pad 2 should be placed along the right mid-axillary line and horizontally in line with the xiphoid process and bottom electrode of Electrode pad 1.

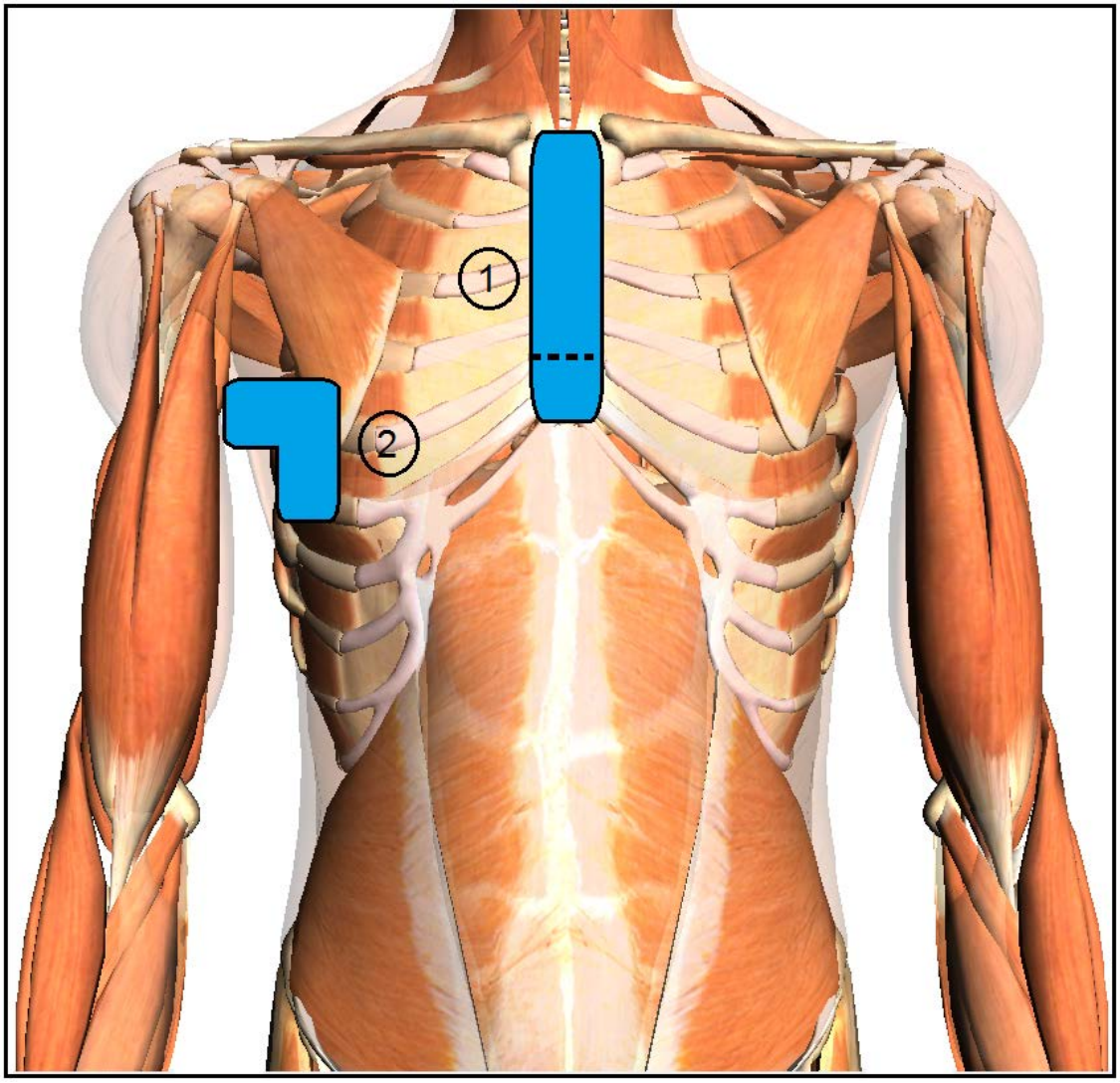

Figure 1 Standard electrode placement diagram.

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Monitor Start-up

1) Plug in the ***ExSpiron*™** monitor.
2) Turn on the monitor via the I/O button.
3) With the monitor turned on, an ***ExSpiron*™** icon will appear on the desktop.
4) Clicking on this icon will launch the graphical user interface and allow for subject data input and data collection.

User Interface

The ***ExSpiron*™** user interface (UI) contains a graphical representation of the respiratory curve, and outputs of three respiratory parameters: minute ventilation (MV), tidal volume (TV), and respiratory rate (RR). When the ***ExSpiron*™** software is launched or a new or different patient is being monitored, the initial starting screen will display only the respiratory curve (Fig 2). No values for MV, TV, or RR will be shown.

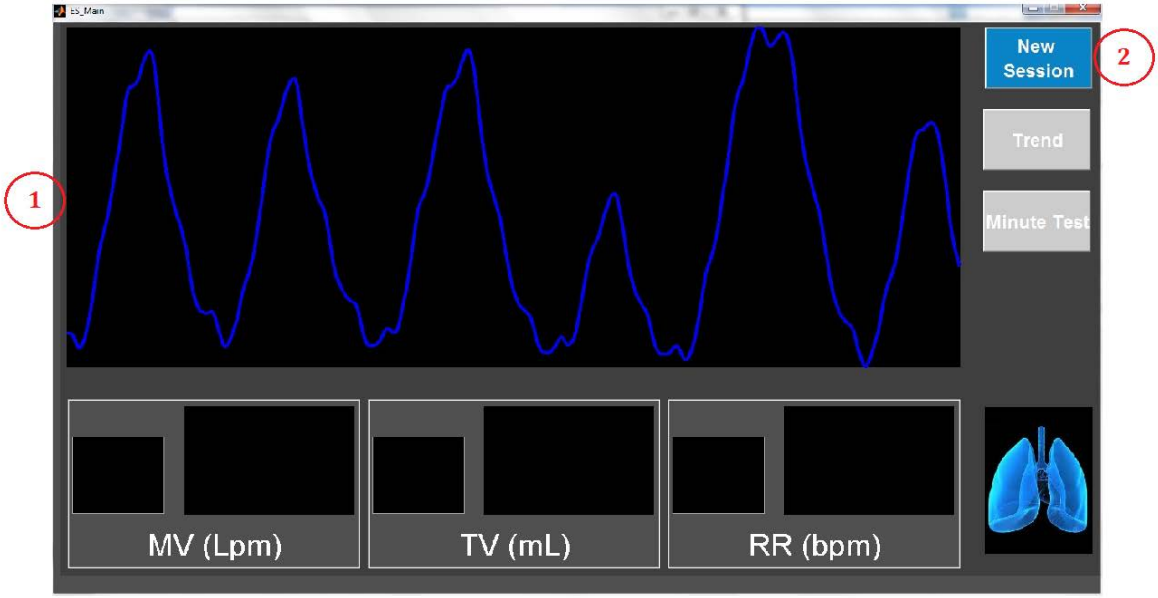

Figure 2 User Interface. The main screen will illustrate the respiratory curve. Navigate the touch screen using the buttons at the right. Beneath the respiratory curve are value boxes and trend curves for the 3 collected respiratory parameters. These will appear empty until a patient has been selected and the device calibrated.

Label	Button/ Field	Function
1	Respiratory Curve	Shows the patient's respiratory curve in real-time.
2	New Session	Brings user to patient ID screen in order to begin monitoring.

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Patient Selection

In order to select a patient for monitoring, the user will be prompted with a patient ID screen (Fig. 3). Enter the patient's ID and click Next to move to the next screen.

Figure 3 Patient ID Input Screen.

Label	Button/Field	Function
1	ID Field	Input the patient's ID.
2	Next	Once the patient's ID is entered, click Next to move to next screen.
3	Cancel	Click to leave the ID screen and return to initial monitoring screen.

Selecting a Calibration Setting for a New Patient

If the patient database does not recognize the patient ID, the new patient calibration screen will be shown (Fig. 4). Enter the fields listed; all are required. New Calibration is the only option for a new patient. Height, weight, and the calibration information used on the next screen will constitute that particular calibration, and it will be stored under the current date. Clicking Next will create a patient record and bring the user to the calibration screen.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

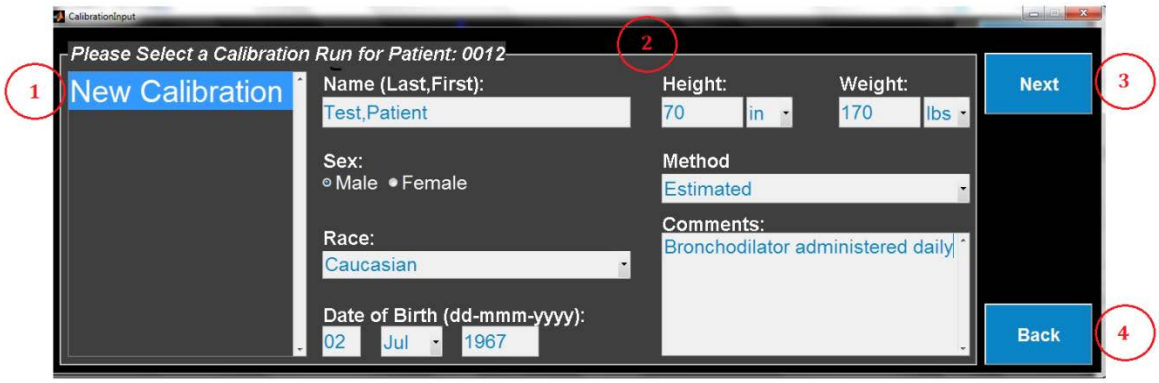

Figure 4 Patient Selection User Interface. Items on the user interface for patient selection.

Label	Button/ Field	Function
1	New Calibration	This will be the only option for a new patient.
2	Required Information	All fields are required. Those listed on the left (name, sex, race, date of birth) cannot be edited after initial entry. Those fields on the right (height, weight, method, comments) can be edited. Method is a dropbox containing options for "estimated" or "measured". Pick one in order to designate the method that was used for acquiring height and weight.
3	Next	Brings user to calibration screen.
4	Back	Brings user back to the initial monitoring screen.

The calibration screen will prompt the user to click Start and begin collecting data for minute ventilation or tidal volume and respiratory rate (Fig. 5). The fields on the right will remain disabled until the collection period is over and the progress bar shows that data acquisition is complete. At that time, the user can input the collected parameter(s) and click Next to go to the calibrated monitoring screen.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

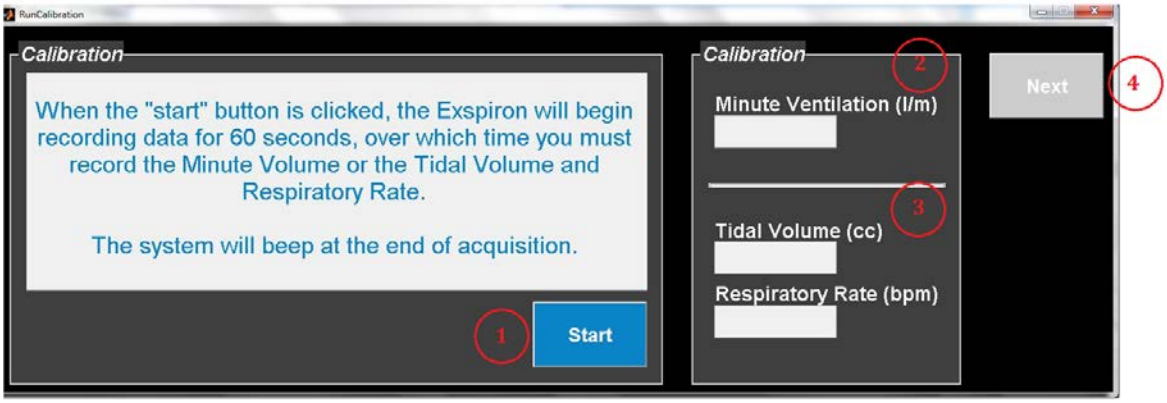

Figure 5 Calibration screen. After inputting the calibration parameters, the ExSpiron will start acquiring data.

Label	Button/Field	Function
1	Start	Begin collecting data for calibration (60 seconds).
2	Minute Ventilation	User can enter the calculated minute ventilation for calibration.
3	Tidal Volume & Respiratory Rate	User can enter tidal volume and respiratory rate for calibration.
4	Next	Brings user to monitoring screen; remains disabled until calibration has completed.

Selecting a Calibration Setting for an Existing Patient

The default screen is used for selecting existing patients (Fig. 6). The data entry fields become available when the operator selects a patient by clicking on an entry in the Patient List. Refer to the list below to navigate the Patient Selection UI.

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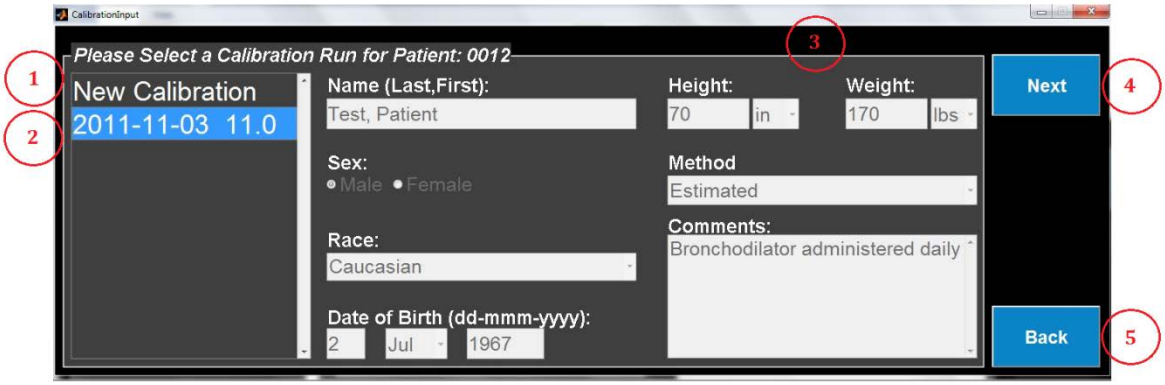

Figure 6 Calibration Selection for Existing Patient.

Label	Button/Field	Function
1	New Calibration	Selecting this for an existing patient allows the user to create a new calibration setting.
2	Existing Calibration Setting	Existing calibration settings are listed by date and minute ventilation. Select one to set calibration to that setting.
3	Changeable fields	In creating a new calibration setting, the user can edit the height, weight, method, and comments fields.
4	Next	Brings user to calibrated monitoring screen.
5	Back	Returns user to initial monitoring screen.

Navigating the Monitoring Session

After the desired patient has been selected, the user will be brought to the monitoring screen (Fig. 7). The graphs will automatically populate with the calibrated respiratory curve and values and trends for TV, RR, and MV. The buttons at the right allow the user to navigate away from the monitoring screen, either to start a new monitoring session, view trends, or the run minute-long tests.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

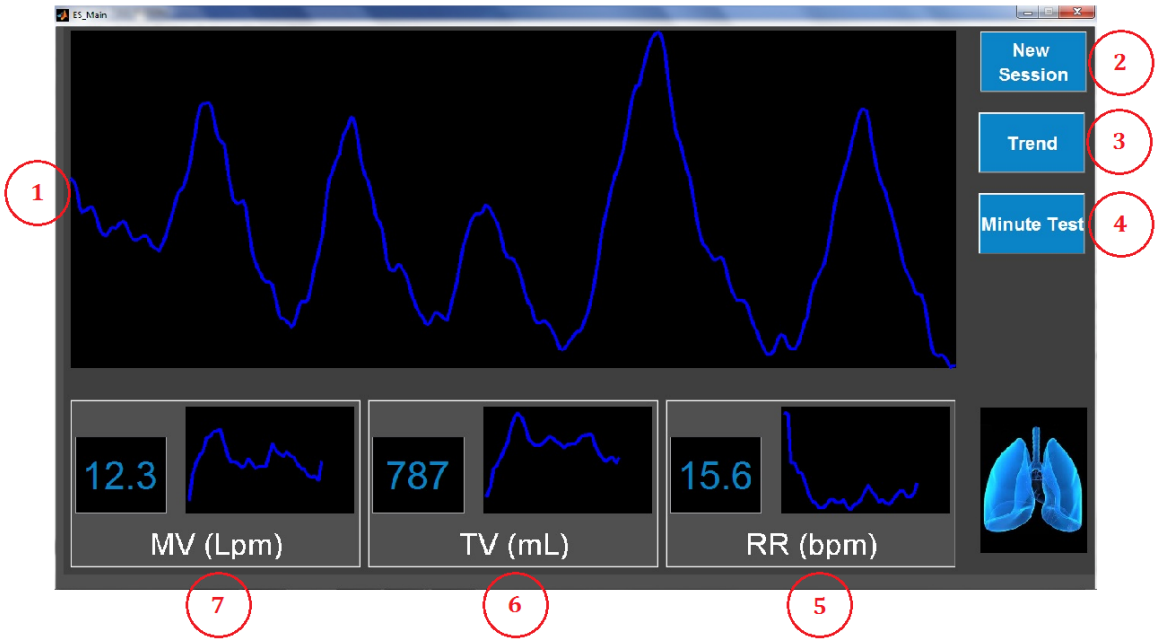

Figure 5 Monitoring Screen. Displays the calibrated respiratory curve and parameters.

Label	Button/Field	Function
1	Respiratory Curve	Tracks current respiratory curve in near real-time in 30-second blocks.
2	New Session	Allows the user to select a new or different patient for monitoring.
3	Trend	Brings user to trending screen.
4	Minute Test	Allows user to run discrete 60-second tests.
5	Respiratory Rate (RR)	Demonstrates graphical representation of RR over the past 60 minutes and provides current RR value.
6	Tidal Volume (TV)	Demonstrates graphical representation of TV over the past 60 minutes and provides current TV value.
7	Minute Ventilation (MV)	Demonstrates graphical representation of MV over the past 60 minutes and provides current MV value.

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Reviewing Patient Trends

The "Trends" tab graphically displays sequential measurements captured within the twenty-four hours of the current session (Fig. 7). Clicking this tab changes the display to show plots for respiratory rate, minute ventilation, and tidal volume. Above the plots is a dropdown menu which is used to select the time interval for the data in the table. Above the trending graphs is a horizontal scroll bar representing time. Move the scroll bar left or right to look at trends throughout the patient's monitoring period. Above the scroll bar is a schematic illustrating in blue when periods of ***ExSpiron***™ monitoring.

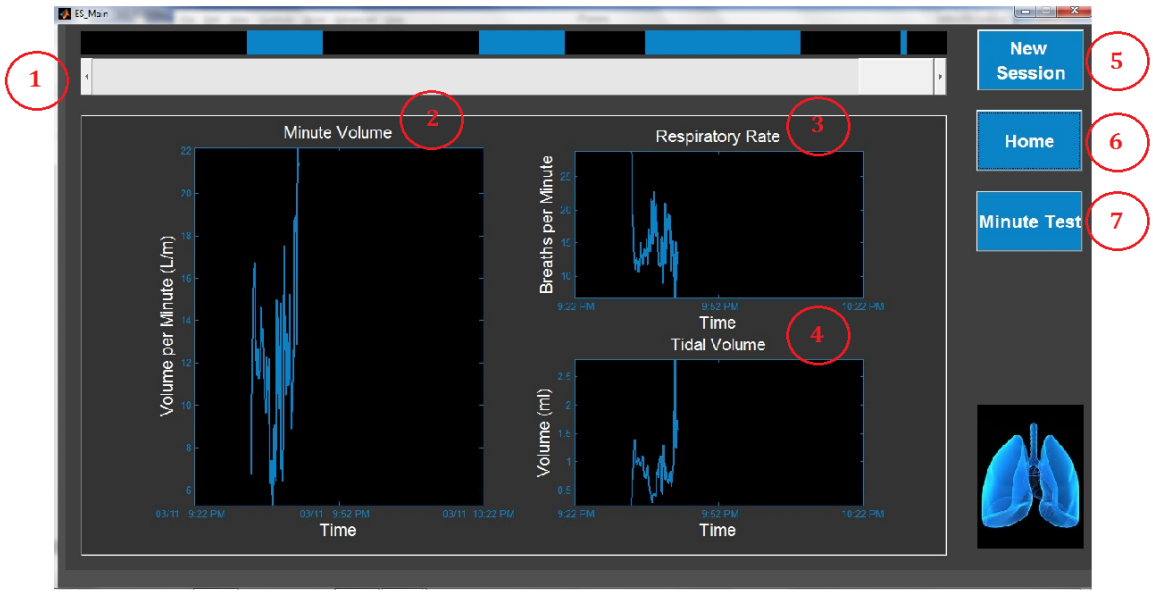

Figure 6 The Trends Tab. Respiratory rate (RR), minute volume (MV), and tidal volume (TV) trends graphs are plotted versus time.

Label	Field	Function
1	Scroll Bar	Moving the scroll (corresponds with time) will display trending graphs for those time periods.
2	MV Trending Graph	MV trends over 60 minutes.
3	RR Trending Graph	RR trends over 60 minutes.
4	TV Trending Graph	TV trends over 60 minutes.
5	New Session	Brings user back to patient ID screen.

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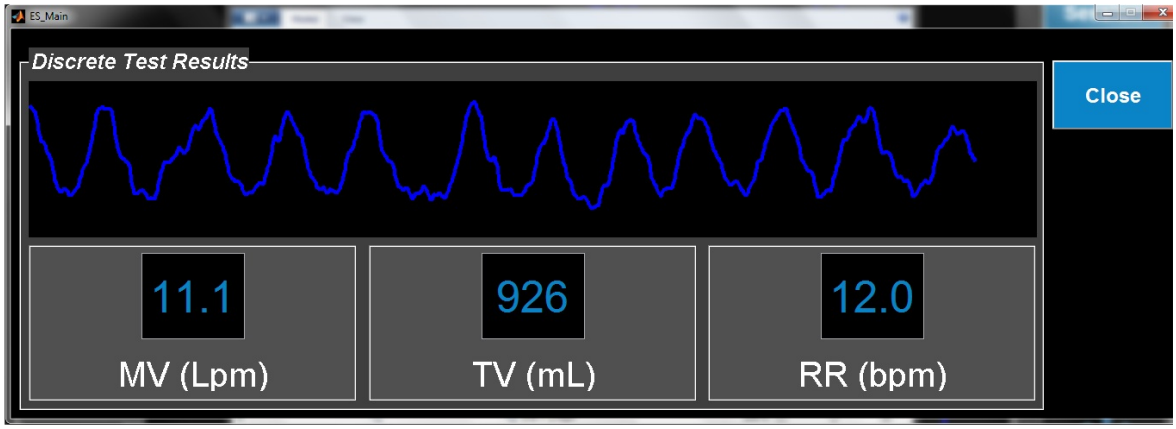
6	Home	Brings user back to the monitoring screen.
7	Minute Test	Allows user to run discrete 60-second tests.

Performing Minute Tests

Clicking on the Minute Test button will temporarily disable the monitoring screen. The progress bar demonstrates that the ***ExSpiron*™** is collecting data for 60 seconds. After the minute test has completed, the results are given as shown below. Click Close to exit the results screen and return to the regular monitoring screen.



Clinical Procedure

The following flow chart details the general procedure for clinical use of the ***ExSpiron*™**.

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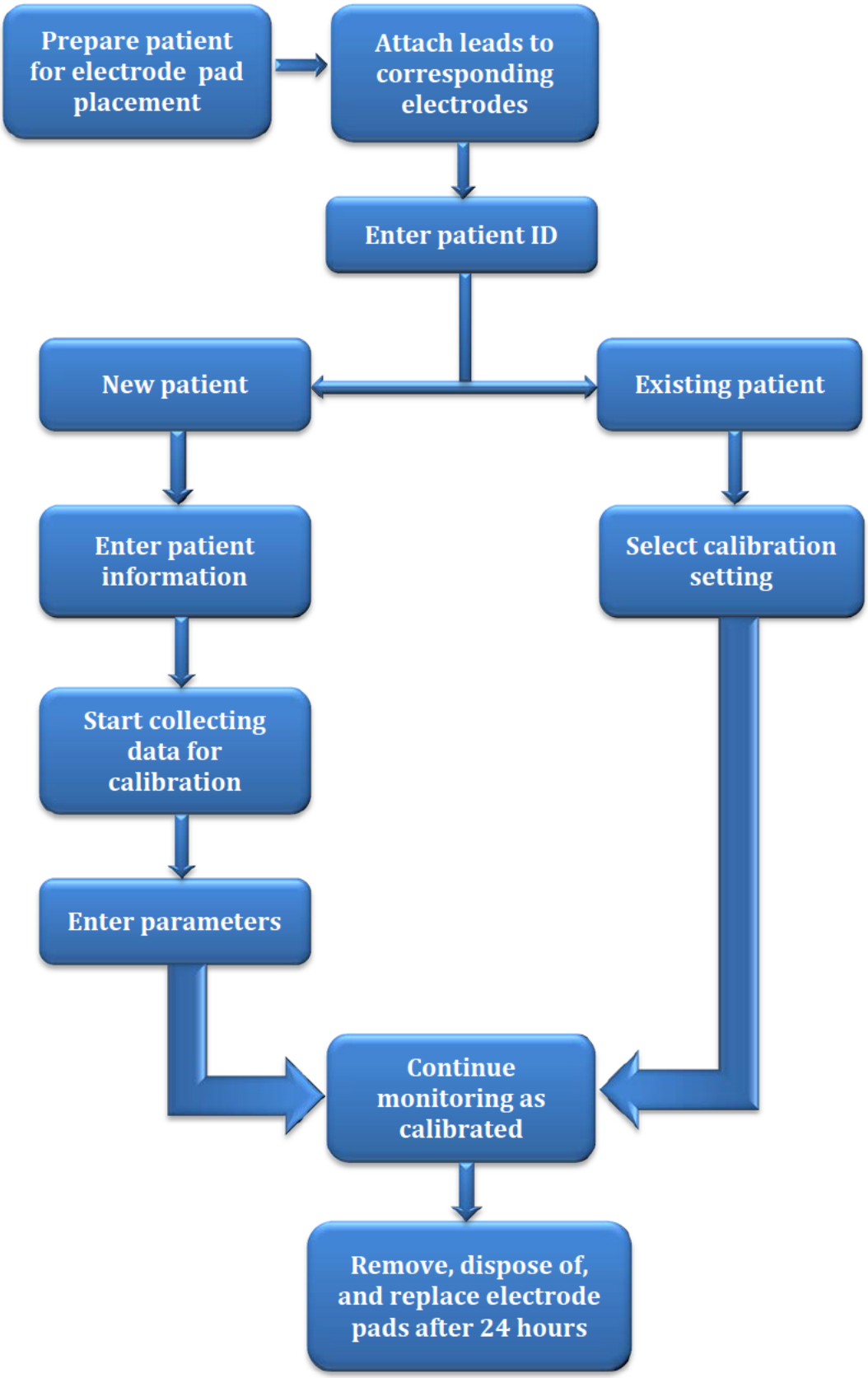

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Figure 7 Clinical Procedure Flow Chart. Start from patient selection to work through a complete monitoring session.

Signal Quality

Lack of adequate signal quality can result in a "flat line" displayed on the panel screen. Flat lining can be a result of the following:

- Electrodes that are not in full contact with the patient's skin. Replace the electrode pads with new ones and record the event. Hair and sweat can affect the ability of the electrode pads to stick to the skin. Routine hospital preparation for electrode placement, such as abrasive cleansing or shaving of the area should be followed to avoid issues such as these. Electrodes are to be used no longer than 24 hours, but can be replaced sooner when necessary.
- Leads that are not properly attached to the electrodes. Check lead-electrode attachment.
- Incorrect matching of electrode to lead. Check that the correct colored lead is attached to the correct electrode.
- Poor signal quality. Check that electrodes were attached in correct configuration. Anatomical differences can also cause poor signal quality.

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Understanding ExSpiron Readings

The following information should be used as informational purposes only and not for use of the ***ExSpiron*™** as a diagnostic tool.

Respiratory Rate

Respiratory Rate is defined as the number of breaths per minute. Respiratory Rate can be classified as normal, abnormally fast (tachypnea), abnormally slow (bradypnea), or nonexistent (apnea).

Tidal Volume

Tidal Volume is the total volume of air displaced between normal inspiration and expiration when extra effort is not applied.

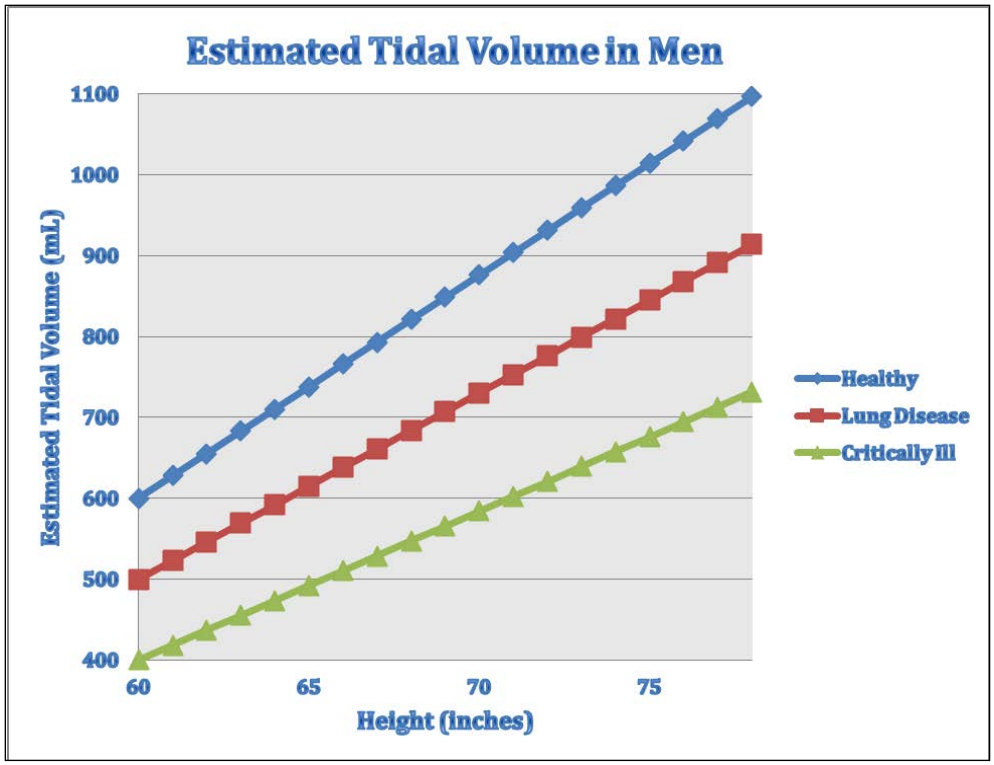
Minute Ventilation

Minute Ventilation is the total volume of air displaced between normal inspiration and expiration over the duration of one minute. It can also be calculated as the product of tidal volume X respiratory rate.

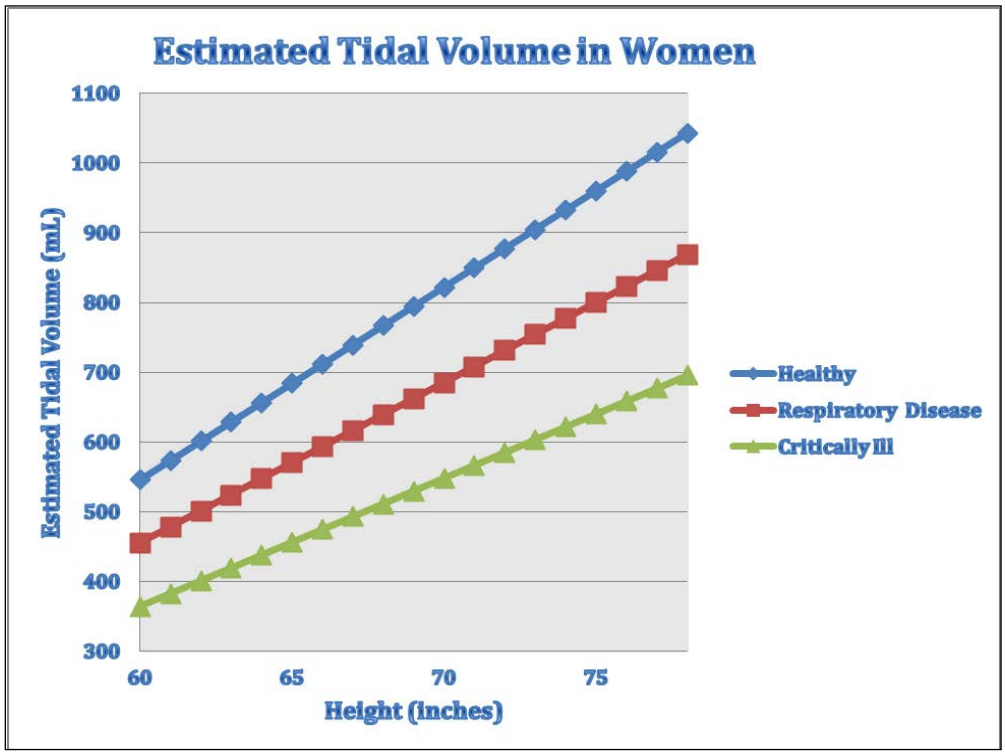
Table 1 Normal Ranges of Respiratory Parameters.

Value	Normal Range	Description
Respiratory Rate	12-18 breaths/min	Breaths per minute
Tidal Volume	Dependent on gender and height. See graphs and tables below.	Milliliters per single breath
Minute Ventilation	RR x TV	Liters of aired breathed in one minute

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118



Graph 1 Estimated tidal volume in men based on height.



Graph 2 Estimated tidal volume in women based on height.

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Appendix A Accessories

Accessory	Model #
Exspiron™ Disposable Electrode Pads	200-010
Exspiron™ Power Supply	200-020

Appendix B Specifications

Size	Computer Module	11.9" (H) x 8.7"(W) x 1.7" (D) 6.5" (H) x 4.5" (W) x 1.5" (D)
Weight		(Less than ten pounds)
Operating conditions		32° – 95° F 20% - 80% non-condensing humidity
Storage and transport conditions		-4° – 112° F 20% - 80% non-condensing humidity

The ***Exspiron™*** Power Supply is a switching power supply with input range:
100-240 V ~ 47-63 Hz 1.35 A

Standards compliance:

- IEC 60601-1 :2005
  - Class 1 protection against electric shock.
  - IPX2 protection against fluid ingress
  - Type BF applied part, defibrillator proof
  - Continuous duty cycle
  - Not suitable for use with flammable anesthetics

- IEC 60601-1-2: 2001
  - Class A Emissions

  Essential Performance: In the event of a disturbance, such as defibrillation, the system may require a reboot, which takes less than 90 seconds.

- FCC Certification

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Appendix 4-3 User Training Outline

User training is led by an experienced user of the ExSpiron.

Introduction and User Manual

1. B4 [redacted]

B4 [redacted]

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

B4

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Appendix 4-4 Useability test data

B4

[redacted]

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B4 Test Data

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Appendix 4-5 Promotional Claims

Promotional claims

Promotional labeling for the ExSpiron monitor will include these claims:

- ExSpiron can monitor breathing in adult patients with respiratory compromise or potential respiratory compromise.
- ExSpiron assists in monitoring at-risk patients.
- ExSpiron is non-invasive, point-of-care, and quantitative.
- ExSpiron provides quantitative measurement of:
  - Minute Ventilation (MV)
  - Tidal Volume (TV)
  - Respiratory Rate (RR)
- ExSpiron displays measurement values both numerically and graphically, displaying trend data.
- MV, TV, and RR are important parameters for assessment of respiratory status. ExSpiron helps improve the standard of respiratory monitoring because it displays MV, TV, and RR over time. Changes in values over time can be compared.
- ExSpiron reports measurement in a user-friendly format.
- ExSpiron is easy to use.
- ExSpiron, as a bioimpedance monitor, does not require a breathing device, e.g., a spirometer, in the breathing path to obtain MV and TV.
- ExSpiron does not require participation of the patient to generate spirometry-like results.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Appendix 7-1 B4 [redacted]

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B4, B6 Testing Data

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B4, B6 Testing Data

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RESPIRATORY MOTION INC.
INSPIRED INNOVATION

K120087 - A002

411 Waverley Oaks Road • Building 1, Suite 150 • Waltham, MA 02452 • (781) 373-1636 • www.respiratorymotion.com

May 9, 2013

U.S. Food and Drug Administration
Center for Devices and Radiological Health
Document Control Center (WO66-G609)
10903 New Hampshire Avenue
Silver Springs, MD 20993-0002

Re: ExSpiron 1Xi Special 510(k) K130170 (pending) ; ExSpiron 1Xi K120087

To the Document Control Office:

Respiratory Motion Inc, has moved.

Please change the address for K130170 and K120087 to:

Respiratory Motion, Inc.
411 Waverley Oaks Road
Building 1, Suite 150
Waltham, MA 02452

Our phone and fax numbers stay the same:
(781) 373-1636 Phone
(781) 373-1653 Fax

Email communication is to me as noted below and to Jenny Freeman at jenny.freeman@respiratorymotion.com. Those details also have not changed.

Sincerely,

Shelby Morss
Manager, Quality Systems
Respiratory Motion Inc.
305 Second Avenue, Suite B
Waltham, MA 02451
shelby.morss@respiratorymotion.com

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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INSPIRED INNOVATION

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K120087-A002

FDA CDRH DMC
MAY 13 2013
Received

May 9, 2013

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Sincerely,

Shelby Morss

Shelby Morss
Manager, Quality Systems
Respiratory Motion Inc.
305 Second Avenue, Suite B
Waltham, MA 02451
shelby.morss@respiratorymotion.com

63

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(781) 373-1653 Fax

Email communication is to me as noted below and to Jenny Freeman at jenny.freeman@respiratorymotion.com. Those details also have not changed.

An ecopy of this letter is attached. The ecopy is an exact duplicate of the paper copy.

Sincerely,

Shelby Morss
Manager, Quality Systems
Respiratory Motion Inc.
305 Second Avenue, Suite B
Waltham, MA 02451
shelby.morss@respiratorymotion.com

Attachment: ecopy CD

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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KM
FDA CDRH DMC
SEP 21 2012
Received

K120087/A2
DAGFD/MN

Respiratory Motion, Inc.
305 Second Avenue, Suite B
Waltham, Massachusetts 02451

U.S. Food and Drug Administration
Center for Devices and Radiological Health
Document Mail Center – WO66-G609
10903 New Hampshire Avenue
Silver Spring, MD 20993-0002
September 20, 2012

Office of Device Evaluation:

Subject: Response to September 20 Request for Additional Information for 510(k) 120087

Respiratory Motion, Inc. (RMI) is submitting this response to FDA's request for additional information, dated September 20, 2012. The response in the enclosed pages includes concise answers and attachments for detailed information.

RMI accepts all comments and believes that the attached response addresses all remaining FDA concerns.

RMI is enclosing a CD with a pdf file containing this cover letter, the response, and its attachments. The paper copies are printed from this pdf file. The contents of the paper copy and the pdf file are identical.

Respectfully,

Chas Burr

Chas Burr
510(k) Correspondent for Respiratory Motion, Inc.

cc: Jenny Freeman, MD, President Respiratory Motion, Inc.
Encl.: CD with pdf file of Response to Request for Additional Information, with attachments

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Response to September 20 Request for Additional Information
510(k) K120087 ExSpiron Respiratory Monitor
Respiratory Motion, Inc. (RMI)

FDA's questions are shown in *italics*.

1. *In your 510(k) Summary page, you stated that the Morgan Spirometer is the "gold standard". However, the Morgan Spirometer is not the "gold standard" because it cannot be used as a continuous monitor. Your proposed device is intended to be used as a continuous monitor. Thus Morgan Spirometer is not an appropriate direct comparator to your proposed device. Please remove your claim that the Morgan Spirometer is the gold standard from your submission. Please provide updated copies of 510(k) Summary page and labeling.*

RMI will no longer claim that the Morgan Spirometer is a "gold standard." A revised 510(k) Summary is found in Appendix 1. It contains a revised description of clinical testing, as well as other changes described in this response. A revised User Manual is found in Appendix 2. It contains a revised description of clinical testing, as well as other changes described in this response.

2. *In your Indications For Use (IFU) statement, you stated that your proposed device can "monitor breathing in patients with potential respiratory compromise". However, your clinical study did not identify or evaluate specific respiratory compromises in patients. Therefore, please remove the statement "with potential respiratory compromise" from your submission. Please provide updated IFU statement page, 510(k) Summary page, and labeling.*

RMI is removing "with potential respiratory compromise" from its IFU. A revised Indications for Use form is found in Appendix 3. A revised 510(k) Summary is found in Appendix 1. A revised User Manual is found in Appendix 2.

3. *In your Indications For Use (IFU) statement, you stated that the measurements from your proposed device are used "to determine respiratory status and appropriate therapy." However, your proposed device is a monitor and not a diagnostic device. In addition, you did not provide clinical study that evaluates how the user used your proposed device to determine respiratory status and appropriate therapy. Therefore, please remove the statement "to determine respiratory status and appropriate therapy" from your submission. Please provide updated IFU statement page, 510(k) Summary page, and labeling.*

RMI is removing "to determine respiratory status and appropriate therapy" from the Indications for Use. A revised Indications for Use form is found in Appendix 3. A revised 510(k) Summary is found in Appendix 1. A revised User Manual is found in Appendix 2.

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4. *You provided promotional claims in Appendix 4-5. However, you made clinical claims about your proposed device without providing supporting evidence from your clinical study. Therefore, please remove the clinical claims identified below from your promotional claims. Please provide updated promotional claims for review.*

    a. *You stated that "ExSpiron can monitor breathing in adult patients with respiratory compromise or potential respiratory compromise." However, your clinical study did not identify or evaluate specific respiratory compromises in patients.*

    b. *You stated that "ExSpiron assists in monitoring at-risk patients in near real-time." However, your clinical study did not identify or evaluate specific at-risk patients.*

    c. *You stated that "ExSpiron helps improve the standard of respiratory monitoring because it displays MV, TV, and RR over time." However, your clinical study did not evaluate how your proposed device improved the standard of respiratory monitoring.*

    d. *You stated that "ExSpiron can help physicians identify patients with inadequate breathing." However, your clinical study did not evaluate how your proposed device helped care providers identify patients with inadequate breathing.*

    e. *You stated that "ExSpiron can assist physicians' decision-making by providing respiratory status data." However, your clinical study did not evaluate how your proposed assisted care providers in their decision making process.*

5. *In your promotional claims in Appendix 4-5, you stated that "ExSpiron is easy to use." You conducted usability testing on 10 test subjects. However, the test reports provided limited granularity regarding user task performance and limited user commentary regarding ease of use. Therefore, please remove the claim "easy to use" from your submission. Please provide updated promotional claims.*

RMI accepts FDA's changes to the promotional claims. A revised list of promotional claims is in Appendix 4.

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Appendixes

1	Revised 510(k) Summary
2	Revised User Manual
3	Revised Indications for Use Statement
4	Revised Promotional Claims

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Appendix 1
Revised 510(k) Summary

The revised Indications for Use statement is on the next page.

The changes are:

- Removal of "with potential respiratory compromise" and "to determine respiratory status and appropriate therapy" from the Indications for Use
- Removal of references to the "gold standard" in the Clinical Performance Testing section

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510(k) Summary

510(k) Owner:	Respiratory Motion, Inc.
Address:	305 Second Avenue, Suite B Waltham, Massachusetts 02451
Phone:	781-373-1636
Fax:	781-373-1653
Contact person:	Jenny Freeman, MD
Date 510(k) Summary prepared:	September 20, 2012
Trade name:	ExSpiron™
Common name:	Respiratory Monitor
Classifications:	Monitoring spirometer Product code: BZK Regulation: 21 CFR 868.1850 Breathing frequency monitor Product code BZQ Regulation: 21 CFR 868.2375
Predicate devices:	For product code BZK, nSpire Wright/Haloscale Respirometer, marketed by nSpire Health, Inc. of Longmont, CO 510(k) K091853 For product code BZQ, Philips MPn0 Intellivue Patient Monitors, marketed by Philips Healthcare 510(k) K060541
Device Description:	The ExSpiron™ consists of: • **Bioimpedance measurement system**: A stabilized high frequency current generator is connected to two outer electrodes. The inner four electrodes are connected to an adaptive circuit that conditions the resulting voltage signal and converts it to digital form. Firmware performs signal acquisition and relays data to the panel PC. • **Panel PC**: A Windows 7 PC performs signal processing and calibration, and runs the graphical user interface (GUI). The PC takes user input from a touch screen through a virtual keyboard and mouse. The GUI is used for recording patient data and displaying the respiratory trace as well as scalar values and trends for minute volume, tidal volume, and respiratory rate. • **Single Patient Use ExSpiron™ Electrode Lead Set:** An electrode lead set containing six electrodes to be placed on the torso. It delivers current and records impedance measurements. The electrode lead set is also used to perform subsystem checks prior to patient measurements.

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Intended use:	ExSpiron™ is indicated for use by healthcare professionals in healthcare facilities, such as post-operative care and critical care units, to monitor breathing in adult (at least 21 years old) patients. ExSpiron™ is a non-invasive system that graphically displays lung volume against time and reports an approximate value of: • Tidal volume, • Respiratory rate, and • Minute ventilation ExSpiron™ measurements are used as an adjunct to other clinical information sources.
Comparison of technological characteristics:	

Characteristic	ExSpiron™	nSpire	Philips Intellivue Monitor	Comment
Intended Use	See above	See K091853	See K060541	The clinical application of the ExSpiron™ is equivalent to that of the nSpire The comparison to the intended use of the Philips monitor is restricted to monitoring of respiration rate ExSpiron™ has no alarm function All devices are used by healthcare professionals
Technology	Measurement is by thoracic bioimpedance	Measurement is by in-line turbine flow meter	Measurement is by bioimpedance	
Volume Measurements	Tidal volume Minute volume Volume vs time chart	Tidal volume Minute volume	None	The time function for the minute volume measurement of the nSpire is provided by a user's stopwatch
Rate Measurements	Respiratory rate (breaths/min)	None	Respiratory rate	
Safety	IEC 60601-1, including electrical and mechanical safety	Mechanical only Safety specifications are not given in the user manual or 510(k) summary	IEC 60601-1, etc	

Nonclinical performance testing:	Performance testing confirmed essential performance by IEC 60601-1 and IEC 60601-1-2 tests and confirmed usability by simulated use by physicians and nurses representative of intended users.

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Clinical performance testing:

A clinical study compared simultaneous measurements from the ExSpiron and the predicate, Wright spirometer. (Respiratory rate was calculated using a stop watch.) Twenty subjects representing a broad range of intended patients participated in the study. (Age range: 20-84, BMI range: 19.9-43.2, 11 female, 9 male) The study involved two sessions for each subject, an initial session in which electrodes were applied, the ExSpiron was calibrated to the individual, and each subject performed ten 60-second breathing tests. Tidal volume, minute ventilation, and respiratory rate were measured simultaneously by the ExSpiron and the Wright spirometer. Each subject returned twenty-four hours after the first session with the original electrodes still attached. Using the same individual calibration values, a second set of ten 60-second breathing tests was performed.

The results of ExSpiron-Wright study were:

ExSpiron-Wright		**Minute Ventilation**	**Tidal Volume**	**Respiratory Rate**
Bias	**Overall**	**-2.1%**	**-1.9%**	**-0.2%**
	Day 1	-2.3%	-1.7%	-0.6%
	Day 2	-1.9%	-2.0%	0.2%
Precision	**Overall**	**10.5 %**	**10.3 %**	**2.0 %**
	Day 1	10.2%	9.7%	2.3%
	Day 2	10.8%	10.8%	1.6%
Accuracy	**Overall**	**10.7 %**	**10.4 %**	**2.0 %**
	Day 1	10.4%	9.8%	2.4%
	Day 2	10.9%	11.0%	1.6%

The results indicate that the individual calibration is stable over a 24-hour period.

A similar study was performed comparing the Wright spirometer to the Morgan SpiroAir LT diagnostic spirometer. (The closed cell construction of the Morgan spirometer limits the breathing test time to 30 seconds. A direct comparison of the ExSpiron to the Morgan spirometer is suboptimal.) A different set of twenty subjects participated. (Age range: 20-60, BMI range: 19.0-28.0, 9 female, 11 male) Each subject participated in one session performing twenty 30-second breathing tests with volume measurements made simultaneously with the Wright spirometer and the Morgan diagnostic spirometer.

The Morgan-Wright study results were:

Wright-Morgan	**Minute Ventilation**	**Tidal Volume**
Bias	**0.4%**	**0.4%**
Accuracy	**3.9%**	**3.9%**

Continued on next page.

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<table>
<tr><td>Clinical performance testing:
Continued from previous page</td><td>Combining the results of the ExSpiron-Wright study and the Wright-Morgan study provided calculated estimates of ExSpiron bias and accuracy with respect to the Morgan diagnostic spirometer:

<table>
<tr><th>ExSpiron-Morgan</th><th>Minute Ventilation</th><th>Tidal Volume</th></tr>
<tr><td>Bias</td><td>-1.7%</td><td>-1.5%</td></tr>
<tr><td>Accuracy</td><td>9.9%</td><td>9.6%</td></tr>
</table></td></tr>
<tr><td>Conclusions regarding safety and effectiveness:</td><td>Based on the comparisons of intended use, and results of nonclinical and clinical testing, the ExSpiron™ is substantially equivalent in intended use, safety, and effectiveness to the nSpire Respirometer and to the breathing frequency monitor function of the Philips Intellivue Patient Monitors.</td></tr>
</table>

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Appendix 2

Revised User Manual

The revised draft User Manual begins on the next page.

Changes are:

- Removal of “with potential respiratory compromise” and “to determine respiratory status and appropriate therapy” from the Intended Use section, page 15
- Removal of references to the term “gold standard” in Appendix C Clinical Studies to Determine Accuracy, starting on page 33

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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User Manual

ExSpiron™
Respiratory Variation Monitor™ (RVM)

© Respiratory Motion, Inc.

305 Second Avenue, Suite B
Waltham, MA 02451-1122

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General Warning:

DO NOT use this monitor

- for any purpose other than specified in this manual
- if parts are broken or missing
- without reading this user manual

ONLY qualified personnel should use the ***ExSpiron™*** Monitor.

The ***ExSpiron™*** Monitor is NOT a diagnostic monitor. The ExSpiron should be used as an adjunct to other clinical information to determine respiratory status and appropriate therapy.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Contact Information

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Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Table of Contents

To be added.

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Introduction

Intended Use

ExSpiron™ is indicated for use by healthcare professionals in healthcare facilities, such as post-operative care and critical care units, to monitor breathing in adult (at least 21 years old) patients.

ExSpiron™ is a non-invasive monitor that graphically displays lung volume against time and reports an approximate value of:

- Tidal volume,
- Respiratory rate, and
- Minute ventilation.

ExSpiron™ measurements are used as an adjunct to other clinical information sources.

NOTE: United States regulation restricts this device to sale by or on the order of licensed medical practitioners.

Intended Operators

***ExSpiron*™** is intended to be operated by trained technicians and clinical professionals.

Brief Description of Device

The system includes:

- **ExSpiron™** Data Acquisition System, including patient cable with leads
- Touch screen panel computer (Windows 7® Operating System)
- **ExSpiron™** Disposable Electrode Pads

The ***ExSpiron*™** Disposable Electrode Pads should always be used with the ExSpiron monitor.

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Safety Measures

Warnings

WARNING: Electric shock hazard. The ***ExSpiron*™** monitor is to be opened only by Respiratory Motion personnel, their designees, or qualified service engineers. There are no user-serviceable parts inside.

WARNING: Do not autoclave, gas-sterilize, or immerse any portion of the ***ExSpiron*™** monitor. This may create an electric shock hazard or damage internal components.

Cautions

CAUTION: ***ExSpiron*™** disposable electrode pad sets are designed for single use only and should not be re-used. Reuse may interfere with monitor function. An electrode pad set should not be used for more than 24 hours. Recalibrate the ***Exspiron™*** after changing electrode pad set. Dispose of electrode pads sets per requirements for biohazard waste.

CAUTION: Use only Respiratory Motion ***ExSpiron*™** electrode pad sets with the ***ExSpiron*™** monitor. Accuracy of the device cannot be assured unless Respiratory Motion ***ExSpiron*™** electrode pad sets are specifically used.

CAUTION: Other bioimpedance monitors may cause functional interference among the ExSpiron and the other monitors. When using ExSpiron with another bioimpedance monitor, confirm that both systems are operating properly.

CAUTION: Do not mount or store the ***ExSpiron*™** monitor under an IV bag or other liquids. Fluid leaking onto the monitor may interfere with monitor function and may create an electric shock hazard.

CAUTION: Before attaching the ***ExSpiron™*** monitor to a medical monitoring pole, ensure that the pole is specified to carry the weight of the ***ExSpiron™*** monitor.

CAUTION: The accuracy of ***ExSpiron*** volume measurements has not been confirmed at very high (> 30 breaths per minute) or very low ($\leq$ 5 breaths per minute) respiratory rates. If a patient has a very high or very low respiratory rate, confirm respiratory status with other clinical information sources.

CAUTION: The accuracy of ***ExSpiron*™** measurements has not been confirmed for patient with a BMI over 43. If a patient has a BMI outside of this range, confirm respiratory status with other clinical information sources.

CAUTION: A very large change in patient hydration may affect the calibration. If a patient experiences a large change in hydration, recalibrate the ***ExSpiron*™** monitor.

Precautions

The ***ExSpiron*™** monitor should not be used as the sole basis for diagnosis or therapy. Healthcare professionals should use ***ExSpiron*™** measurements as an adjunct to other clinical information sources to help determine regulatory status and appropriate therapy.

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The ***ExSpiron*™** monitor should not be used as an apnea monitoring system.

Cleaning and disinfection

Clean external surfaces of the ***ExSpiron™*** monitor with a cloth dampened with warm water. Cleaning with a mild disinfectant is recommended.

Disposal

Dispose of used electrode pad sets as biohazard waste.

Dispose of used batteries per local or national waste regulations.

At the end of its life, dispose of or recycle the ***ExSpiron™*** monitor per local or national regulations.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Operation

Principles of Operation

Various types of bodily tissue have varying levels of electrical impedance. Impedance is the measure of an object's opposition to carrying an alternate current. Air has far more impedance than any bodily tissue. As an individual inhales and exhales, the movement of air in and out of the lungs sequentially increases and decreases the level of electrical impedance within the thorax. Similar to standard leads that measure respiratory rate, the ***ExSpiron*™** measures changes in impedance by passing a low level alternating constant current through the thorax. Respiratory Motion algorithms are able to correlate directly these changes in impedance with lung volumes. Analysis of the respiratory curve yields three important parameters: tidal volume of each breath, respiratory rate and minute ventilation.

Features of Design

Device Design

The ***ExSpiron*™** monitor is comprised of a set of electronics and standard computer functionality, which collects and analyzes pertinent patient information. ***ExSpiron*™** leads originating from the device connect to ***ExSpiron*™** electrode pads placed in predetermined configurations on the patient's skin. Electrode configuration and the monitor user interface are detailed in Sections 2 and 3.

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Electrode Configuration

Electrode configuration is detailed in Figure 1. There are two electrode pads, designated 1 and 2 (Fig. 1). Routine skin preparation following standard hospital procedures should be undertaken before electrode pad placement. The patient's skin should be thoroughly cleansed and failure to do so could interference with the integrity of the ***ExSpiron™*** readings.

Electrode pad 1 should be placed over the sternal notch and extend to the xiphoid process. If necessary, the bottom electrode pad can be torn along the perforated edge to allow for further extension.

Electrode pad 2 should be placed along the right mid-axillary line and horizontally in line with the xiphoid process and bottom electrode of Electrode pad 1.

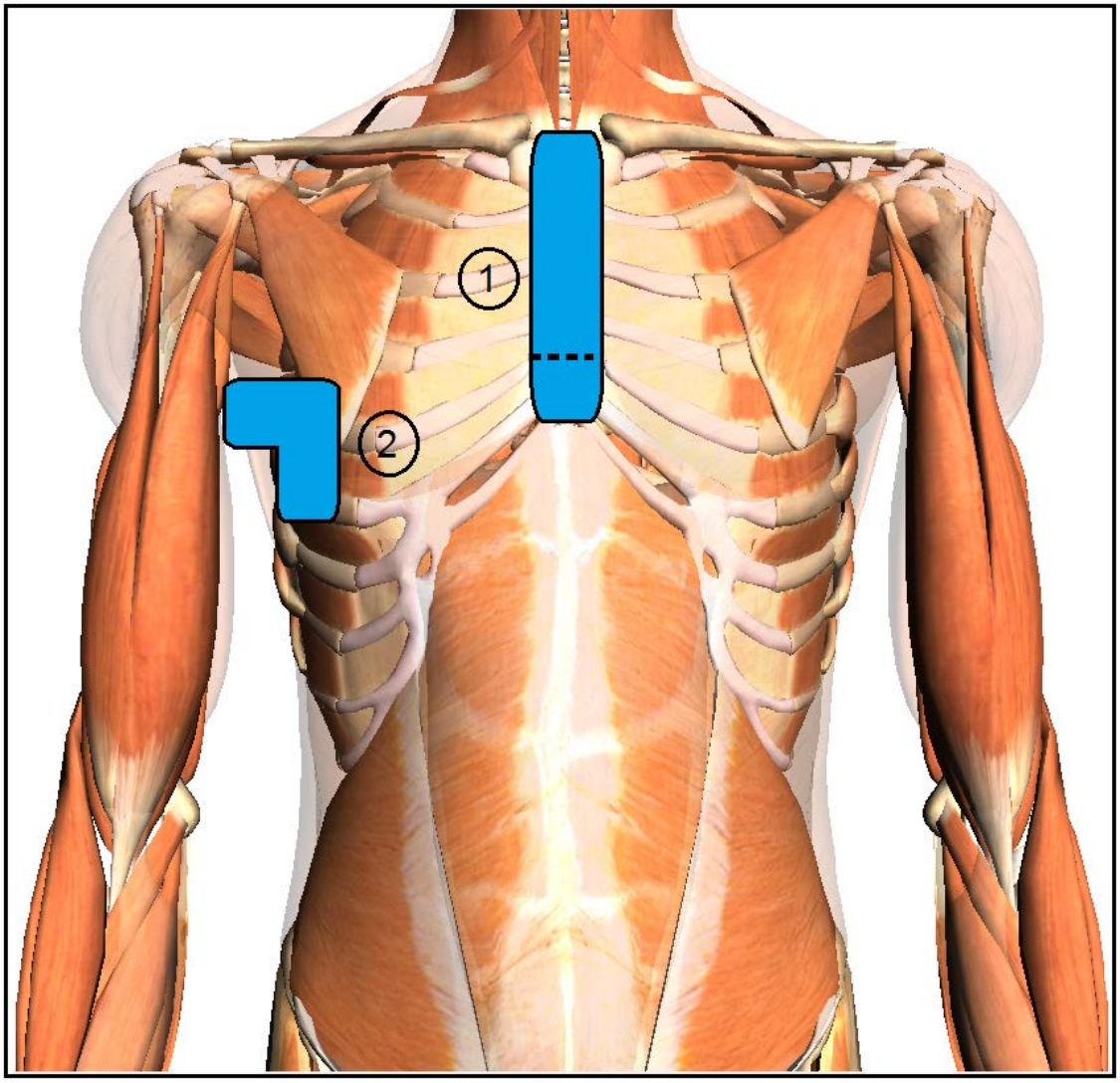

Figure 1 Standard electrode placement diagram.

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Monitor Start-up

1) Plug in the ***ExSpiron*™** monitor.
2) Turn on the monitor via the I/O button.
3) With the monitor turned on, an ***ExSpiron*™** icon will appear on the desktop.
4) Clicking on this icon will launch the graphical user interface and allow for subject data input and data collection.

User Interface

The ***ExSpiron*™** user interface (UI) contains a graphical representation of the respiratory curve, and outputs of three respiratory parameters: minute ventilation (MV), tidal volume (TV), and respiratory rate (RR). When the ***ExSpiron*™** software is launched or a new or different patient is being monitored, the initial starting screen will display only the respiratory curve (Fig 2). No values for MV, TV, or RR will be shown.

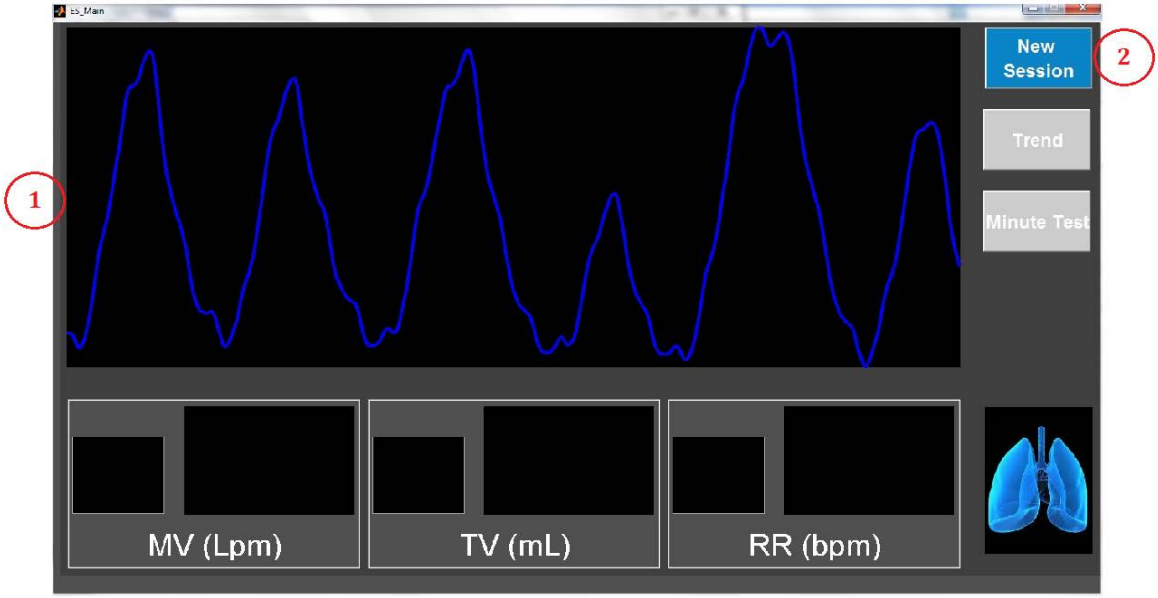

Figure 2 User Interface. The main screen will illustrate the respiratory curve. Navigate the touch screen using the buttons at the right. Beneath the respiratory curve are value boxes and trend curves for the 3 collected respiratory parameters. These will appear empty until a patient has been selected and the device calibrated.

Label	Button/ Field	Function
1	Respiratory Curve	Shows the patient's respiratory curve in real-time.
2	New Session	Brings user to patient ID screen in order to begin monitoring.

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Patient Selection

In order to select a patient for monitoring, the user will be prompted with a patient ID screen (Fig. 3). Enter the patient's ID and click Next to move to the next screen.

Figure 3 Patient ID Input Screen.

Label	Button/Field	Function
1	ID Field	Input the patient's ID.
2	Next	Once the patient's ID is entered, click Next to move to next screen.
3	Cancel	Click to leave the ID screen and return to initial monitoring screen.

Selecting a Calibration Setting for a New Patient

If the patient database does not recognize the patient ID, the new patient calibration screen will be shown (Fig. 4). Enter the fields listed; all are required. New Calibration is the only option for a new patient. Height, weight, and the calibration information used on the next screen will constitute that particular calibration, and it will be stored under the current date. Clicking Next will create a patient record and bring the user to the calibration screen.

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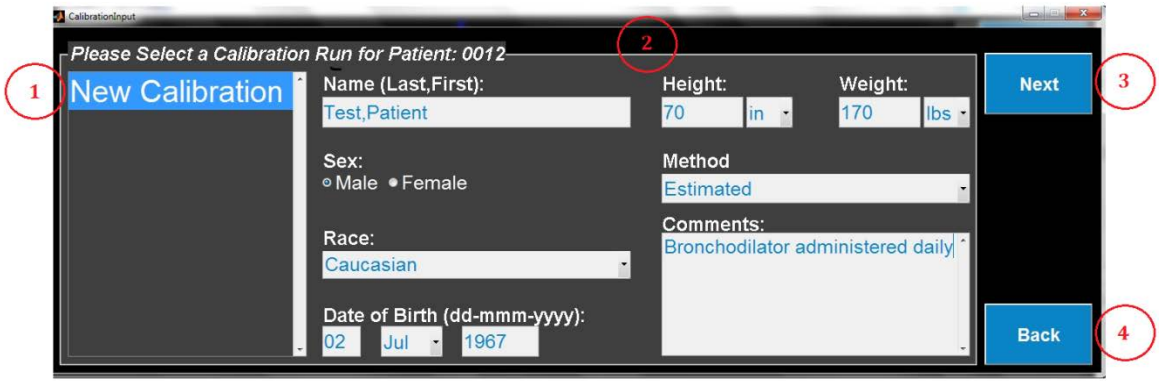

Figure 4 Patient Selection User Interface. Items on the user interface for patient selection.

Label	Button/ Field	Function
1	New Calibration	This will be the only option for a new patient.
2	Required Information	All fields are required. Those listed on the left (name, sex, race, date of birth) cannot be edited after initial entry. Those fields on the right (height, weight, method, comments) can be edited. Method is a dropbox containing options for "estimated" or "measured". Pick one in order to designate the method that was used for acquiring height and weight.
3	Next	Brings user to calibration screen.
4	Back	Brings user back to the initial monitoring screen.

The calibration screen will prompt the user to click Start and begin collecting data for minute ventilation or tidal volume and respiratory rate (Fig. 5). The fields on the right will remain disabled until the collection period is over and the progress bar shows that data acquisition is complete. At that time, the user can input the collected parameter(s) and click Next to go to the calibrated monitoring screen.

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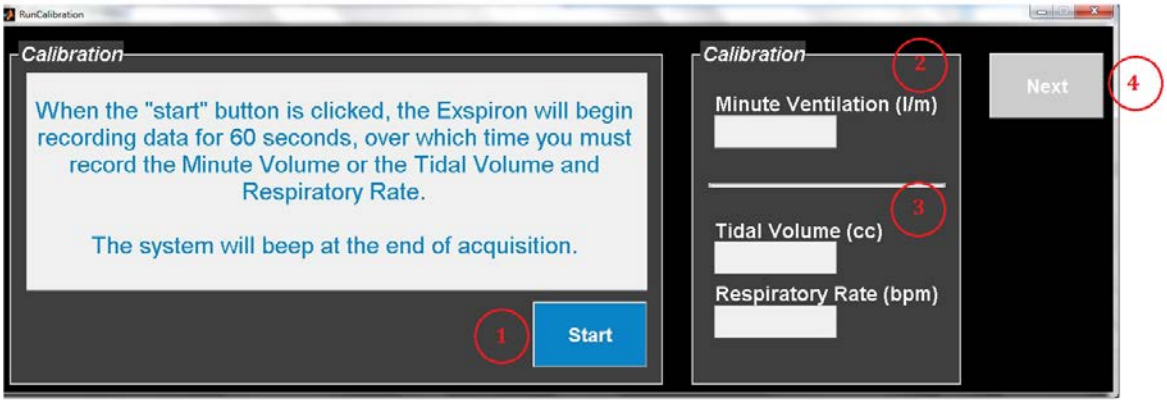

Figure 5 Calibration screen. After inputting the calibration parameters, the ExSpiron will start acquiring data.

Label	Button/Field	Function
1	Start	Begin collecting data for calibration (60 seconds).
2	Minute Ventilation	User can enter the calculated minute ventilation for calibration.
3	Tidal Volume & Respiratory Rate	User can enter tidal volume and respiratory rate for calibration.
4	Next	Brings user to monitoring screen; remains disabled until calibration has completed.

Selecting a Calibration Setting for an Existing Patient

The default screen is used for selecting existing patients (Fig. 6). The data entry fields become available when the operator selects a patient by clicking on an entry in the Patient List. Refer to the list below to navigate the Patient Selection UI.

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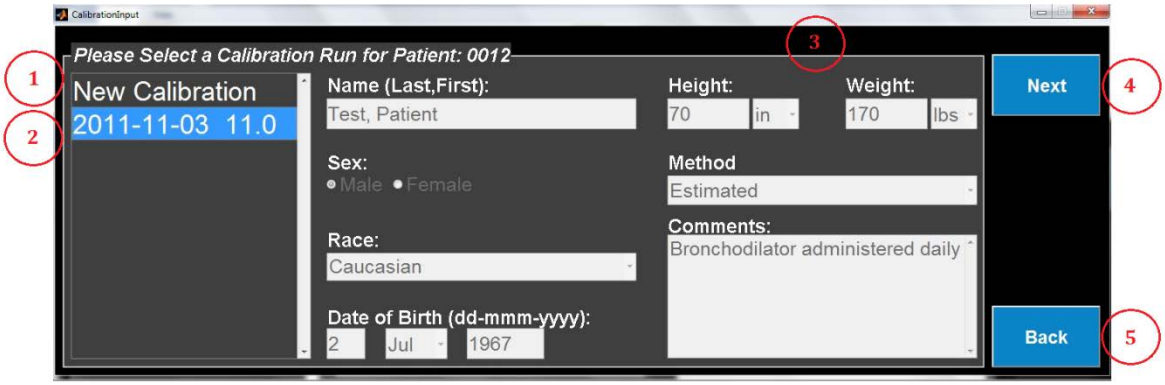

Figure 6 Calibration Selection for Existing Patient.

Label	Button/Field	Function
1	New Calibration	Selecting this for an existing patient allows the user to create a new calibration setting.
2	Existing Calibration Setting	Existing calibration settings are listed by date and minute ventilation. Select one to set calibration to that setting.
3	Changeable fields	In creating a new calibration setting, the user can edit the height, weight, method, and comments fields.
4	Next	Brings user to calibrated monitoring screen.
5	Back	Returns user to initial monitoring screen.

Navigating the Monitoring Session

After the desired patient has been selected, the user will be brought to the monitoring screen (Fig. 7). The graphs will automatically populate with the calibrated respiratory curve and values and trends for TV, RR, and MV. The buttons at the right allow the user to navigate away from the monitoring screen, either to start a new monitoring session, view trends, or the run minute-long tests.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

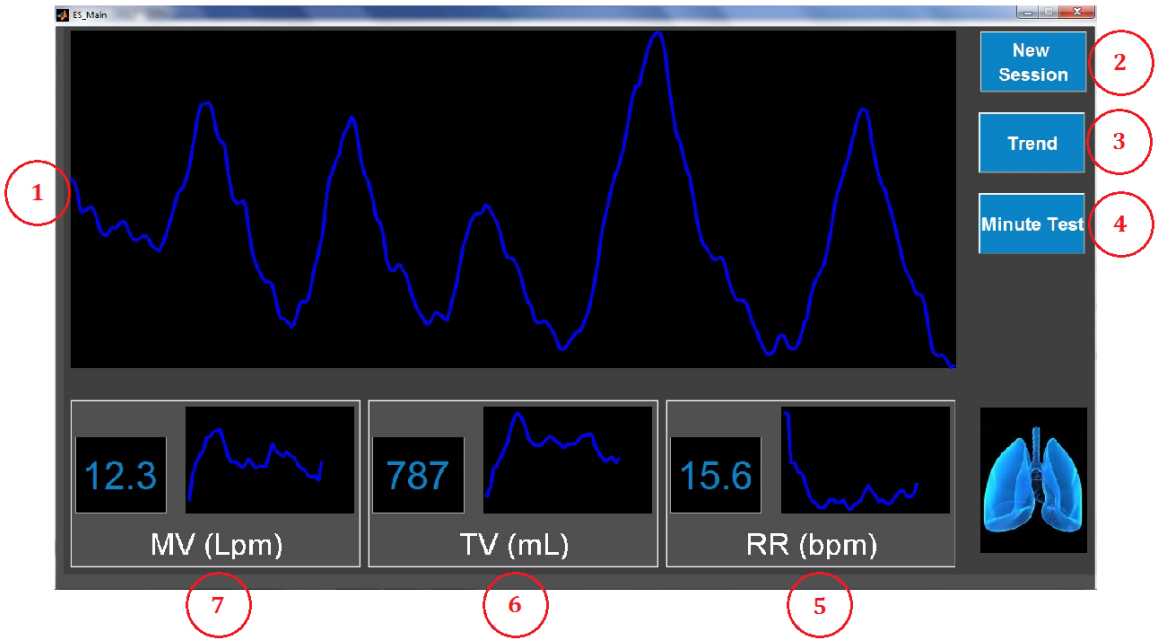

Figure 5 Monitoring Screen. Displays the calibrated respiratory curve and parameters.

Label	Button/Field	Function
1	Respiratory Curve	Tracks current respiratory curve in near real-time in 30-second blocks.
2	New Session	Allows the user to select a new or different patient for monitoring.
3	Trend	Brings user to trending screen.
4	Minute Test	Allows user to run discrete 60-second tests.
5	Respiratory Rate (RR)	Demonstrates graphical representation of RR over the past 60 minutes and provides current RR value.
6	Tidal Volume (TV)	Demonstrates graphical representation of TV over the past 60 minutes and provides current TV value.
7	Minute Ventilation (MV)	Demonstrates graphical representation of MV over the past 60 minutes and provides current MV value.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Reviewing Patient Trends

The "Trends" tab graphically displays sequential measurements captured within the twenty-four hours of the current session (Fig. 7). Clicking this tab changes the display to show plots for respiratory rate, minute ventilation, and tidal volume. Above the plots is a dropdown menu which is used to select the time interval for the data in the table. Above the trending graphs is a horizontal scroll bar representing time. Move the scroll bar left or right to look at trends throughout the patient's monitoring period. Above the scroll bar is a schematic illustrating in blue when periods of ***ExSpiron***™ monitoring.

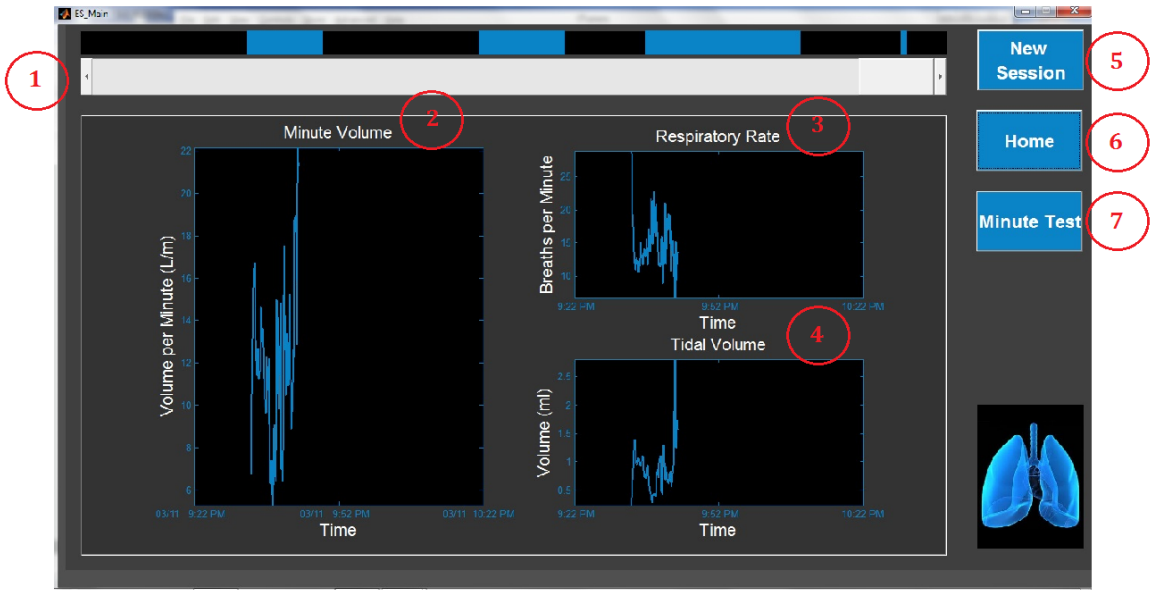

Figure 6 The Trends Tab. Respiratory rate (RR), minute volume (MV), and tidal volume (TV) trends graphs are plotted versus time.

Label	Field	Function
1	Scroll Bar	Moving the scroll (corresponds with time) will display trending graphs for those time periods.
2	MV Trending Graph	MV trends over 60 minutes.
3	RR Trending Graph	RR trends over 60 minutes.
4	TV Trending Graph	TV trends over 60 minutes.
5	New Session	Brings user back to patient ID screen.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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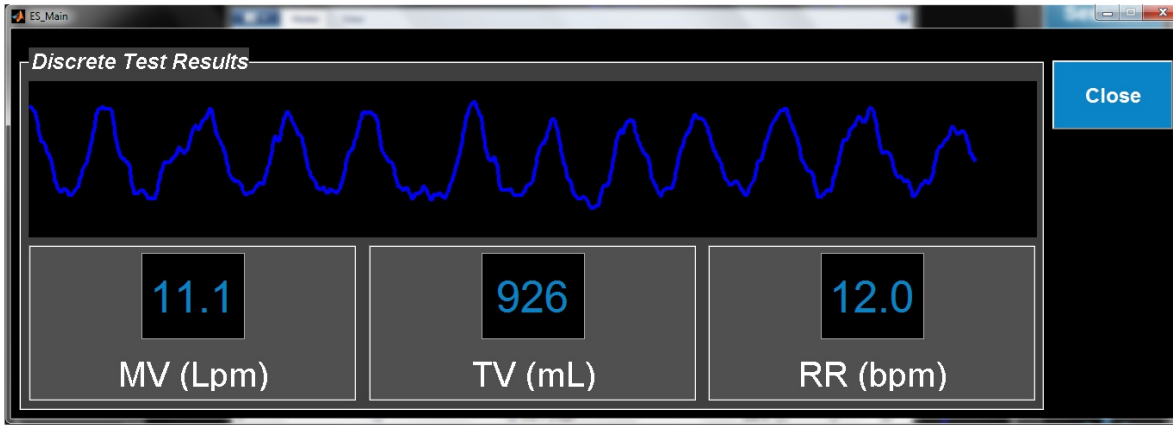
6	Home	Brings user back to the monitoring screen.
7	Minute Test	Allows user to run discrete 60-second tests.

Performing Minute Tests

Clicking on the Minute Test button will temporarily disable the monitoring screen. The progress bar demonstrates that the ***ExSpiron*™** is collecting data for 60 seconds. After the minute test has completed, the results are given as shown below. Click Close to exit the results screen and return to the regular monitoring screen.



Clinical Procedure

The following flow chart details the general procedure for clinical use of the ***ExSpiron*™**.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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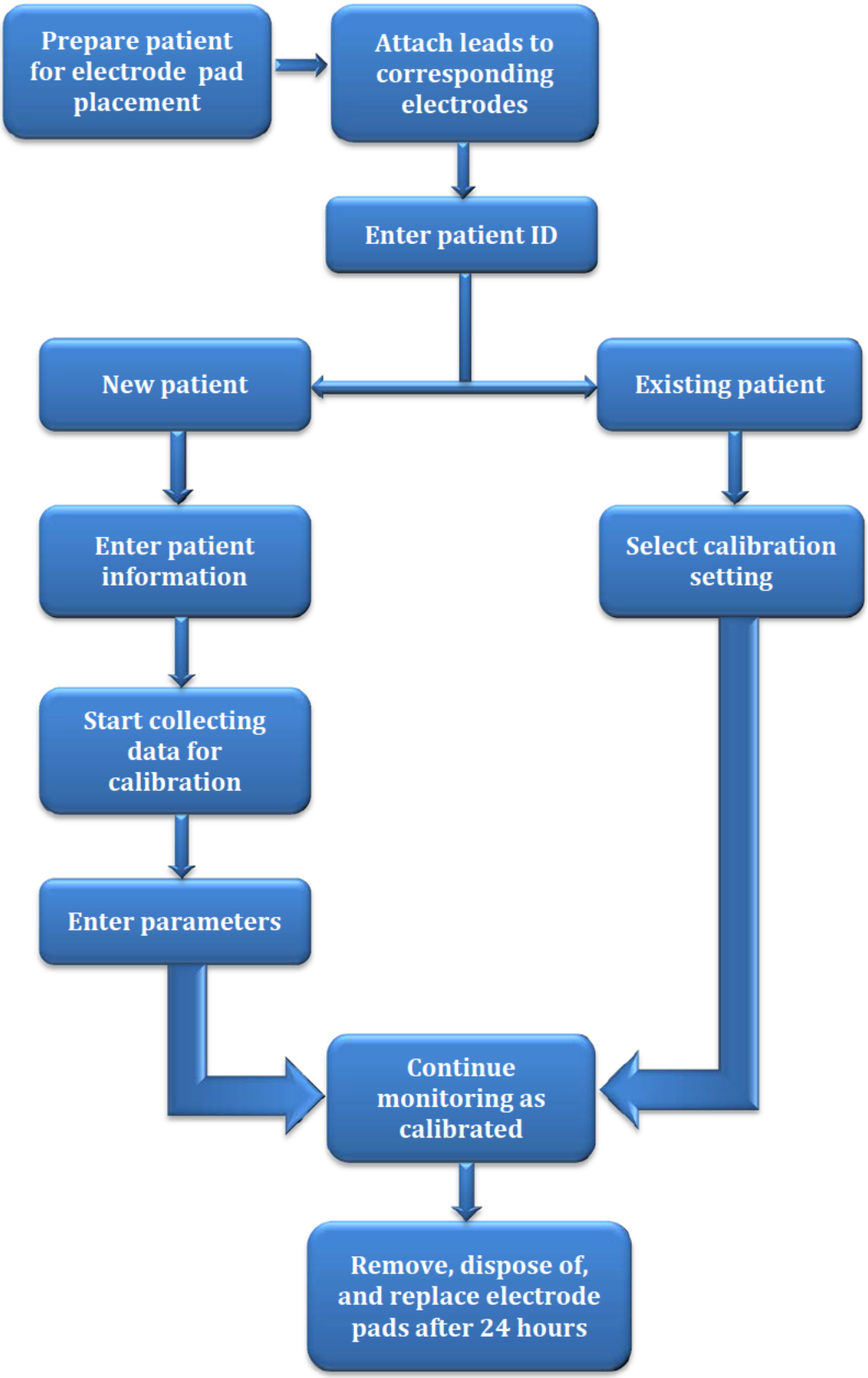

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Figure 7 Clinical Procedure Flow Chart. Start from patient selection to work through a complete monitoring session.

Signal Quality

Lack of adequate signal quality can result in a "flat line" displayed on the panel screen. Flat lining can be a result of the following:

- Electrode pads that are not in full contact with the patient's skin. Replace the electrode pads with new ones and record the event. Hair and sweat can affect the ability of the electrode pads to stick to the skin. Routine hospital preparation for electrode pad placement, such as abrasive cleansing or shaving of the area should be followed to avoid issues such as these. Electrodes are to be used no longer than 24 hours, but can be replaced sooner if necessary.
- Leads that are not properly attached to the electrode pads. Check lead-electrode pad attachment.
- Incorrect matching of electrode pad to lead. Check that the correct colored lead is attached to the correct electrode pad.
- Poor signal quality. Check that electrodes were attached in correct configuration. Anatomical differences can also cause poor signal quality.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Understanding ExSpiron Readings

The following information should be used as informational purposes only and not for use of the ***ExSpiron™*** as a diagnostic tool.

Respiratory Rate

Respiratory Rate is defined as the number of breaths per minute. Respiratory Rate can be classified as normal, abnormally fast (tachypnea), abnormally slow (bradypnea), or nonexistent (apnea).

Tidal Volume

Tidal Volume is the total volume of air displaced between normal inspiration and expiration when extra effort is not applied.

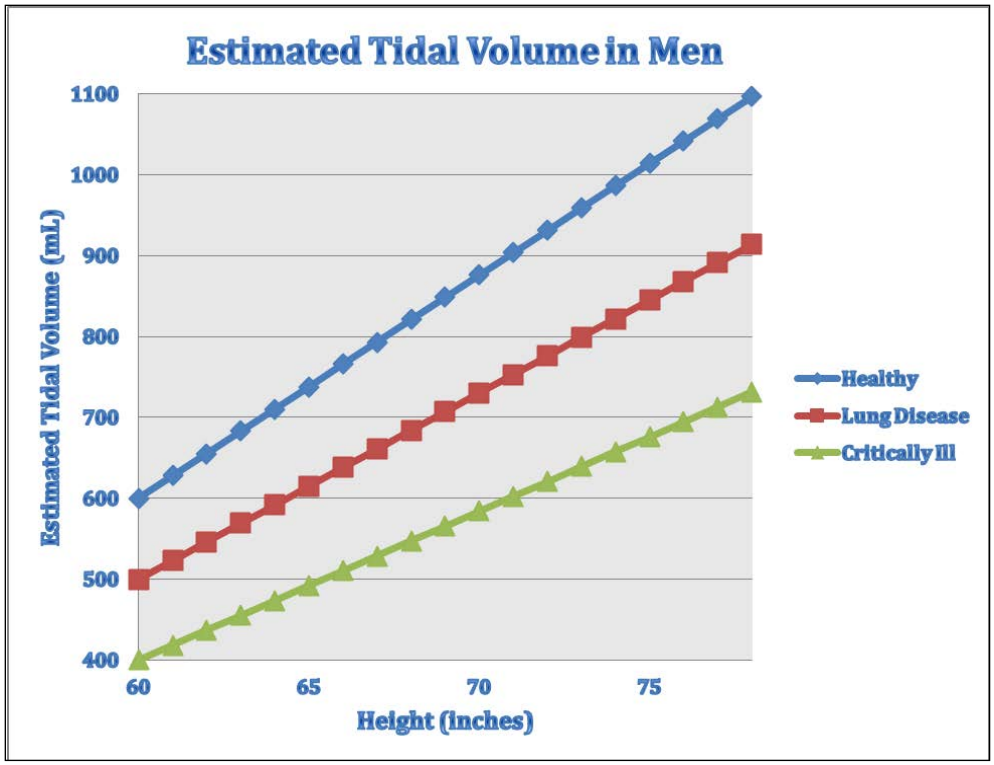
Minute Ventilation

Minute Ventilation is the total volume of air displaced between normal inspiration and expiration over the duration of one minute. It can also be calculated as the product of tidal volume X respiratory rate.

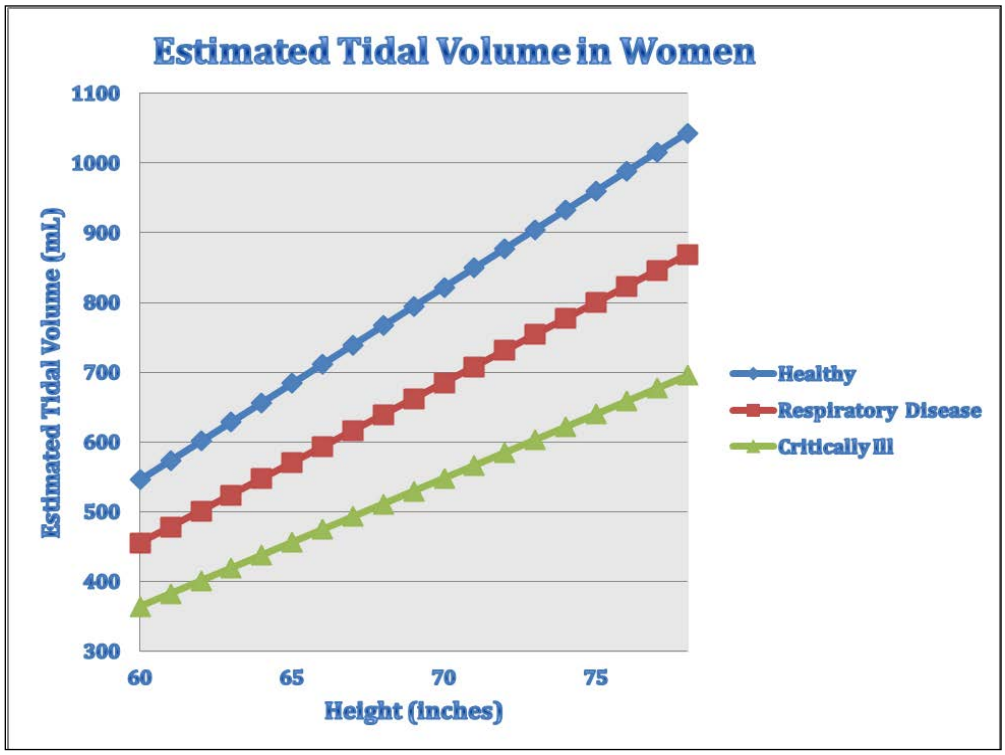
Table 1 Normal Ranges of Respiratory Parameters.

Value	Normal Range	Description
Respiratory Rate	12-18 breaths/min	Breaths per minute
Tidal Volume	Dependent on gender and height. See graphs and tables below.	Milliliters per single breath
Minute Ventilation	RR x TV	Liters of aired breathed in one minute

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118



Graph 1 Estimated tidal volume in men based on height.



Graph 2 Estimated tidal volume in women based on height.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Appendix A Accessories

Accessory	Model #
Exspiron™ Disposable Electrode Pads	200-010

Appendix B Specifications

Size	Computer Module	11.9" (H) x 8.7"(W) x 1.7" (D) 6.5" (H) x 4.5" (W) x 1.5" (D)
Weight		(Less than ten pounds)
Operating conditions		32° – 95° F 20% - 80% non-condensing humidity
Storage and transport conditions		-4° – 112° F 20% - 80% non-condensing humidity

The ***Exspiron™*** Power Supply is a switching power supply with input range:
100-240 V ~ 50/60 Hz 2 A

Standards compliance:

- IEC 60601-1 Second edition
  - Class 1 protection against electric shock.
  - Type BF applied part
  - Continuous duty cycle
  - Not suitable for use with flammable anesthetics

- IEC 60601-1-2: 2001
  - Class A Emissions

- FCC Certification

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Appendix C Clinical Studies to Determine Accuracy

Two similar clinical studies provided ExSpiron accuracy information. The first study compared ExSpiron measurements to measurements made with Wright/Haloscale Respirometer. This study produced measurement performance statistics and confirmed that the ExSpiron calibration is stable for 24 hours. The second study compared the Wright/Haloscale Respirometer to the Morgan SpiroAir LT diagnostic spirometer. Results of the two studies were combined mathematically to produce measurement performance statistics relative to the Morgan spirometer.

ExSprion – Wright comparison

A clinical study compared simultaneous measurements from the ExSpiron and the Wright spirometer. Twenty subjects representing a broad range of intended patients participated in the study. (Age range: 20-84, BMI range: 19.9-43.2, 11 female, 9 male) Tidal volume, minute ventilation, and respiratory rate were measured simultaneously by the ExSpiron and the Wright spirometer. Each subject returned twenty-four hours after the first session with the original electrodes still attached. Using the same individual calibration values, a second set of ten 60-second breathing tests was performed.

The results of the ExSpiron comparison indicate that the individual calibration is stable over a 24-hour period.

ExSpiron-Wright Comparison		**Minute Ventilation**	**Tidal Volume**	**Respiratory Rate**
Bias	**Overall**	**-2.1%**	**-1.9%**	**-0.2%**
	Day 1	-2.3%	-1.7%	-0.6%
	Day 2	-1.9%	-2.0%	0.2%
Precision	**Overall**	**10.5 %**	**10.3 %**	**2.0 %**
	Day 1	10.2%	9.7%	2.3%
	Day 2	10.8%	10.8%	1.6%
Accuracy	**Overall**	**10.7 %**	**10.4 %**	**2.0 %**
	Day 1	10.4%	9.8%	2.4%
	Day 2	10.9%	11.0%	1.6%

RMI performed a Bland-Altman analysis of the clinical trial data. (See Bland and Altman, The Lancet, vol. 327, issue 8476, pp. 307-310, February 1986.) The analyses confirmed that the average disparity between ExSpiron and the Wright spirometer was small and clinically irrelevant (differences of -0.2 bmp, -5ml and -0.14 L/min for RR, TV, and MV, respectively).

RMI calculated the difference between ExSpiron and the Wright spirometer for each measure (MV, TV, and RR) and calculated the average of ExSpiron and the predicate for each measure. The resulting plots are shown below. Data from different subjects are depicted with a different color/symbol combination (i.e. blue plus sign is one subject, cyan plus sign in another subject, blue circle is a third subject, etc.). The charts show each subject's averaged data. The middle black dashed line on each plot depicts the average difference and the upper and lower black

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dashed lines indicate the 95% confidence intervals (±2 SD from the mean). The mean differences between devices in all six plots are essentially zero.

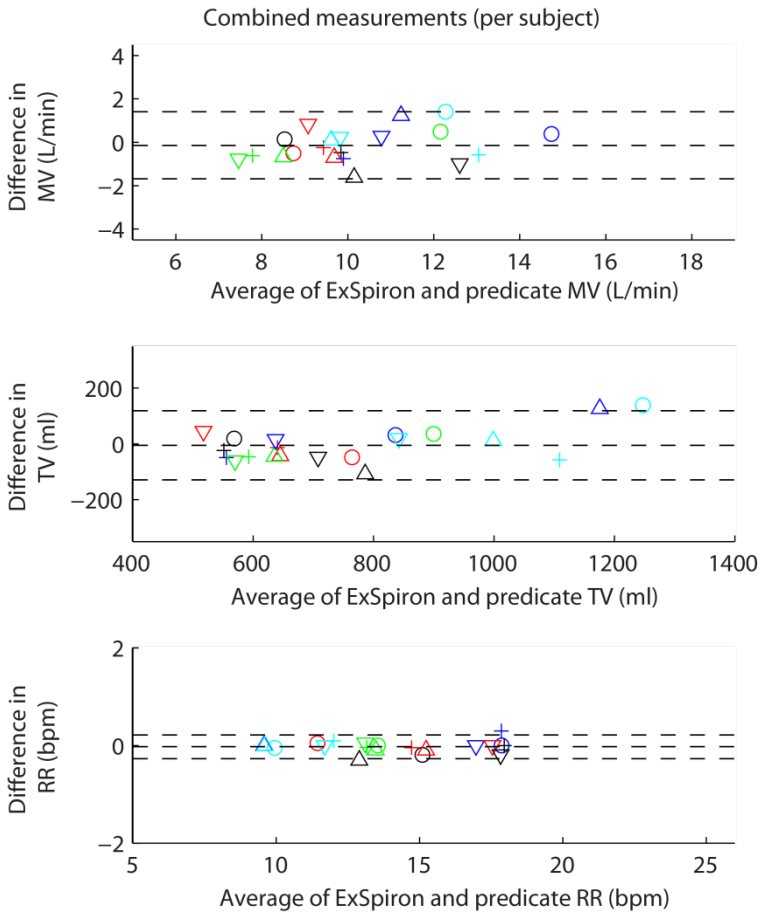

Figure 1 Bland-Altman plots of ExSpiron-Wright comparison

Subject demographics

The demographics of the twenty subjects are shown in these tables.

Age Range	
20-29	3
30-39	3
40-49	4
50-59	4
60-69	2
70-79	2
80-89	2

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Gender	
female	11
male	9

Race	
Asian	2
white	16
black	2
Hispanic	0

BMI Range		
18.5-24.9	11	normal
25-29.9	4	overweight
30-39.9	3	obese
40+	2	morbidly obese

The range of ages, 20-84, is consistent with ExSpiron's intended use with adults, at 21 years of age.

The maximum subject body mass index (BMI) was 43.2.

Subject hydration was not controlled in this study. Test data indicate that measurement performance is not sensitive to a subject's baseline impedance, an indicator of hydration.

Wright spirometer - Morgan SpiroAir LT diagnostic spirometer study

A second, similar study was performed comparing the Wright spirometer to the Morgan SpiroAir LT diagnostic spirometer. (The closed cell construction of the Morgan spirometer limits the individual breathing test time to 30 seconds. A direct comparison of the ExSpiron to the Morgan spirometer is not feasible.) A different set of twenty subjects participated. (Age range: 20-60, BMI range: 19.0-28.0, 9 female, 11 male) Each subject participated in one session performing twenty 30-second breathing tests with volume measurements made simultaneously with the Wright spirometer and the Morgan diagnostic spirometer.

The results of the Morgan-Wright comparison are consistent with the performance claims in their documentation, 2% accuracy for the Morgan and 2% accuracy in the tested flow range for the Wright. The Morgan-Wright study results were:

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

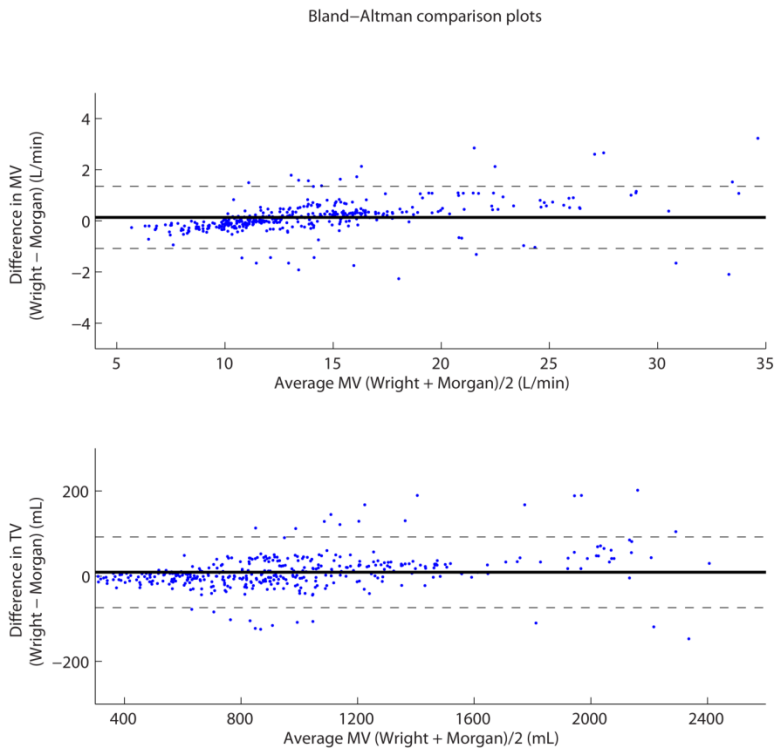

Figure 2: Bland-Altman plots. The average disparity between the two spirometers was confirmed to be small and clinically irrelevant (differences of 9 ml and 0.13 L/min for TV and MV, respectively). Both plots show individual data from all subjects and from all trials. The middle black solid line on each plot depicts the average difference and the upper and lower black dashed lines indicate the 95% confidence intervals (±2 SD from the mean). The mean differences between devices in both plots are essentially zero.

ExSpiron – Morgan Calculated Measurement Performance

Combining the results of the ExSpiron-Wright comparison and the Wright-Morgan comparison provided calculated estimates of ExSpiron bias and accuracy with respect to the Morgan diagnostic spirometer:

ExSpiron-Morgan	Minute Ventilation	Tidal Volume
Bias	**-1.7%**	**-1.5%**
Accuracy	**9.9%**	**9.6%**

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Appendix 3
Revised Indications for Use

The Indications for Use form begins on the next page.

The change is the removal of “with potential respiratory compromise” and “to determine respiratory status and appropriate therapy.”

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Indications For Use

510(k) Number (if known): K120087
Device Name: ExSpiron
Indications for Use:

ExSpiron is indicated for use by healthcare professionals in healthcare facilities, such as post-operative care and critical care units, to monitor breathing in adult (at least 21 years of age) patients.

ExSpiron is a non-invasive system that graphically displays lung volume against time and reports an approximate value of:

- Tidal volume,
- Respiratory rate, and
- Minute ventilation.

ExSpiron measurements are used as an adjunct to other clinical information sources.

Prescription Use ___X____ AND/OR Over-The-Counter Use_____
(Part 21 CFR 801 Subpart D) (Part 21 CFR 801 Subpart C)

(PLEASE DO NOT WRITE BELOW THIS LINE-CONTINUE ON ANOTHER PAGE IF NEEDED)

Concurrence of CDRH, Office of Device Evaluation (ODE)

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Appendix 4
Revised Promotional Claims

Changes are the removal of claims as requested by FDA.

Promotional labeling for the ExSpiron monitor will include these claims:

- ExSpiron can monitor breathing in adult patients.
- ExSpiron assists in monitoring patients in near real-time.
- ExSpiron is non-invasive, point-of-care, and quantitative.
- ExSpiron provides quantitative measurement of:
  - Minute Ventilation (MV)
  - Tidal Volume (TV)
  - Respiratory Rate (RR)
- ExSpiron can measure MV, TV, and RR in non-ventilated patients.
- ExSpiron displays measurement values both numerically and graphically, displaying trend data.
- ExSpiron can quantify a patient's respiratory status and provide trending data in their respiratory parameters.
- MV, TV, and RR are important parameters for assessment of respiratory status. ExSpiron displays MV, TV, and RR over time. Changes in values over time can be compared.
- ExSpiron reports measurement in a user-friendly format.
- ExSpiron, as a bioimpedance monitor, does not require a breathing device, e.g., a spirometer, in the breathing path to obtain MV and TV.
- ExSpiron does not require participation of the patient to generate spirometry-like results.
- ExSpiron measures respiration without potential contamination that could result from having a monitor or probe (e.g. a capnometer or spirometer) in the patient's air-stream.
- ExSpiron measurements of MV, TV and RR do not rely on the measurement of sound.
- ExSpiron provides objective data about respiratory status that may facilitate better patient care.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Services
Food and Drug Administration

Memorandum

Date: 5-13-13

From: DMC (HFZ-401)

Subject: Premarket Notification Number(s): K120087-A2

To: Division Director: AU / DAGER ID

The attached information has been received by the 510(k) DMC on the above referenced 510(k) submission(s). Since a final decision has been rendered, this record is officially closed.

Please review the attached document and return it to the DMC, with one of the statements checked below.

_____ Information does not change the status of the 510(k); no other action required by the DMC; please add to image file. (Prepare K-25) THIS DOES NOT APPLY TO TRANSFER OF OWNERSHIP. PLEASE BRING ANY TRANSFER OF OWNERSHIP TO POS.

_____ Additional information requires a new 510(k); however, the information submitted is incomplete; (Notify company to submit a new 510(k); [Prepare the K30 Letter on the LAN]

__X__ No response necessary (e.g., hard copy of fax for the truthful and accuracy statement, 510(k) statement, change of address, phone number, or fax number).

CLIA CATEGORIZATION refers to laboratory test system devices reviewed by the Division of Clinical Laboratory Devices (HFZ-440

_____ Information requires a **CLIA CATEGORIZATION**; the complexity may remain the same as the original 510(k) or may change as a result of the additional information (Prepare a CAT letter)

_____ Additional information requires a **CLIA CATEGORIZATION**; however, the information submitted is incomplete; (call or fax firm)

_____ No response necessary

This information should be returned to the DMC within 10 working days from the date of this Memorandum.

Reviewed by: CHAN LEE

Date: 5/30/2013

COL

DLL 5/30

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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DEPARTMENT OF HEALTH & HUMAN SERVICES **Public Health Service**

U.S. Food and Drug Administration
Center for Devices and Radiological Health
Document Control Center WO66-G609
10903 New Hampshire Avenue
Silver Spring, MD 20993-0002

September 24, 2012

RESPIRATORY MOTION, INC.
C/O CHAS BURR QR SERVICES
11 MYSTIC AVENUE
WINCHESTER, MASSACHUSETTS 01890-2920
ATTN: CHAS BURR

510k Number: K120087
Product: EXSPIRON
On Hold As of 9/20/2012

We are holding your above-referenced Premarket Notification (510(k)) for 30 days pending receipt of the additional information that was requested by the Office of Device Evaluation. Please remember that all correspondence concerning your submission MUST cite your 510(k) number and be sent in duplicate to the Document Mail Center at the above letterhead address. Correspondence sent to any address other than the one above will not be considered as part of your official premarket notification submission. Also, please note the new Blue Book Memorandum regarding Fax and E-mail Policy entitled, "Fax and E-Mail Communication with Industry about Premarket Files Under Review. Please refer to this guidance for information on current fax and e-mail practices at http://www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/GuidanceDocuments/ucm089402.htm.

The deficiencies identified represent the issues that we believe need to be resolved before our review of your 510(k) submission can be successfully completed. In developing the deficiencies, we carefully considered the statutory criteria as defined in Section 513(i) of the Federal Food, Drug, and Cosmetic Act for determining substantial equivalence of your device. We also considered the burden that may be incurred in your attempt to respond to the deficiencies. We believe that we have considered the least burdensome approach to resolving these issues. If, however, you believe that information is being requested that is not relevant to the regulatory decision or that there is a less burdensome way to resolve the issues, you should follow the procedures outlined in the "A Suggested Approach to Resolving Least Burdensome Issues" document. It is available on our Center web page at: http://www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/Overview/MedicalDeviceProvisionsofFDAModernizationAct/ucm136685.htm.

If after 30 days the additional information (AI), or a request for an extension of time, is not received, we will discontinue review of your submission and proceed to delete your file from our review system (21 CFR 807.87(l)). Please note our guidance document entitled, "Guidance for Industry and FDA Staff, FDA and Industry Actions on Premarket Notification (510(k)) Submissions: Effect on FDA Review Clock and Performance Assessment". If the submitter does submit a written request for an extension, FDA will permit the 510(k) to remain on hold for up to a maximum of 180 days from the date of the AI request. The purpose of this document is to assist agency staff and the device industry in understanding how various FDA and industry actions that may be taken on 510(k)s should affect the review clock for purposes of meeting the Medical Device User Fee and Modernization Act. You may review this document at http://www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/GuidanceDocuments/ucm089735.htm. Pursuant to 21 CFR 20.29, a copy of your 510(k) submission will remain in the Office of Device Evaluation. If you then wish to resubmit this 510(k) notification, a new number will be assigned and your submission will be considered a new premarket notification submission.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Please remember that the Safe Medical Devices Act of 1990 states that you may not place this device into commercial distribution until you receive a decision letter from FDA allowing you to do so.

If you have procedural questions, please contact the Division of Small Manufacturers International and Consumer Assistance (DSMICA) at (301)796-7100 or at their toll-free number (800)638-2041, or contact the 510k staff at (301)796-5640.

Sincerely yours,

Marjorie Shulman
Director, 510(k) Program
Premarket Notification Section
Office of Device Evaluation
Center for Devices and Radiological Health

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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DEPARTMENT OF HEALTH & HUMAN SERVICES **Public Health Service**

U.S. Food and Drug Administration
Center for Devices and Radiological Health
Document Control Center WO66-G609
10903 New Hampshire Avenue
Silver Spring, MD 20993-0002

September 17, 2012

RESPIRATORY MOTION, INC.
C/O CHAS BURR QR SERVICES
11 MYSTIC AVENUE
WINCHESTER, MASSACHUSETTS 01890-2920
ATTN: CHAS BURR

510k Number: K120087

Product: EXSPIRON

The additional information you have submitted has been received.

We will notify you when the processing of this submission has been completed or if any additional information is required. Pleaseremember that all correspondence concerning your submission MUST be sent to the Document Mail Center at the above letterhead address. Correspondence sent to any address other than the one above will not be considered as part of your official premarket notification submission. Also, please note the new Blue Book Memorandum regarding Fax and E-mail Policy entitled, "Fax and E-Mail Communication with Industry about Premarket Files Under Review. Please refer to this guidance for information on current fax and e-mail practices at http://www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/GuidanceDocuments/ucm089402.htm. On August 12, 2005 CDRH issued the Guidance for Industry and FDA Staff: Format for Traditional and Abbreviated 510(k)s. This guidance can be found at http://www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/GuidanceDocuments/ucm084365.htm. Please refer to this guidance for assistance on how to format an original submission for a Traditional or Abbreviated 510(k).

The Safe Medical Devices Act of 1990, signed on November 28, states that you may not place this device into commercial distribution until you receive a letter from FDA allowing you to do so. As in the past, we intend to complete our review as quickly as possible. Generally we do so in 90 days. However, the complexity of a submission or a requirement for additional information may occasionally cause the review to extend beyond 90 days. Thus, if you have not received a written decision or been contacted within 90 days of our receipt date you may want to check with FDA to determine the status of your submission.

Please ensure that whether you submit a 510(k) Summary as per 21 CFR 807.92, or a 510(k) Statement as per 21 CFR 807.93, it meets the content and format regulatory requirements.

If you have procedural questions, please contact the Division of Small Manufacturers International and Consumer Assistance (DSMICA) at (301)796-7100 or at their toll-free number (800)638-2041, or contact the 510k staff at (301)796-5640.

Sincerely,

510(k) Staff

27

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Grayson, Giovanna *

From: Microsoft Outlook
To: chas_burr@alum.mit.edu
Sent: Monday, September 17, 2012 8:48 AM
Subject: Relayed: ack letter

Delivery to these recipients or groups is complete, but no delivery notification was sent by the destination server:

chas_burr@alum.mit.edu (chas_burr@alum.mit.edu)

Subject: ack letter

28

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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DEPARTMENT OF HEALTH & HUMAN SERVICES **Public Health Service**

U.S. Food and Drug Administration
Center for Devices and Radiological Health
Document Control Center WO66-G609
10903 New Hampshire Avenue
Silver Spring, MD 20993-0002

June 28, 2012

RESPIRATORY MOTION, INC.
C/O CHAS BURR QR SERVICES
11 MYSTIC AVENUE
WINCHESTER, MASSACHUSETTS 01890-2920
ATTN: CHAS BURR

510k Number: K120087

Product: EXSPIRON

Extended Until: 07/30/2012

Based on your recent request, an extension of time has been granted for you to submit the additional information we requested.

If the additional information (AI) is not received by the "Extended Until" date shown above, your premarket notification will be considered withdrawn (21 CFR 807.87(l)). If the submitter does submit a written request for an extension, FDA will permit the 510(k) to remain on hold for up to a maximum of 180 days from the date of the AI request.

If you have procedural questions, please contact the Division of Small Manufacturers International and Consumer Assistance (DSMICA) at (301)796-7100 or at their toll-free number (800)638-2041, or contact the 510k staff at (301)796-5640.

Sincerely yours,

Marjorie Shulman
Director, 510(k) Program
Premarket Notification Section
Office of Device Evaluation
Center for Devices and Radiological Health

29

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Records processed under FOIA Request 2014-156; Released 10/20/14

* * * COMMUNICATION RESULT REPORT (JUN. 28. 2012 4:00PM) * * *

FAX HEADER 1:
FAX HEADER 2:

T' 'SMITTED/STORED : JUN. 28. 2012 4:00PM

F MODE	OPTION	ADDRESS	RESULT	PAGE
7048 MEMORY TX		17817232422	OK	1/1

REASON FOR ERROR
E-1) HANG UP OR LINE FAIL
E-2) BUSY
E-3) NO ANSWER
E-4) NO FACSIMILE CONNECTION

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

U.S. Food and Drug Administration
Center for Devices and Radiological Health
Document Control Center WO66-G609
10903 New Hampshire Avenue
Silver Spring, MD 20993-0002

June 28, 2012

RESPIRATORY MOTION, INC.
C/O CHAS BURR QR SERVICES
11 MYSTIC AVENUE
WINCHESTER, MASSACHUSETTS 01890-2920
ATTN: CHAS BURR

510k Number: K120087
Product: EXSPIRON

Extended Until: 07/30/2012

Based on your recent request, an extension of time has been granted for you to submit the additional information we requested.

If the additional information (AI) is not received by the "Extended Until" date shown above, your premarket notification will be considered withdrawn (21 CFR 807.87(l)). If the submitter does submit a written request for an extension, FDA will permit the 510(k) to remain on hold for up to a maximum of 180 days from the date of the AI request.

If you have procedural questions, please contact the Division of Small Manufacturers International and Consumer Assistance (DSMICA) at (301)796-7100 or at their toll-free number (800)638-2041, or contact the 510k staff at (301)796-5640.

Sincerely yours,

Marjorie Shulman
Director, 510(k) Program
Premarket Notification Section
Office of Device Evaluation
Center for Devices and Radiological Health

30

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Records processed under FOIA Request 2014-156; Released 10/20/14

Chas Burr Q/R Services
11 Mystic Avenue
Winchester, Massachusetts
01890-2920

FDA/CDR
JUN 28 2012
RECEIVED

U.S. Food and Drug Administration
Center for Devices and Radiological Health
Document Control Center WO66-G609
10903 New Hampshire Avenue
Silver Spring, MD 20993-0002

June 27, 2012

Subject: **Request for an Extension of Time to Respond to an FDA Letter Requesting Additional Information 510(k) K120087 – Respiratory Motion, Inc. ExSpiron product**

CDRH Document Control Center:

Respiratory Motion, Inc. (RMI) requests an extension of time to respond to questions regarding 510(k) K120087, sent March 30, 2012.

Respectfully,

Chas Burr
510(k) Correspondent for K120087

cc: Jenny Freeman, CEO, Respiratory Motion, Inc.
Chan Lee, CDRH ODE

31

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Records processed under FOIA Request 2014-156; Released 10/20/14

DEPARTMENT OF HEALTH & HUMAN SERVICES **Public Health Service**

U.S. Food and Drug Administration
Center for Devices and Radiological Health
Document Control Center WO66-G609
10903 New Hampshire Avenue
Silver Spring, MD 20993-0002

June 01, 2012

RESPIRATORY MOTION, INC.
C/O CHAS BURR QR SERVICES
11 MYSTIC AVENUE
WINCHESTER, MASSACHUSETTS 01890-2920
ATTN: CHAS BURR

510k Number: K120087

Product: EXSPIRON

Extended Until: 06/28/2012

Based on your recent request, an extension of time has been granted for you to submit the additional information we requested.

If the additional information (AI) is not received by the "Extended Until" date shown above, your premarket notification will be considered withdrawn (21 CFR 807.87(l)). If the submitter does submit a written request for an extension, FDA will permit the 510(k) to remain on hold for up to a maximum of 180 days from the date of the AI request.

If you have procedural questions, please contact the Division of Small Manufacturers International and Consumer Assistance (DSMICA) at (301)796-7100 or at their toll-free number (800)638-2041, or contact the 510k staff at (301)796-5640.

Sincerely yours,

Marjorie Shulman
Consumer Safety Officer
Premarket Notification Section
Office of Device Evaluation
Center for Devices and Radiological Health

32

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Records processed under FOIA Request 2014-156; Released 10/20/14

x x x COMMUNICATION RESULT REPORT (JUN. 1. 2012 5:52PM) x x x

FAX HEADER 1:
FAX HEADER 2:

T SMITTED/STORED : JUN. 1. 2012 5:52PM				
F MODE	OPTION	ADDRESS	RESULT	PAGE
6007 MEMORY TX		17817232422	OK	1/1

REASON FOR ERROR
E-1) HANG UP OR LINE FAIL
E-2) BUSY
E-3) NO ANSWER
E-4) NO FACSIMILE CONNECTION

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

U.S. Food and Drug Administration
Center for Devices and Radiological Health
Document Control Center WO66-G609
10903 New Hampshire Avenue
Silver Spring, MD 20993-0002

June 01, 2012

RESPIRATORY MOTION, INC.
C/O CHAS BURR QR SERVICES
11 MYSTIC AVENUE
WINCHESTER, MASSACHUSETTS 01890-2920
ATTN: CHAS BURR

510k Number: K120087
Product: EXSPIRON

Extended Until: 06/28/2012

Based on your recent request, an extension of time has been granted for you to submit the additional information we requested.

If the additional information (AI) is not received by the "Extended Until" date shown above, your premarket notification will be considered withdrawn (21 CFR 807.87(l)). If the submitter does submit a written request for an extension, FDA will permit the 510(k) to remain on hold for up to a maximum of 180 days from the date of the AI request.

If you have procedural questions, please contact the Division of Small Manufacturers International and Consumer Assistance (DSMICA) at (301)796-7100 or at their toll-free number (800)638-2041, or contact the 510k staff at (301)796-5640.

Sincerely yours,

Marjorie Shulman
Consumer Safety Officer
Premarket Notification Section
Office of Device Evaluation
Center for Devices and Radiological Health

33

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Records processed under FOIA Request 2014-156; Released 10/20/14

Chas Burr Q/R Services
11 Mystic Avenue
Winchester, Massachusetts
01890-2920

U.S. Food and Drug Administration
Center for Devices and Radiological Health
Document Control Center WO66-G609
10903 New Hampshire Avenue
Silver Spring, MD 20993-0002

FDA/CDRH/DCC
JUN 1 2012
RECEIVED K29

May 31, 2012

Subject: **Request for an Extension of Time to Respond to an FDA Letter Requesting Additional Information 510(k) K120087 – Respiratory Motion, Inc. ExSpiron product**

CDRH Document Control Center:

Respiratory Motion, Inc. (RMI) requests an extension of time to respond to questions regarding 510(k) K120087, sent March 30, 2012.

RMI recently submitted a response, but just received notice from the reviewer that the response is inadequate. RMI has requested clarification. The reason cited by the reviewer seems to be contradicted by the facts in the response.

RMI sincerely hopes that the confusion will be resolved very soon. Until that time, an extension is requested.

Respectfully,

Chas Burr
510(k) Correspondent for K120087

cc: Jenny Freeman, CEO, Respiratory Motion, Inc.
Chan Lee, CDRH ODE

34

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Records processed under FOIA Request 2014-156; Released 10/20/14

Lee, Chan

From: Lee, Chan
Sent: Thursday, May 31, 2012 12:34 PM
To: 'chas_burr@alum.mit.edu'
Subject: Inadequate Incoming for K120087 Supplemental Response

Dear Mr. Burr,

This letter is to inform you that your response letter dated May 24, 2012 was determined inadequate.

In your response letter dated May 24, 2012, you requested that your 510(k) submission be converted from Traditional to Abbreviated. However, we determined that your proposed device is not appropriate for an Abbreviated 510(k) submission according to our guidance document titled "How to Prepare an Abbreviated 510(k)" which is located at http://www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/HowtoMarketYourDevice/PremarketSubmissions/PremarketNotification510k/ucm134574.htm. The guidance document provides the following three conditions for an Abbreviated 510(k): a guidance documents exists; a special control has been established; or FDA has recognized a relevant consensus standard. Your proposed device monitors respiratory function of the patient. However, you have not identified an appropriate guidance document, a special control, or relevant consensus standards relevant to the intended use of your proposed device. Therefore, please provide the requested information in our additional information request letter dated March 30, 2012.

Please be reminded that your response time period is still considered to have started on March 30, 2012 which is the day that you received our additional information request letter dated March 30, 2012. Please contact me directly if you have any questions about this letter.

Sincerely,

Chan O. Lee
Regulatory Reviewer
Food and Drug Administration
Center for Devices and Radiological Health
WO66-2543
10903 New Hampshire Avenue
Silver Spring, MD 20993
Phone: (301) 796-6267
Email: chan.lee@fda.hhs.gov

35

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Records processed under FOIA Request 2014-156; Released 10/20/14

DEPARTMENT OF HEALTH & HUMAN SERVICES **Public Health Service**

U.S. Food and Drug Administration
Center for Devices and Radiological Health
Document Control Center WO66-G609
10903 New Hampshire Avenue
Silver Spring, MD 20993-0002

April 27, 2012

RESPIRATORY MOTION, INC.
C/O CHAS BURR QR SERVICES
11 MYSTIC AVENUE
WINCHESTER, MASSACHUSETTS 01890-2920
ATTN: CHAS BURR

510k Number: K120087

Product: EXSPIRON

Extended Until: 05/31/2012

Based on your recent request, an extension of time has been granted for you to submit the additional information we requested.

If the additional information (AI) is not received by the "Extended Until" date shown above, your premarket notification will be considered withdrawn (21 CFR 807.87(l)). If the submitter does submit a written request for an extension, FDA will permit the 510(k) to remain on hold for up to a maximum of 180 days from the date of the AI request.

If you have procedural questions, please contact the Division of Small Manufacturers International and Consumer Assistance (DSMICA) at (301)796-7100 or at their toll-free number (800)638-2041, or contact the 510k staff at (301)796-5640.

Sincerely yours,

Marjorie Shulman
Consumer Safety Officer
Premarket Notification Section
Office of Device Evaluation
Center for Devices and Radiological Health

36

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Records processed under FOIA Request 2014-156; Released 10/20/14

Mcdonald, Lisa *

From: Microsoft Outlook
To: 'chas_burr@alum.mit.edu'
Sent: Friday, April 27, 2012 8:00 AM
Subject: Relayed: K120087 Ext Letter

Delivery to these recipients or distribution lists is complete, but delivery notification was not sent by the destination:

'chas_burr@alum.mit.edu'

Subject: K120087 Ext Letter

Sent by Microsoft Exchange Server 2007

37

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Records processed under FOIA Request 2014-156; Released 10/20/14

Chas Burr Q/R Services
11 Mystic Avenue
Winchester, Massachusetts
01890-2920

U.S. Food and Drug Administration
Center for Devices and Radiological Health
Document Control Center WO66-G609
10903 New Hampshire Avenue
Silver Spring, MD 20993-0002

K35
FDA CDRH DMC
APR 25 2012
Received

April 23, 2012

Subject: **Request for an Extension of Time to Respond to an FDA Letter Requesting Additional Information 510(k) K120087 – Respiratory Motion, Inc. ExSpiron product**

CDRH Document Control Center:

Respiratory Motion, Inc. (RMI) requests an extension of time to respond to questions regarding 510(k) K120087, sent March 30, 2012.

Our estimate of the time needed for clarification of questions and for additional testing is one month. RMI requests an extension until May 31, 2012.

Respectfully,

Chas Burr
510(k) Correspondent for K120087

cc: Jenny Freeman, CEO, Respiratory Motion, Inc.
Chan Lee, CDRH ODE

38

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Records processed under FOIA Request 2014-156; Released 10/20/14

DEPARTMENT OF HEALTH & HUMAN SERVICES **Public Health Service**

U.S. Food and Drug Administration
Center for Devices and Radiological Health
Document Control Center WO66-G609
10903 New Hampshire Avenue
Silver Spring, MD 20993-0002

April 02, 2012

RESPIRATORY MOTION, INC.
C/O CHAS BURR QR SERVICES
11 MYSTIC AVENUE
WINCHESTER, MASSACHUSETTS 01890-2920
ATTN: CHAS BURR

510k Number: K120087
Product: EXSPIRON
On Hold As of 3/30/2012

We are holding your above-referenced Premarket Notification (510(k)) for 30 days pending receipt of the additional information that was requested by the Office of Device Evaluation. Please remember that all correspondence concerning your submission MUST cite your 510(k) number and be sent in duplicate to the Document Mail Center at the above letterhead address. Correspondence sent to any address other than the one above will not be considered as part of your official premarket notification submission. Also, please note the new Blue Book Memorandum regarding Fax and E-mail Policy entitled, "Fax and E-Mail Communication with Industry about Premarket Files Under Review. Please refer to this guidance for information on current fax and e-mail practices at http://www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/GuidanceDocuments/ucm089402.htm.

The deficiencies identified represent the issues that we believe need to be resolved before our review of your 510(k) submission can be successfully completed. In developing the deficiencies, we carefully considered the statutory criteria as defined in Section 513(i) of the Federal Food, Drug, and Cosmetic Act for determining substantial equivalence of your device. We also considered the burden that may be incurred in your attempt to respond to the deficiencies. We believe that we have considered the least burdensome approach to resolving these issues. If, however, you believe that information is being requested that is not relevant to the regulatory decision or that there is a less burdensome way to resolve the issues, you should follow the procedures outlined in the "A Suggested Approach to Resolving Least Burdensome Issues" document. It is available on our Center web page at: http://www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/Overview/MedicalDeviceProvisionsofFDAModernizationAct/ucm136685.htm.

If after 30 days the additional information (AI), or a request for an extension of time, is not received, we will discontinue review of your submission and proceed to delete your file from our review system (21 CFR 807.87(l)). Please note our guidance document entitled, "Guidance for Industry and FDA Staff, FDA and Industry Actions on Premarket Notification (510(k)) Submissions: Effect on FDA Review Clock and Performance Assessment". If the submitter does submit a written request for an extension, FDA will permit the 510(k) to remain on hold for up to a maximum of 180 days from the date of the AI request. The purpose of this document is to assist agency staff and the device industry in understanding how various FDA and industry actions that may be taken on 510(k)s should affect the review clock for purposes of meeting the Medical Device User Fee and Modernization Act. You may review this document at http://www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/GuidanceDocuments/ucm089735.htm. Pursuant to 21 CFR 20.29, a copy of your 510(k) submission will remain in the Office of Device Evaluation. If you then wish to resubmit this 510(k) notification, a new number will be assigned and your submission will be considered a new premarket notification submission.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Records processed under FOIA Request 2014-156; Released 10/20/14

Please remember that the Safe Medical Devices Act of 1990 states that you may not place this device into commercial distribution until you receive a decision letter from FDA allowing you to do so.

If you have procedural questions, please contact the Division of Small Manufacturers International and Consumer Assistance (DSMICA) at (301)796-7100 or at their toll-free number (800)638-2041, or contact the 510k staff at (301)796-5640.

Sincerely yours,

Marjorie Shulman
Consumer Safety Officer
Premarket Notification Section
Office of Device Evaluation
Center for Devices and Radiological Health

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Records processed under FOIA Request 2014-156; Released 10/20/14

Mcdonald, Lisa *

From: Microsoft Outlook
To: 'chas_burr@alum.mit.edu'
Sent: Monday, April 02, 2012 9:15 AM
Subject: Relayed: K120087 Hold Letter

Delivery to these recipients or distribution lists is complete, but delivery notification was not sent by the destination:

'chas_burr@alum.mit.edu'

Subject: K120087 Hold Letter

Sent by Microsoft Exchange Server 2007

41

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Records processed under FOIA Request 2014-156; Released 10/20/14

DEPARTMENT OF HEALTH & HUMAN SERVICES **Public Health Service**

U.S. Food and Drug Administration
Center for Devices and Radiological Health
Document Control Center WO66-G609
10903 New Hampshire Avenue
Silver Spring, MD 20993-0002

January 11, 2012

RESPIRATORY MOTION, INC.
C/O CHAS BURR QR SERVICES
11 MYSTIC AVENUE
WINCHESTER, MASSACHUSETTS 01890-2920
ATTN: CHAS BURR

510k Number: K120087
Received: 1/11/2012
Product: EXSPIRON

The Food and Drug Administration (FDA), Center for Devices and Radiological Health (CDRH), has received the Premarket Notification, (510(k)), you submitted in accordance with Section 510(k) of the Federal Food, Drug, and Cosmetic Act(Act) for the above referenced product and for the above referenced 510(k) submitter. Please note, if the 510(k) submitter is incorrect, please notify the 510(k) Staff immediately. We have assigned your submission a unique 510(k) number that is cited above. Please refer prominently to this 510(k) number in all future correspondence that relates to this submission. We will notify you when the processing of your 510(k) has been completed or if any additional information is required. YOU MAY NOT PLACE THIS DEVICE INTO COMMERCIAL DISTRIBUTION UNTIL YOU RECEIVE A LETTER FROM FDA ALLOWING YOU TO DO SO.

Please remember that all correspondence concerning your submission MUST be sent to the Document Mail Center (DMC) at the above letterhead address. Correspondence sent to any address other than the one above will not be considered as part of your official 510(k) submission.

On September 27, 2007, the President signed an act reauthorizing medical device user fees for fiscal years 2008 - 2012. The legislation - the Medical Device User Fee Amendments of 2007 is part of a larger bill, the Food and Drug Amendments Act of 2007. Please visit our website at http://www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/Overview/MedicalDeviceUserFeeandModernizationActMDUFMA/default.htm
for more information regarding fees and FDA review goals. In addition, effective January 2, 2008, any firm that chooses to use a standard in the review of ANY new 510(k) needs to fill out the new standards form (Form 3654) and submit it with their 510(k). The form may be found at http://www.fda.gov/AboutFDA/ReportsManualsForms/Forms/default.htm.

We remind you that Title VIII of the Food and Drug Administration Amendments Act of 2007 (FDAAA) amended the PHS Act by adding new section 402(j) (42 U.S.C. § 282(j)), which expanded the current database known as ClinicalTrials.gov to include mandatory registration and reporting of results for applicable clinical trials of human drugs (including biological products) and devices. Section 402(j) requires that a certification form http://www.fda.gov/AboutFDA/ReportsManualsForms/Forms/default.htm accompany 510(k)/HDE/PMA submissions. The agency has issued a draft guidance titled: "Certifications To Accompany Drug, Biological

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Product, and Device Applications/Submissions: Compliance with Section 402(j) of The Public Health Service Act, Added By Title VIII of The Food and Drug Administration Amendments Act of 2007" http://www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/HowtoMarketYourDevice/PremarketSubmissions/PremarketNotification510k/ucm134034.htm. According to the draft guidance, 510(k) submissions that do not contain clinical data do not need the certification form.

Please note the following documents as they relate to 510(k) review: 1) Guidance for Industry and FDA Staff entitled, "Interactive Review for Medical Device Submissions: 510(k)s, Original PMAs, PMA Supplements, Original BLAs and BLA Supplements". This guidance can be found at http://www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/GuidanceDocuments/ucm089402.htm. Please refer to this guidance for information on a formalized interactive review process. 2) Guidance for Industry and FDA Staff entitled, "Format for Traditional and Abbreviated 510(k)s". This guidance can be found at http://www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/GuidanceDocuments/ucm084365.htm. Please refer to this guidance for assistance on how to format an original submission for a Traditional or Abbreviated 510(k).

In all future premarket submissions, we encourage you to provide an electronic copy of your submission. By doing so, you will save FDA resources and may help reviewers navigate through longer documents more easily. Under CDRH's e-Copy Program, you may replace one paper copy of any premarket submission (e.g., 510(k), IDE, PMA, HDE) with an electronic copy. For more information about the program, including the formatting requirements, please visit our web site at http://www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/HowtoMarketYourDevice/PremarketSubmissions/ucm134508.html. In addition, the 510(k) Program Video is now available for viewing on line at http://www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/HowtoMarketYourDevice/PremarketSubmissions/PremarketNotification510k/ucm070201.htm .

Please ensure that whether you submit a 510(k) Summary as per 21 CFR 807.92, or a 510(k) Statement as per 21 CFR 807.93, it meets the content and format regulatory requirements.

Lastly, you should be familiar with the regulatory requirements for medical devices available at Device Advice http://www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/default.htm. If you have questions on the status of your submission, please contact DSMICA at (301)796-7100 or the toll-free number (800)638-2041 , or at their internet address http://www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/default.htm. If you have procedural questions, please contact the 510(k) Staff at (301)796-5640.

Sincerely,

510(k) Staff

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Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Records processed under FOIA Request 2014-156; Released 10/20/14

Sanders, Aisha *

From: Microsoft Outlook
To: 'chas_burr@alum.mit.edu'
Sent: Wednesday, January 11, 2012 2:35 PM
Subject: Relayed: K120087-ACK Letter

Delivery to these recipients or distribution lists is complete, but delivery notification was not sent by the destination:

'chas_burr@alum.mit.edu'

Subject: K120087-ACK Letter

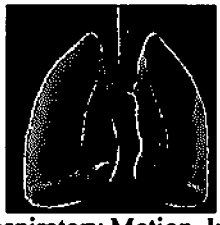
Sent by Microsoft Exchange Server 2007

73

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Records processed under FOIA Request 2014-156; Released 10/20/14

AN/DAGID K120087



Respiratory Motion, Inc.
305 Second Avenue, Suite B
Waltham, Massachusetts 02451

U.S. Food and Drug Administration
Center for Devices and Radiological Health
Document Mail Center – WO66-G609
10903 New Hampshire Avenue
Silver Spring, MD 20993-0002
January 3, 2012

FDA CDRH DMC
JAN 11 2012
Received

Office of Device Evaluation:

Subject: Traditional 510(k) for ExSpiron developed by Respiratory Motion, Inc.

Respiratory Motion, Inc. is submitting a traditional 510(k) for its new product, ExSpiron.

Administrative Information

Common name	Respiratory monitor
Submitter	Respiratory Motion, Inc. 305 Second Avenue, Suite B Waltham, MA 02451
Contact for this 510(k)	Chas Burr Chas Burr Q/R Services 11 Mystic Avenue Winchester, MA 01890-2920 chas_burr@alum.mit.edu 781-789-1646 Fax: 781-723-2422
Long term contact	Jenny Freeman, MD Respiratory Motion, Inc. 305 Second Avenue, Suite B Waltham, MA 02451 jfreeman@respiratorymotion.com 781-373-1526 Fax: 781-373-1653
Confidentiality	Respiratory Motion, Inc. has disclosed publicly its intent to market the device.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Records processed under FOIA Request 2014-156; Released 10/20/14

Classification	21 CFR 868.1850 Monitoring spirometer Product code: BZK Class: II 21 CFR 868.2375 Breathing frequency monitor Product code: BZQ Class: II
Panel	Anesthesiology devices Division of Anesthesiology, General Hospital, Infection Control, and Dental Devices
Prior formal correspondence	Pre-IDE: I110201
Basis for submittal	New device

Design and Use of the ExSpiron

Is the device intended for prescription use (21 CFR 801 Subpart D)?	Yes
Is the device intended for over-the-counter use (21 CFR 807 Subpart C)?	No
Does the device contain components derived from a tissue or other biologic source?	No
Is the device provided sterile?	No
Is the device intended for single use?	No[1]
Is the device a reprocessed single use device?	No
Does the device contain a drug?	No
Does the device contain a biologic?	No
Does the device use software?	Yes
Does the submission include clinical information?	Yes
Is the device implanted?	No

1. The electrode accessories are single use. The primary device is durable equipment.

The electronic copy of this 510(k), provided on an attached CD, is identical in content, to this hard copy 510(k).

Respectfully,

Jenny Freeman, MD
President
Respiratory Motion, Inc.

Encl:

CD with electronic copy of this 510(k)

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Records processed under FOIA Request 2014-156; Released 10/20/14

Respiratory Motion, Inc.

510(k) for ExSpiron Respiratory Monitor

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Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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1. Medical Device User Fee Cover Sheet (Form FDA 3601)

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Records processed under FOIA Request 2014-156; Released 10/20/14

Form Approved: OMB No. 0910-511. See Instructions for OMB Statement.

DEPARTMENT OF HEALTH AND HUMAN SERVICES
FOOD AND DRUG ADMINISTRATION
MEDICAL DEVICE USER FEE COVER SHEET

PAYMENT IDENTIFICATION NUMBER:
B4B4[redacted]
Write the Payment Identification number on your check.

A completed cover sheet must accompany each original application or supplement subject to fees. If payment is sent by U.S. mail or courier, please include a copy of this completed form with payment. Payment and mailing instructions can be found at: http://www.fda.gov/oc/mdufma/coversheet.html

1. COMPANY NAME AND ADDRESS (include name, street address, city state, country, and post office code)

RESPIRATORY MOTION, INC.
305 Second Avenue
Suite B
Waltham MA 02451
US

1.1 EMPLOYER IDENTIFICATION NUMBER (EIN)
B4[redacted]

2. CONTACT NAME
Kamen Bliznashki

2.1 E-MAIL ADDRESS
kamen.bliznashki@respiratorymotion.com

2.2 TELEPHONE NUMBER (include Area code)
781-3731636

2.3 FACSIMILE (FAX) NUMBER (Include Area code)

3. TYPE OF PREMARKET APPLICATION (Select one of the following in each column; if you are unsure, please refer to the application descriptions at the following web site: http://www.fda.gov/oc/mdufma

Select an application type:
[X] Premarket notification(510(k)); except for third party
[ ] 513(g) Request for Information
[ ] Biologics License Application (BLA)
[ ] Premarket Approval Application (PMA)
[ ] Modular PMA
[ ] Product Development Protocol (PDP)
[ ] Premarket Report (PMR)
[ ] Annual Fee for Periodic Reporting (APR)
[ ] 30-Day Notice

3.1 Select a center
[X] CDRH
[ ] CBER

3.2 Select one of the types below
[X] Original Application

Supplement Types:
[ ] Efficacy (BLA)
[ ] Panel Track (PMA, PMR, PDP)
[ ] Real-Time (PMA, PMR, PDP)
[ ] 180-day (PMA, PMR, PDP)

4. ARE YOU A SMALL BUSINESS? (See the instructions for more information on determining this status)
[X] YES, I meet the small business criteria and have submitted the required qualifying documents to FDA
NO, I am not a small business

4.1 If Yes, please enter your Small Business Decision Number: SBD128060

5. FDA WILL NOT ACCEPT YOUR SUBMISSION IF YOUR COMPANY HAS NOT PAID AN ESTABLISHMENT REGISTRATION FEE THAT IS DUE TO FDA. HAS YOUR COMPANY PAID ALL ESTABLISHMENT REGISTRATION FEES THAT ARE DUE TO FDA?
[X] YES (All of our establishments have registered and paid the fee, or this is our first

device, and we will register and pay the fee within 30 days of FDA's approval/clearance of this device.)

[ ] NO (If "NO," FDA will not accept your submission until you have paid all fees due to FDA. This submission will not be processed; see http://www.fda.gov/cdrh/mdufma for additional information)

6. IS THIS PREMARKET APPLICATION COVERED BY ANY OF THE FOLLOWING USER FEE EXCEPTIONS? IF SO, CHECK THE APPLICABLE EXCEPTION.

[ ] This application is the first PMA submitted by a qualified small business, including any affiliates

[ ] The sole purpose of the application is to support conditions of use for a pediatric population

[ ] This biologics application is submitted under section 351 of the Public Health Service Act for a product licensed for further manufacturing use only

[ ] The application is submitted by a state or federal government entity for a device that is not to be distributed commercially

7. IS THIS A SUPPLEMENT TO A PREMARKET APPLICATION FOR WHICH FEES WERE WAIVED DUE TO SOLE USE IN A PEDIATRIC POPULATION THAT NOW PROPOSES CONDITION OF USE FOR ANY ADULT POPULATION? (If so, the application is subject to the fee that applies for an original premarket approval application (PMA).

[ ] YES [X] NO

PAPERWORK REDUCTION ACT STATEMENT

Public reporting burden for this collection of information is estimated to average 18 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the address below.

Department of Health and Human Services, Food and Drug Administration, Office of Chief Information Officer, 1350 Piccard Drive, 4th Floor Rockville, MD 20850

[Please do NOT return this form to the above address, except as it pertains to comments on the burden estimate.]

8. USER FEE PAYMENT AMOUNT SUBMITTED FOR THIS PREMARKET APPLICATION

B4 [redacted]

01-Nov-2011

Form FDA 3601 (01/2007)

"Close Window" Print Cover sheet

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2. CDRH Premarket Review Submission Cover Sheet

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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DEPARTMENT OF HEALTH AND HUMAN SERVICES
FOOD AND DRUG ADMINISTRATION

CDRH PREMARKET REVIEW SUBMISSION COVER SHEET

Form Approval
OMB No. 0910-0120
Expiration Date: December 31, 2013
See OMB Statement on page 5.

Date of Submission	User Fee Payment ID Number	FDA Submission Document Number *(if known)*
December 19, 2011	B4 [redacted]	Not known

SECTION A — TYPE OF SUBMISSION

PMA	PMA & HDE Supplement	PDP	510(k)	Meeting
☐ Original Submission	☐ Regular (180 day)	☐ Original PDP	☒ Original Submission:	☐ Pre-510(K) Meeting
☐ Premarket Report	☐ Special	☐ Notice of Completion	☒ Traditional	☐ Pre-IDE Meeting
☐ Modular Submission	☐ Panel Track (PMA Only)	☐ Amendment to PDP	☐ Special	☐ Pre-PMA Meeting
☐ Amendment	☐ 30-day Supplement		☐ Abbreviated (Complete section I, Page 5)	☐ Pre-PDP Meeting
☐ Report	☐ 30-day Notice		☐ Additional Information	☐ Day 100 Meeting
☐ Report Amendment	☐ 135-day Supplement		☐ Third Party	☐ Agreement Meeting
☐ Licensing Agreement	☐ Real-time Review			☐ Determination Meeting
	☐ Amendment to PMA & HDE Supplement			☐ Other *(specify)*:
	☐ Other			

IDE	Humanitarian Device Exemption (HDE)	Class II Exemption Petition	Evaluation of Automatic Class III Designation (De Novo)	Other Submission
☐ Original Submission	☐ Original Submission	☐ Original Submission	☐ Original Submission	☐ 513(g)
☐ Amendment	☐ Amendment	☐ Additional Information	☐ Additional Information	☐ Other *(describe submission)*:
☐ Supplement	☐ Supplement			
	☐ Report			
	☐ Report Amendment			

Have you used or cited Standards in your submission? ☐ Yes ☐ No *(If Yes, please complete Section I, Page 5)*

SECTION B — SUBMITTER, APPLICANT OR SPONSOR

Company / Institution Name: Respiratory Motion, Inc.	Establishment Registration Number *(if known)*: Not yet registered.		
Division Name *(if applicable)*: Not applicable.	Phone Number *(including area code)*: 781-373-1526		
Street Address: 305 Second Avenue, Suite B	FAX Number *(including area code)*: 781-373-1653		
City: Waltham	State / Province: MA	ZIP/Postal Code: 02451	Country: USA
Contact Name: Jenny Freeman, MD			
Contact Title: President	Contact E-mail Address: jfreeman@respiratorymotion.com		

SECTION C — APPLICATION CORRESPONDENT (e.g., consultant, if different from above)

Company / Institution Name: Chas Burr QR Services			
Division Name *(if applicable)*: Not applicable	Phone Number *(including area code)*: 781-789-1646		
Street Address: 11 Mystic Avenue	FAX Number *(including area code)*: 781-723-2422		
City: Winchester	State / Province: MA	ZIP Code: 01890-2920	Country: USA
Contact Name: Chas Burr			
Contact Title: Consultant	Contact E-mail Address: chas_burr@alum.mit.edu		

PSC Publishing Services (301) 443-6740 EF

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

SECTION D1 — REASON FOR APPLICATION - PMA, PDP, OR HDE

- ☐ New Device
- ☐ Withdrawal
- ☐ Additional or Expanded Indications
- ☐ Request for Extension
- ☐ Post-approval Study Protocol
- ☐ Request for Applicant Hold
- ☐ Request for Removal of Applicant Hold
- ☐ Request to Remove or Add Manufacturing Site

- ☐ Change in design, component, or specification:
  - ☐ Software / Hardware
  - ☐ Color Additive
  - ☐ Material
  - ☐ Specifications
  - ☐ Other *(specify below)*

- ☐ Location change:
  - ☐ Manufacturer
  - ☐ Sterilizer
  - ☐ Packager

- ☐ Process change:
  - ☐ Manufacturing ☐ Packaging
  - ☐ Sterilization
  - ☐ Other *(specify below)*

- ☐ Labeling change:
  - ☐ Indications
  - ☐ Instructions
  - ☐ Performance Characteristics
  - ☐ Shelf Life
  - ☐ Trade Name
  - ☐ Other *(specify below)*

- ☐ Report Submission:
  - ☐ Annual or Periodic
  - ☐ Post-approval Study
  - ☐ Adverse Reaction
  - ☐ Device Defect
  - ☐ Amendment

- ☐ Response to FDA correspondence:

- ☐ Change in Ownership
- ☐ Change in Correspondent
- ☐ Change of Applicant Address

☐ Other Reason *(specify)*:

SECTION D2 — REASON FOR APPLICATION - IDE

- ☐ New Device
- ☐ New Indication
- ☐ Addition of Institution
- ☐ Expansion / Extension of Study
- ☐ IRB Certification
- ☐ Termination of Study
- ☐ Withdrawal of Application
- ☐ Unanticipated Adverse Effect
- ☐ Notification of Emergency Use
- ☐ Compassionate Use Request
- ☐ Treatment IDE
- ☐ Continued Access

- ☐ Change in:
  - ☐ Correspondent / Applicant
  - ☐ Design / Device
  - ☐ Informed Consent
  - ☐ Manufacturer
  - ☐ Manufacturing Process
  - ☐ Protocol - Feasibility
  - ☐ Protocol - Other
  - ☐ Sponsor

- ☐ Report submission:
  - ☐ Current Investigator
  - ☐ Annual Progress Report
  - ☐ Site Waiver Report
  - ☐ Final

- ☐ Response to FDA Letter Concerning:
  - ☐ Conditional Approval
  - ☐ Deemed Approved
  - ☐ Deficient Final Report
  - ☐ Deficient Progress Report
  - ☐ Deficient Investigator Report
  - ☐ Disapproval
  - ☐ Request Extension of Time to Respond to FDA
  - ☐ Request Meeting
  - ☐ Request Hearing

☐ Other Reason *(specify)*:

SECTION D3 — REASON FOR SUBMISSION - 510(k)

- ☒ New Device
- ☐ Additional or Expanded Indications
- ☐ Change in Technology

☐ Other Reason *(specify)*:

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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SECTION E ADDITIONAL INFORMATION ON 510(K) SUBMISSIONS

Product codes of devices to which substantial equivalence is claimed

1	BZK	2	BZQ	3		4	
5		6		7		8	

Summary of, or statement concerning, safety and effectiveness information

- [x] 510 (k) summary attached
- [ ] 510 (k) statement

Information on devices to which substantial equivalence is claimed *(if known)*

	510(k) Number		*Trade or Proprietary or Model Name*		*Manufacturer*
1	K091853	1	nSpire Wright/Haloscale Respirometer	1	nSpire Health, Inc.
2	K060541	2	Philips MPn0 Intellivue Patient Monitors	2	Philips Healthcare
3		3		3	
4		4		4	
5		5		5	
6		6		6	

SECTION F PRODUCT INFORMATION - APPLICATION TO ALL APPLICATIONS

Common or usual name or classification name

Respiratory Monitor

	Trade or Proprietary or Model Name for This Device		Model Number
1	ExSpiron	1	200
2		2	
3		3	
4		4	
5		5	

FDA document numbers of all prior related submissions *(regardless of outcome)*

1 Pre-IDE I110201	2	3	4	5	6
7	8	9	10	11	12

Data Included in Submission

- [ ] Laboratory Testing
- [ ] Animal Trials
- [x] Human Trials

SECTION G PRODUCT CLASSIFICATION - APPLICATION TO ALL APPLICATIONS

Product Code	C.F.R. Section *(if applicable)*	Device Class
BZK, BZQ	21 CFR 868.1850, 21 CFR 868.2375	[ ] Class I [x] Class II [ ] Class III [ ] Unclassified

Classification Panel

Anesthesiology devices

Indications *(from labeling)*

Insufficient space of Indications. Please see the additional document attached to this cover sheet.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Note: Submission of the information entered in Section H does not affect the need to submit device establishment registration.

FDA Document Number *(if known)*: Not yet known

SECTION H — MANUFACTURING / PACKAGING / STERILIZATION SITES RELATING TO A SUBMISSION

☒ Original ☐ Add ☐ Delete

Facility Establishment Identifier (FEI) Number: Not yet registered

☒ Manufacturer ☐ Contract Sterilizer ☐ Contract Manufacturer ☐ Repackager / Relabeler

Company / Institution Name: Respiratory Motion, Inc.

Establishment Registration Number: Not yet registered

Division Name *(if applicable)*: Not applicable

Phone Number *(including area code)*: 781-373-1636

Street Address: 305 Second Avenue, Suite B

FAX Number *(including area code)*: 781-373-1653

City: Waltham

State / Province: MA

ZIP Code: 02451

Country: USA

Contact Name: Jenny Freeman, MD

Contact Title: President

Contact E-mail Address: jfreeman@respiratorymotion.com

☐ Original ☐ Add ☐ Delete

Facility Establishment Identifier (FEI) Number:

☐ Manufacturer ☐ Contract Sterilizer ☐ Contract Manufacturer ☐ Repackager / Relabeler

Company / Institution Name:

Establishment Registration Number:

Division Name *(if applicable)*:

Phone Number *(including area code)*:

Street Address:

FAX Number *(including area code)*:

City:

State / Province:

ZIP Code:

Country:

Contact Name:

Contact Title:

Contact E-mail Address:

☐ Original ☐ Add ☐ Delete

Facility Establishment Identifier (FEI) Number:

☐ Manufacturer ☐ Contract Sterilizer ☐ Contract Manufacturer ☐ Repackager / Relabeler

Company / Institution Name:

Establishment Registration Number:

Division Name *(if applicable)*:

Phone Number *(including area code)*:

Street Address:

FAX Number *(including area code)*:

City:

State / Province:

ZIP Code:

Country:

Contact Name:

Contact Title:

Contact E-mail Address:

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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SECTION I UTILIZATION OF STANDARDS

Note: Complete this section if your application or submission cites standards or includes a *"Declaration of Conformity to a Recognized Standard"* statement.

	Standards No.	Standards Organization	Standards Title	Version	Date
1	IEC 60601-1	International Electrotechnical Commission	Medical Electrical Equipment - Part 1: General Requirements for Safety	3d edition 2005	
2	AAMI/ANSI/IEC 60601-1-2	International Electrotechnical Commission	Medical Electrical Equipment -Part 1-2: General Requirements for Safety - Collateral standard: Electromagnetic Compatibility - Requirements and Tests	2001 with Amendment 1 2004	
3	21 CFR 898	FDA	Performance Standard for Electrode Lead Wire and Patient Cables		
4	ANSI/AAMI EC 53	ANSI / AAMI	ECG Cables and Wires	1995(R)2008	
5					
6					
7					

Please include any additional standards to be cited on a separate page.

Public reporting burden for this collection of information is estimated to average 0.5 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to:

Department of Health and Human Services
Food and Drug Administration
Office of Chief Information Officer
1350 Piccard Drive, Room 400
Rockville, MD 20850

An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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3. 510(k) Cover Letter

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Records processed under FOIA Request 2014-156; Released 10/20/14

Respiratory Motion, Inc.
305 Second Avenue, Suite B
Waltham, Massachusetts 02451

U.S. Food and Drug Administration
Center for Devices and Radiological Health
Document Mail Center – WO66-G609
10903 New Hampshire Avenue
Silver Spring, MD 20993-0002
January 3, 2012

Office of Device Evaluation:

Subject: Traditional 510(k) for ExSpiron developed by Respiratory Motion, Inc.

Respiratory Motion, Inc. is submitting a traditional 510(k) for its new product, ExSpiron.

Administrative Information

Common name	Respiratory monitor
Submitter	Respiratory Motion, Inc. 305 Second Avenue, Suite B Waltham, MA 02451
Contact for this 510(k)	Chas Burr Chas Burr Q/R Services 11 Mystic Avenue Winchester, MA 01890-2920 chas_burr@alum.mit.edu 781-789-1646 Fax: 781-723-2422
Long term contact	Jenny Freeman, MD Respiratory Motion, Inc. 305 Second Avenue, Suite B Waltham, MA 02451 jfreeman@respiratorymotion.com 781-373-1526 Fax: 781-373-1653
Confidentiality	Respiratory Motion, Inc. has disclosed publicly its intent to market the device.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Classification	21 CFR 868.1850 Monitoring spirometer Product code: BZK Class: II 21 CFR 868.2375 Breathing frequency monitor Product code: BZQ Class: II
Panel	Anesthesiology devices Division of Anesthesiology, General Hospital, Infection Control, and Dental Devices
Prior formal correspondence	Pre-IDE: I110201
Basis for submittal	New device

Design and Use of the ExSpiron

Is the device intended for prescription use (21 CFR 801 Subpart D)?	Yes
Is the device intended for over-the-counter use (21 CFR 807 Subpart C)?	No
Does the device contain components derived from a tissue or other biologic source?	No
Is the device provided sterile?	No
Is the device intended for single use?	No[1]
Is the device a reprocessed single use device?	No
Does the device contain a drug?	No
Does the device contain a biologic?	No
Does the device use software?	Yes
Does the submission include clinical information?	Yes
Is the device implanted?	No

1. The electrode accessories are single use. The primary device is durable equipment.

The electronic copy of this 510(k), provided on an attached CD, is identical in content, to this hard copy 510(k).

Respectfully,

Jenny Freeman, MD
President
Respiratory Motion, Inc.

Encl:

CD with electronic copy of this 510(k)

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Records processed under FOIA Request 2014-156; Released 10/20/14

4. Indications for Use Statement

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Records processed under FOIA Request 2014-156; Released 10/20/14

Indications For Use

510(k) Number (if known): Not known at time of submission
Device Name: ExSpiron
Indications for Use:

ExSpiron is indicated for use by healthcare professionals in healthcare facilities, such as post-operative care and critical care units, to monitor breathing in patients with potential respiratory compromise.

ExSpiron is a non-invasive system that graphically displays lung volume against time and reports an approximate value of:

- Tidal volume,
- Respiratory rate, and
- Minute ventilation.

ExSpiron measurements are used as an adjunct to other clinical information sources to determine respiratory status and appropriate therapy.

Prescription Use _____ AND/OR Over-The-Counter Use_____
(Part 21 CFR 801 Subpart D) (Part 21 CFR 801 Subpart C)

(PLEASE DO NOT WRITE BELOW THIS LINE-CONTINUE ON ANOTHER PAGE IF NEEDED)

Concurrence of CDRH, Office of Device Evaluation (ODE)

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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5. 510(k) Summary

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Records processed under FOIA Request 2014-156; Released 10/20/14

510(k) Summary

510(k) Owner:	Respiratory Motion, Inc.
Address:	305 Second Avenue, Suite B Waltham, Massachusetts 02451
Phone:	781-373-1636
Fax:	781-373-1653
Contact person:	Jenny Freeman, MD
Date 510(k) Summary prepared:	January 2, 2012
Trade name:	ExSpiron™
Common name:	Respiratory Monitor
Classifications:	Monitoring spirometer Product code: BZK Regulation: 21 CFR 868.1850 Breathing frequency monitor Product code BZQ Regulation: 21 CFR 868.2375
Predicate devices:	For product code BZK, nSpire Wright/Haloscale Respirometer, marketed by nSpire Health, Inc. of Longmont, CO 510(k) K091853 For product code BZQ, Philips MPn0 Intellivue Patient Monitors, marketed by Philips Healthcare 510(k) K060541
Device Description:	The ExSpiron™ consists of: • **Bioimpedance measurement system**: A stabilized high frequency current generator connected to the outer two electrodes. Two measurement channels convert the resulting voltage signal to digital form. Each channel consists of a pair of electrodes placed between the two "source" electrodes, and an adaptive circuit to condition the signal. Firmware performs signal acquisition and relays data to the panel PC. • **Panel PC**: A Windows 7 PC that performs signal processing and calibration, and runs the graphical user interface (GUI). The PC takes user input from the touch screen through a virtual keyboard and mouse. The GUI is used for recording patient data and displaying the respiratory trace as well as scalar values and trends for minute ventilation, tidal volume, and respiratory rate. • **Single Patient Use ExSpiron Electrode Pad Set:** An electrode set containing two electrode pads to be placed on the torso. It delivers current and records impedance measurements. The electrode pad set is also used to perform subsystem checks prior to patient measurements.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Records processed under FOIA Request 2014-156; Released 10/20/14

Intended use:	ExSpiron is indicated for use by healthcare professionals in healthcare facilities, such as post-operative care and critical care units, to monitor breathing in patients with potential respiratory compromise. ExSpiron is a non-invasive system that graphically displays lung volume against time and reports an approximate value of: • Tidal volume, • Respiratory rate, and • Minute ventilation. ExSpiron measurements are used as an adjunct to other clinical information sources to determine respiratory status and appropriate therapy.
Comparison of technological characteristics:	

Characteristic	ExSpiron	nSpire	Philips Intellivue Monitor	Comment
Intended Use	See above	See K091853	See K060541	The clinical application of the ExSpiron is equivalent to that of the nSpire The comparison to the intended use of the Philips monitor is restricted to monitoring of respiration rate ExSpiron has no alarm function All devices are used by healthcare professionals
Technology	Measurement is by thoracic bioimpedance	Measurement is by in-line turbine flow meter	Measurement is by bioimpedance	
Volume Measurements	Tidal volume Minute ventilation Volume vs time chart	Tidal volume Minute ventilation	None	The time function for the minute ventilation measurement of the nSpire is provided by a user's stopwatch
Rate Measurements	Respiratory rate (breaths/min)	None	Respiratory rate	
Safety	IEC 60601-1, including electrical and mechanical safety	Mechanical only Safety specifications are not given in the user manual or 510(k) summary	IEC 60601-1, etc	

Nonclinical testing:	Nonclinical testing is for conformance to IEC 60601-1.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Clinical performance data:

A clinical study with twenty subjects determined that the ExSpiron™ is equivalent in performance to the predicate device, a Wright Respirometer. The study also determined that calibration remained adequate for 24 hours.

Subjects varied in age, ethnicity, and anthropometrics. Pertinent co-morbidities included asthma, chronic obstructive pulmonary disease (COPD), obstructive sleep apnea, congestive heart failure, and chronic renal insufficiency.

Measurements of Minute Ventilation (MV), Tidal Volume (TV), and Respiratory Rate (RR) were taken simultaneously from the ExSpiron™ and the Wright Respirometer. Each subject completed ten sets of measurements on Day 1, and another ten sets 24 hours later on Day 2.

Bias, precision, and accuracy were calculated based on the relative error between the ExSpiron™ and Wright Respirometer measurements. Results for Day 1 and Day 2 are shown in Tables 1 and 2. Results for Day 1 and Day 2 were not statistically different.

Table 1 - Percentage Bias, Precision and Accuracy on Day 1

	Minute Ventilation	Tidal Volume	Respiratory Rate
Bias	-2.3	-1.7	-0.6
Precision	10. 2	9.7	2.3
Accuracy	10.4	9.8	2.4

Table 2 - Percentage Bias, Precision and Accuracy on Day 2

	Minute Ventilation	Tidal Volume	Respiratory Rate
Bias	-1.9	-2.0	0.2
Precision	10.8	10.8	1.6
Accuracy	10.9	11.0	1.6

Data from both days were combined. The results, shown in Table 3, demonstrate equivalent performance between ExSpiron™ and the Wright Respirometer.

Table 3 - Percentage Bias, Precision and Accuracy on Days 1 and 2

	Minute Ventilation	Tidal Volume	Respiratory Rate
Bias	-2. 1	-1.9	-0.2
Precision	10.5	10.3	2.0
Accuracy	10.7	10.4	2.0

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Records processed under FOIA Request 2014-156; Released 10/20/14

Conclusions regarding safety and effectiveness:	Based on the comparisons of intended use, and results of nonclinical and clinical testing, the ExSpiron is substantially equivalent in intended use, safety, and effectiveness to the nSpire Respirometer and to the breathing frequency monitor function of the Philips Intellivue Patient Monitors.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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6. Truthful and Accurate Statement

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Truthful and Accurate Statement

I certify that, in my capacity as President of Respiratory Motion, Inc. I believe to the best of my knowledge, that all data and information submitted in the premarket notification are truthful and accurate and that no material fact has been omitted.

(Signature)

Jenny Freeman, MD

_December 19, 2011_____
(Date)

ExSpiron 510(k) 510(k) number not known at submission.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Records processed under FOIA Request 2014-156; Released 10/20/14

7. Class III Summary and Certification

A Class III Summary and Certification is not applicable, because the ExSpiron™ is a Class II device.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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8. Financial Certification Statement

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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DEPARTMENT OF HEALTH AND HUMAN SERVICES
Food and Drug Administration

CERTIFICATION: FINANCIAL INTERESTS AND ARRANGEMENTS OF CLINICAL INVESTIGATORS

Form Approved: OMB No. 0910-0396
Expiration Date: August 31, 2012

TO BE COMPLETED BY APPLICANT

With respect to all covered clinical studies (or specific clinical studies listed below (if appropriate)) submitted in support of this application, I certify to one of the statements below as appropriate. I understand that this certification is made in compliance with 21 CFR part 54 and that for the purposes of this statement, a clinical investigator includes the spouse and each dependent child of the investigator as defined in 21 CFR 54.2(d).

Please mark the applicable checkbox.

☒ (1) As the sponsor of the submitted studies, I certify that I have not entered into any financial arrangement with the listed clinical investigators (enter names of clinical investigators below or attach list of names to this form) whereby the value of compensation to the investigator could be affected by the outcome of the study as defined in 21 CFR 54.2(a). I also certify that each listed clinical investigator required to disclose to the sponsor whether the investigator had a proprietary interest in this product or a significant equity in the sponsor as defined in 21 CFR 54.2(b) did not disclose any such interests. I further certify that no listed investigator was the recipient of significant payments of other sorts as defined in 21 CFR 54.2(f).

Clinical Investigators		
	Agustin Florian, MD	

☐ (2) As the applicant who is submitting a study or studies sponsored by a firm or party other than the applicant, I certify that based on information obtained from the sponsor or from participating clinical investigators, the listed clinical investigators (attach list of names to this form) did not participate in any financial arrangement with the sponsor of a covered study whereby the value of compensation to the investigator for conducting the study could be affected by the outcome of the study (as defined in 21 CFR 54.2(a)); had no proprietary interest in this product or significant equity interest in the sponsor of the covered study (as defined in 21 CFR 54.2(b)); and was not the recipient of significant payments of other sorts (as defined in 21 CFR 54.2(f)).

☐ (3) As the applicant who is submitting a study or studies sponsored by a firm or party other than the applicant, I certify that I have acted with due diligence to obtain from the listed clinical investigators (attach list of names) or from the sponsor the information required under 54.4 and it was not possible to do so. The reason why this information could not be obtained is attached.

NAME	TITLE
Jenny Freeman, MD	President
FIRM/ORGANIZATION Respiratory Motion, Inc.	
SIGNATURE	DATE *(mm/dd/yyyy)* 11/18/2011

Paperwork Reduction Act Statement

An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. Public reporting burden for this collection of information is estimated to average 1 hour per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the necessary data, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information to the address to the right:

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Food and Drug Administration
Office of Chief Information Officer
1350 Piccard Drive, 420A
Rockville, MD 20850

PSC Graphics (301) 443-1090 EF

FORM FDA 3454 (10/09)

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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9. Statement Regarding Reliance on Standards

Before ExSpiron™ is released for commercial shipment, the system will be tested for conformance to:

- IEC 60601-1:2005, 3d edition, Medical Electrical Equipment - Part 1: General Requirements for Safety
- IEC 60601-1-2:2001 with Amendment 1:2004 Medical Electrical Equipment - Part 1-2: General Requirements for Safety - Collateral standard: Electromagnetic Compatibility - Requirements and Tests

The entire ExSpiron™ operates on power from the Medix 11i panel PC's power adaptor connected to mains power. There is no battery power.

B4 [redacted]

Respiratory Motion's testing will confirm that the entire device is compliant to IEC 60601-1. In particular:

- Class 1 protection against electric shock, operating from a specified supply.
- IPX2 protection against fluid
- Type BF applied part, defibrillator proof
- Continuous duty cycle
- Not suitable for use with flammable anesthetics

For IEC 60601-1-2, ExSpiron will comply with Class A emissions and to non-life-supporting levels for immunity.

B4 [redacted] disposable electrodes, states that they meet or exceed AAMI specifications for monitoring electrodes, presumably including ANSI/AAMI EC12.

The patient cable and patient leads will conform to FDA's Performance Standard for Electrode Lead Wires and Patient Cables, 21 CFR 898, and to ANSI/AAMI EC53: 1995/(R)2008 – ECG Cables and Wires

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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10. Executive Summary

Description of the device

The ExSpiron™ is a respiratory monitor that consists of:

- Bioimpedance measurement system:
  A stabilized high frequency current generator connected to the outer two electrodes. Two measurement channels convert the resulting voltage signal to digital form. Each channel consists of a pair of electrodes placed between the two "source" electrodes and an adaptive circuit to condition the signal. Firmware performs signal acquisition and relays data to the panel PC.
- Panel PC:
  A Windows 7 PC that performs signal processing and calibration, and runs the graphical user interface (GUI). The PC takes user input from the touch screen through a virtual keyboard and mouse. The GUI is used for recording patient data and displaying the respiratory trace as well as scalar values and trends for minute volume, tidal volume, and respiratory rate.
- Single Patient Use ExSpiron Electrode Lead Set: An electrode set containing two electrode pads to be placed on the torso. It delivers current and records impedance measurements. The electrode lead set is also used to perform subsystem checks prior to patient measurements.

The intended use is:

ExSpiron is indicated for use by healthcare professionals in healthcare facilities, such as post-operative care and critical care units, to monitor breathing in patients with potential respiratory compromise.

ExSpiron is a non-invasive system that graphically displays lung volume against time and reports an approximate value of:

- Tidal volume,
- Respiratory rate, and
- Minute ventilation.

ExSpiron measurements are used as an adjunct to other clinical information sources to determine respiratory status and appropriate therapy.

The ExSpiron functions match two device classifications:

- Monitoring spirometer, product code BZK, 21 CFR 868.1850
  Predicate device - nSpire Wright/Haloscale Respirometer, 510(k) K091853

- Breathing frequency monitor, product code BZQ, 21 CFR 868.2375
  Predicate device - Philips MPn0 Intellivue Patient Monitors, 510(k) K060541

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Device comparison table

Characteristic	ExSpiron™	nSpire	Philips Intellivue Monitor	Comment
Intended Use	ExSpiron™ is indicated for use by healthcare professionals in healthcare facilities, such as post-operative care and critical care units, to monitor breathing in patients with potential respiratory compromise ExSpiron is a non-invasive system that graphically displays lung volume against time and reports an approximate value of: • Tidal volume, • Respiratory rate, and • Minute ventilation ExSpiron measurements are used as an adjunct to other clinical information sources to determine respiratory status and appropriate therapy	"The intended use of the Wright/Haloscale Respirometer is the measurement and monitoring of the level of lung ventilation achieved by intensive care patients, during anesthesia and post operative recovery It measures expired volumes and thus indicates whether adequate ventilation is being achieved, whether in open or closed circuit or spontaneously breathing or mechanically ventilated patients "	"Indicated for use by health care professionals whenever there is a need for monitoring the physiological parameters of patients Intended for monitoring, recording and alarming of multiple physiological parameters of adults, pediatrics and neonates in healthcare facilities The MP20, MP30, MP40 and MP 50 are additionally intended for use in transport situations within healthcare facilities ST Segment monitoring is restricted to adult patients only The transcutaneous gas measurement (tcpO2 / tcpCO2 is restricted to neonatal patients only "	The clinical application of the ExSpiron is equivalent to that of the nSpire The comparison to the intended use of the Philips monitor is restricted to monitoring of respiration rate ExSpiron has no alarm function All devices are to be used by healthcare professionals
Technology	Measurement is by thoracic bioimpedance	Measurement is by in-line turbine flow meter	Measurement is by bioimpedance	
Volume Measurements	Tidal volume Minute volume Volume vs time chart	Tidal volume Minute volume	None	The time function for the minute volume measurement of the nSpire is provided by a user's stopwatch
Rate Measurements	Respiratory rate (breaths/min)	None	Respiratory rate	
Safety	IEC 60601-1, including electrical and mechanical safety	Mechanical only Safety specifications are not given in the user manual or 510(k) summary	IEC 60601-1, etc	

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Summary of performance testing

A clinical study with twenty subjects determined that the ExSpiron™ is equivalent in performance to the predicate device, a Wright Respirometer. The study also determined that calibration remained adequate for 24 hours.

Subjects varied in age, ethnicity, and anthropometrics. Pertinent co-morbidities included asthma, chronic obstructive pulmonary disease (COPD), obstructive sleep apnea, congestive heart failure, and chronic renal insufficiency.

Measurements of Minute Ventilation (MV), Tidal Volume (TV), and Respiratory Rate (RR) were taken simultaneously from the ExSpiron™ and the Wright Respirometer. Each subject completed ten sets of measurements on Day 1, and another ten sets 24 hours later on Day 2.

Bias, precision, and accuracy were calculated based on the relative error between the ExSpiron™ and Wright Respirometer measurements. Results for Day 1 and Day 2 are shown in Tables 1 and 2. Results for Day 1 and Day 2 were not statistically different.

Table 1 - Percentage Bias, Precision and Accuracy on Day 1

	Minute Ventilation	Tidal Volume	Respiratory Rate
Bias	-2.3	-1.7	-0.6
Precision	10. 2	9.7	2.3
Accuracy	10.4	9.8	2.4

Table 2 - Percentage Bias, Precision and Accuracy on Day 2

	Minute Ventilation	Tidal Volume	Respiratory Rate
Bias	-1.9	-2.0	0.2
Precision	10.8	10.8	1.6
Accuracy	10.9	11.0	1.6

Data from both days were combined. The results, shown in Table 3, demonstrate equivalent performance between ExSpiron™ and the Wright Respirometer.

Table 3 - Percentage Bias, Precision and Accuracy on Days 1 and 2

	Minute Ventilation	Tidal Volume	Respiratory Rate
Bias	-2. 1	-1.9	-0.2
Precision	10.5	10.3	2.0
Accuracy	10.7	10.4	2.0

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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11. Device Description

Device Overview

Introduction

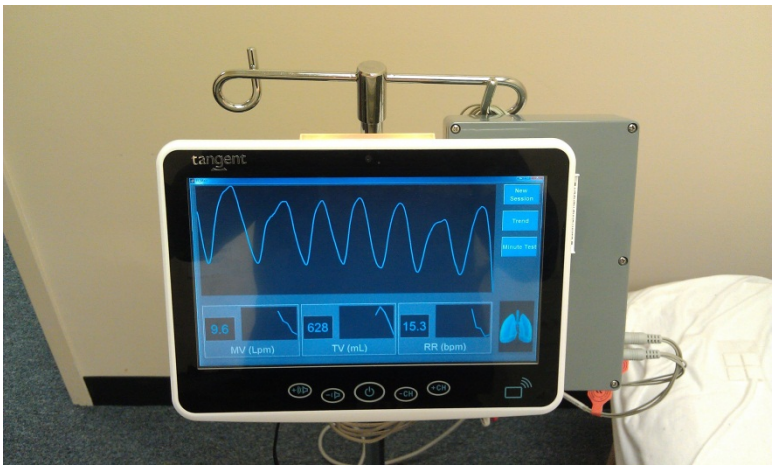
The system consists of a portable medical grade computer connected by USB to an impedance-measuring module. The impedance-measuring module measures impedance over two channels, utilizing six electrodes. The device has a clamp to allow it to attach to medical monitoring poles. The monitor is designed to be portable (although not operable in transport) and convenient for hospital staff. The electrode pads are applied to the patient and connected to the leads by the user.

The monitor acquires bioelectrical impedance data and determines an approximate value for lung volume, from which it is possible to calculate values tidal volume, minute ventilation, and respiratory rate. The monitor then presents the time-series volume data in the form of a scrolling graph. Calculated values for respiratory parameters are averaged over a period of approximately one minute and displayed as scalar values, updating with an approximate period of 5 seconds.

Electrodes can be used for up to 24 hours and are disposed after use. This minimizes the risk of patient irritation and cross-patient infection.

The monitor is automatically tested and then the user conducts a calibration procedure before each patient monitoring session.

Photos



Front view of prototype

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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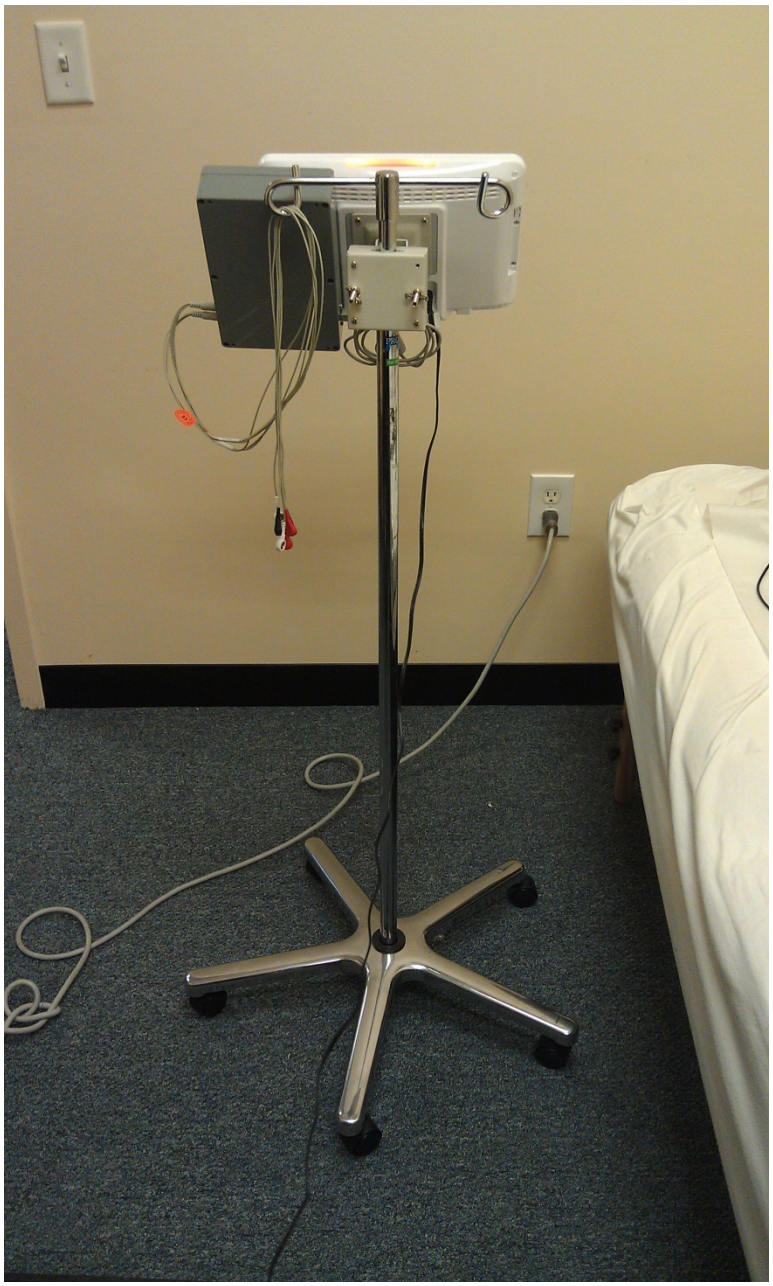

Back view of prototype on medical monitoring pole

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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B4

Physical Specifications

B4

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B4 Technical Specs

B4 Technical Specs

B4 Technical Specs

B4 Technical Specs

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12. Substantial Equivalence Discussion

This section contains a summary of how FDA's *"510(k) 'Substantial Equivalence' Decision Making Process"* applies to the ExSpiron. The summary is then followed by a summary comparison table.

510(k) 'Substantial Equivalence' Decision Making Process

New Device is Compared to Marketed Device

For product code BZK, monitoring spirometer, the ExSpiron is compared to the nSpire Wright/Haloscale Respirometer, marketed by nSpire Health, Inc. of Longmont, CO. FDA cleared the nSpire respirometer in 510(k) K 091853.

For product code BZQ, breathing frequency monitor, the ExSpiron is compared to the Philips MP*n*0 Intellivue Patient Monitors, marketed by Philips Healthcare. FDA cleared the Intellivue monitor in 510(k) K060541.

Does New Device have Same Indication Statements?

No. The indication statements are similar but not identical.

The ExSpiron intended use is:

> ExSpiron is indicated for use by healthcare professionals in healthcare facilities, such as post-operative care and critical care units, to monitor breathing in patients with potential respiratory compromise.
>
> ExSpiron is a non-invasive system that graphically displays lung volume against time and reports an approximate value of:
>
> - Tidal volume,
> - Respiratory rate, and
> - Minute ventilation.
>
> ExSpiron measurements are used as an adjunct to other clinical information sources to determine respiratory status and appropriate therapy.

The nSpire intended use (from the 510(k) summary) is:

> "The intended use of the Wright/Haloscale Respirometer is the measurement and monitoring of the level of lung ventilation achieved by intensive care patients, during anesthesia and post-operative recovery.
>
> It measures expired volumes and thus indicates whether adequate ventilation is being achieved, whether in open or closed circuit or spontaneously breathing or mechanically ventilated patients."

The Philips Intellivue Monitors' intended use is:

> "Indicated for use by health care professionals whenever there is a need for monitoring the physiological parameters of patients. Intended for monitoring, recording and alarming of multiple physiological parameters of adults, pediatrics and neonates in

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healthcare facilities. The MP20, MP30, MP40 and MP 50 are additionally intended for use in transport situations within healthcare facilities.

ST Segment monitoring is restricted to adult patients only.

The transcutaneous gas measurement ($tcpO_2$ / $tcpCO_2$ is restricted to neonatal patients only."

(Note: The Philips monitor can monitor many physiological variables. For this sake of this 510(k), only the breathing frequencey function is applicable.)

Do the Differences Alter the Intended Therapeutic/Diagnostic/etc. Effect (In Deciding, May Consider Impact on Safety and Effectiveness)?

No. The devices are intended for use by healthcare professionals. The purpose is to determine adequacy of respiration. Thus, the clinical application of the nSpire and the ExSpiron is essentially the same

The Philips Intellivue monitor intended use covers many functions that ExSpiron does not have. Only the respiration monitoring is relevant. ExSpiron has no alarm function.

New Device Has Same Intended Use and May be "Substantially Equivalent".

Does New Device Have Same Technological Characteristics, e.g., Design, Materials. Etc.?

Yes. The ExSpiron uses bioimpedance measurements and calculates volume and breathing frequency values. The Philips Intellivue Monitor uses impedance measurement for measuring breathing frequency. The nSpire uses an in-line turbine to measure flow and calculates volume and flow.

Are the Descriptive Characteristics Precise Enough to Ensure Equivalence?

No.

Are Performance Data Available to Assess Equivalence?

Yes. Accuracy of measurements can be determined by clinical studies that simultaneously measure patient's ventilation with both the ExSpiron and the nSpire. A stop watch is used to determine actual breathing frequency. The study is a clinical experiment because bioimpedance measurements must be conducted in a living human.

Safety of bioimpedance testing is determined by specification comparison to bioimpedance measurements in the Philips Intellivue monitors, a device with a similar function and by conformance to the IEC 60601-1 medical device safety standard.

Performance Data Demonstrate Equivalence?

Yes. Data demonstrates that ExSpiron's displayed values for volumes and rate are equivalent to nSpire's displayed values for volumes and rates.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Data in chapter 18 demonstrates that the electrical safety of ExSpiron's bioimpedance measurement is consistent with existing devices that use bioimpedance measurements and complies with electrical safety standards.

"Substantially Equivalent" Determination

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Comparison of the ExSpiron to the nSpire respirometer and the Philips Intellivue Monitor

Characteristic	ExSpiron	nSpire	Philips Intellivue Monitor	Comment
Intended Use	ExSpiron™ is indicated for use by healthcare professionals in healthcare facilities, such as post-operative care and critical care units, to monitor breathing in patients with potential respiratory compromise ExSpiron is a non-invasive system that graphically displays lung volume against time and reports an approximate value of: • Tidal volume, • Respiratory rate, and • Minute ventilation ExSpiron measurements are used as an adjunct to other clinical information sources to determine respiratory status and appropriate therapy	"The intended use of the Wright/Haloscale Respirometer is the measurement and monitoring of the level of lung ventilation achieved by intensive care patients, during anesthesia and post operative recovery It measures expired volumes and thus indicates whether adequate ventilation is being achieved, whether in open or closed circuit or spontaneously breathing or mechanically ventilated patients "	"Indicated for use by health care professionals whenever there is a need for monitoring the physiological parameters of patients Intended for monitoring, recording and alarming of multiple physiological parameters of adults, pediatrics and neonates in healthcare facilities The MP20, MP30, MP40 and MP 50 are additionally intended for use in transport situations within healthcare facilities ST Segment monitoring is restricted to adult patients only The transcutaneous gas measurement (tcpO2 / tcpCO2 is restricted to neonatal patients only "	The clinical application of the ExSpiron is equivalent to that of the nSpire The comparison to the intended use of the Philips monitor is restricted to monitoring of respiration rate ExSpiron has no alarm function All devices are to be used by healthcare professionals
Technology	Thoracic bioimpedance	In-line turbine flow meter	Thoracic bioimpedance	
Volume Measurements	Tidal volume Minute ventilation Volume vs time chart	Tidal volume Minute ventilation	None	The time function for the minute ventilation measurement of the nSpire is provided by a user's stopwatch
Rate Measurements	Respiratory rate (breaths/min)	None	Respiratory rate	
Safety	IEC 60601-1, including electrical and mechanical safety	Mechanical only Safety specifications are not given in the user manual or 510(k) summary	IEC 60601-1, etc	

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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13. Proposed Labeling

Product Label

Respiratory Motion, Inc. 305 Second Avenue, Suite B Waltham, MA 02451 USA 781-373-1635	**ExSpiron™** Respiratory Monitor Model: 200 SN: 12345 Input Volts: 19V 2.63A (NRTL Mark for IEC 60601-1)

Note: Specification for the mains input is on the power supply accessory: 100 – 240 V~, 50 – 60 Hz

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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User Manual

ExSpiron™
Respiratory Variation Monitor™ (RVM)

© Respiratory Motion, Inc.
305 Second Avenue, Suite B
Waltham, MA 02451-1122

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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General Warning:

DO NOT use this monitor

- for any purpose other than specified in this manual
- if parts are broken or missing
- without reading this user manual

ONLY qualified personnel should use the ***ExSpiron™*** Monitor.

The ***ExSpiron™*** Monitor is NOT a diagnostic monitor. The ExSpiron should be used as an adjunct to other clinical information to determine respiratory status and appropriate therapy.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Records processed under FOIA Request 2014-156; Released 10/20/14

Contact Information

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781-373-1635
Fax: 781-373-1653
www.respiratorymotion.com

Clinical Support:
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techsupport@respiratorymotion.com

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Table of Contents

To be added.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Introduction

Intended Use

ExSpiron™ is indicated for use by healthcare professionals in healthcare facilities, such as post-operative care and critical care units, to monitor breathing in patients with potential respiratory compromise.

ExSpiron™ is a non-invasive monitor that graphically displays lung volume against time and reports an approximate value of:

- Tidal volume,
- Respiratory rate, and
- Minute ventilation.

ExSpiron™ measurements are used as an adjunct to other clinical information sources to determine respiratory status and appropriate therapy.

NOTE: United States regulation restricts this device to sale by or on the order of licensed medical practitioners.

Intended Operators

***ExSpiron*™** is intended to be operated by trained technicians and clinical professionals.

Brief Description of Device

The system includes:

- **ExSpiron™** Data Acquisition System, including patient cable with leads
- Touch screen panel computer (Windows 7® Operating System)
- PC Power Supply
- **ExSpiron™** Disposable Electrode Pads

The ***ExSpiron*™** Disposable Electrode Pads should always be used with the ExSpiron monitor.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Safety Measures

Warnings

WARNING: Electric shock hazard. The ***ExSpiron*™** monitor is to be opened only by Respiratory Motion personnel, their designees, or qualified service engineers. There are no user-serviceable parts inside.

WARNING: Do not autoclave, gas-sterilize, or immerse any portion of the ***ExSpiron*™** monitor. This may create an electric shock hazard or damage internal components.

Cautions

CAUTION: ***ExSpiron*™** disposable electrode sets are designed for single use only and should not be re-used. Reuse may interfere with monitor function. An electrode pad should not be used for more than 24 hours. Recalibrate the ***Exspiron™*** after changing electrode pads. Dispose of electrode pads s per requirements for biohazard waste.

CAUTION: Use only Respiratory Motion ***ExSpiron*™** electrode pad sets with the ***ExSpiron*™** monitor. Use of other electrodes may interfere with monitor function.

CAUTION: Do not use the ***ExSpiron™*** monitor with another bioimpedance measurement system, such as an impedance cardiograph. Such devices may cause functional interference among the bioimpedance systems.

CAUTION: Do not mount or store the ***ExSpiron*™** monitor under an IV bag or other liquids. Fluid leaking onto the monitor may interfere with monitor function and may create an electric shock hazard. (ExSpiron is resistant to the ingress of fluids, with an IPX2 rating. However ExSpiron is not waterproof.)

CAUTION: Before attaching the ***ExSpiron™*** monitor to a medical monitoring pole, ensure that the pole is specified to carry the weight of the ***ExSpiron™*** monitor.

Precautions

The ***ExSpiron*™** monitor should not be used as the sole basis for diagnosis or therapy. Healthcare professionals should use ***ExSpiron*™** measurements as an adjunct to other clinical information sources to help determine regulatory status and appropriate therapy.

The ***ExSpiron*™** monitor should not be used as an apnea monitoring system.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Cleaning and disinfection

Clean external surfaces of the ***ExSpiron™*** monitor with a cloth dampened with warm water. Cleaning with a mild disinfectant is recommended.

Disposal

Dispose of used electrodes as biohazard waste.

Dispose of used batteries per local or national waste regulations.

At the end of its life, dispose of or recycle the ***ExSpiron™*** monitor per local or national regulations.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Operation

Principles of Operation

Various types of bodily tissue have varying levels of electrical impedance. Impedance is the measure of an object's opposition to carrying an alternate current. Air has far more impedance than any bodily tissue. As an individual inhales and exhales, the movement of air in and out of the lungs sequentially increases and decreases the level of electrical impedance within the thorax. Similar to standard leads that measure respiratory rate, the ***ExSpiron*™** measures changes in impedance by passing a low level alternating constant current through the thorax. Respiratory Motion algorithms are able to correlate directly these changes in impedance with lung volumes. Analysis of the respiratory curve yields three important parameters: tidal volume of each breath, respiratory rate and minute ventilation.

Features of Design

Device Design

The ***ExSpiron*™** monitor is comprised of a set of electronics and standard computer functionality, which collects and analyzes pertinent patient information. ***ExSpiron*™** leads originating from the device connect to ***ExSpiron*™** electrodes placed in predetermined configurations on the patient's skin. Electrode configuration and the monitor user interface are detailed in Sections 2 and 3.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Electrode Configuration

Electrode configuration is detailed in Figure 1. There are two electrode pads, designated 1 and 2 (Fig. 1). Routine skin preparation following standard hospital procedures should be undertaken before electrode pad placement. The patient's skin should be thoroughly cleansed and failure to do so could interference with the integrity of the ***ExSpiron™*** readings.

Electrode pad 1 should be placed over the sternal notch and extend to the xiphoid process. If necessary, the bottom electrode pad can be torn along the perforated edge to allow for further extension.

Electrode pad 2 should be placed along the right mid-axillary line and horizontally in line with the xiphoid process and bottom electrode of Electrode pad 1.

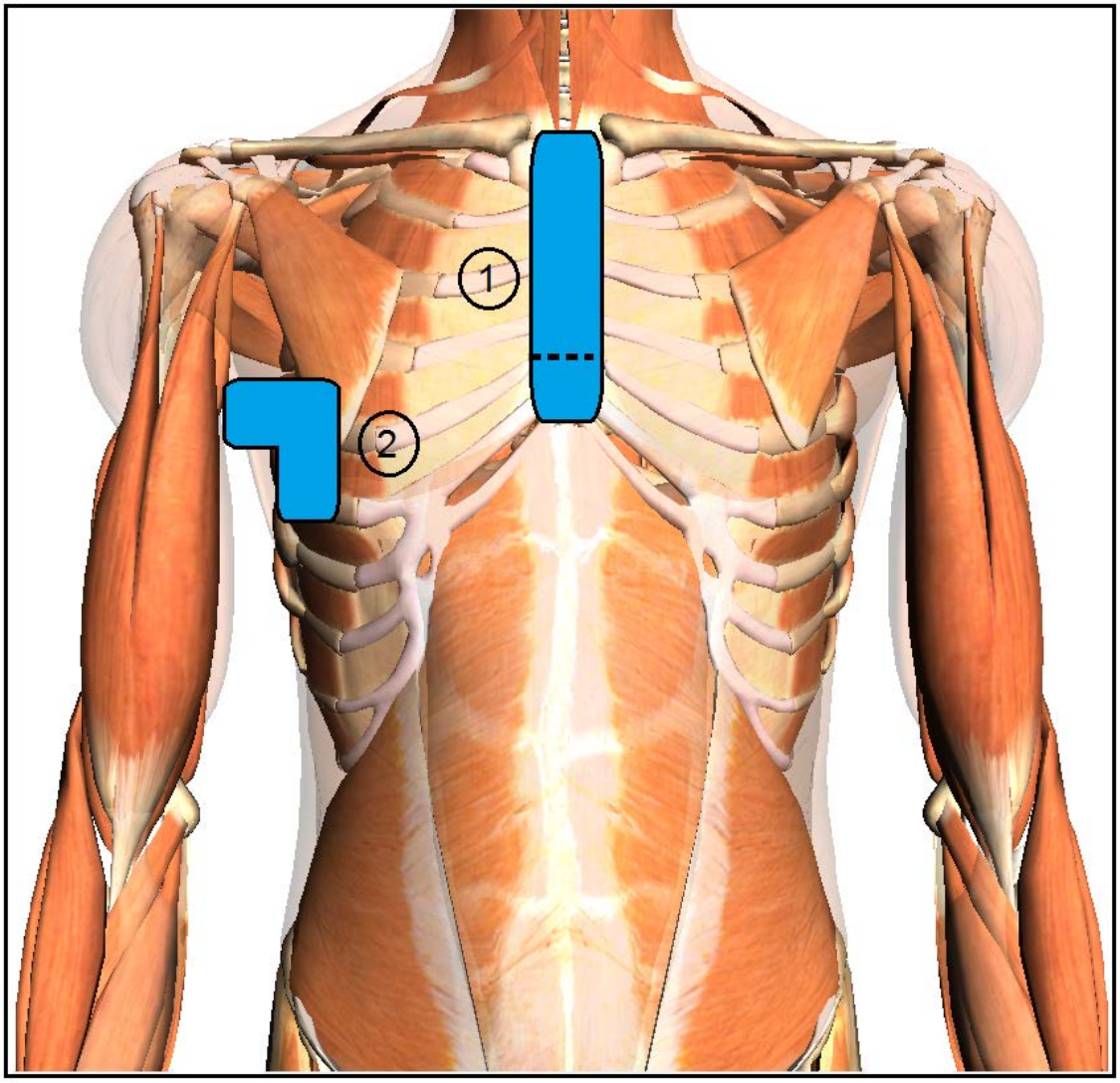

Figure 1 Standard electrode placement diagram.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Monitor Start-up

1) Plug in the ***ExSpiron*™** monitor.
2) Turn on the monitor via the I/O button.
3) With the monitor turned on, an ***ExSpiron*™** icon will appear on the desktop.
4) Clicking on this icon will launch the graphical user interface and allow for subject data input and data collection.

User Interface

The ***ExSpiron*™** user interface (UI) contains a graphical representation of the respiratory curve, and outputs of three respiratory parameters: minute ventilation (MV), tidal volume (TV), and respiratory rate (RR). When the ***ExSpiron*™** software is launched or a new or different patient is being monitored, the initial starting screen will display only the respiratory curve (Fig 2). No values for MV, TV, or RR will be shown.

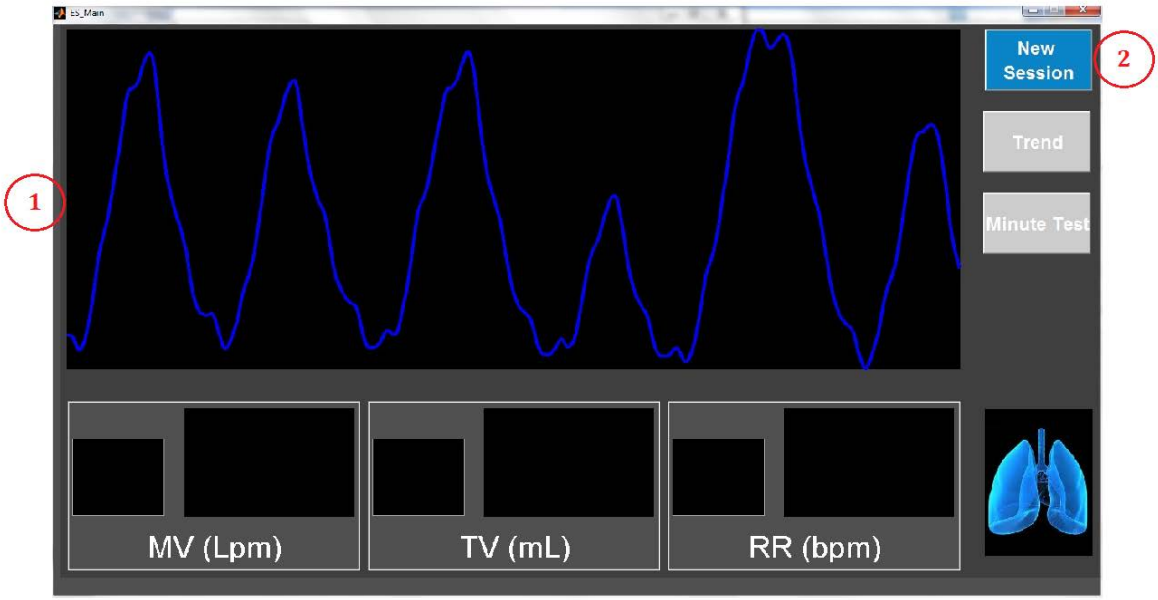

Figure 2 User Interface. The main screen will illustrate the respiratory curve. Navigate the touch screen using the buttons at the right. Beneath the respiratory curve are value boxes and trend curves for the 3 collected respiratory parameters. These will appear empty until a patient has been selected and the device calibrated.

Label	Button/ Field	Function
1	Respiratory Curve	Shows the patient's respiratory curve in real-time.
2	New Session	Brings user to patient ID screen in order to begin monitoring.

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Patient Selection

In order to select a patient for monitoring, the user will be prompted with a patient ID screen (Fig. 3). Enter the patient's ID and click Next to move to the next screen.

Figure 3 Patient ID Input Screen.

Label	Button/Field	Function
1	ID Field	Input the patient's ID.
2	Next	Once the patient's ID is entered, click Next to move to next screen.
3	Cancel	Click to leave the ID screen and return to initial monitoring screen.

Selecting a Calibration Setting for a New Patient

If the patient database does not recognize the patient ID, the new patient calibration screen will be shown (Fig. 4). Enter the fields listed; all are required. New Calibration is the only option for a new patient. Height, weight, and the calibration information used on the next screen will constitute that particular calibration, and it will be stored under the current date. Clicking Next will create a patient record and bring the user to the calibration screen.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

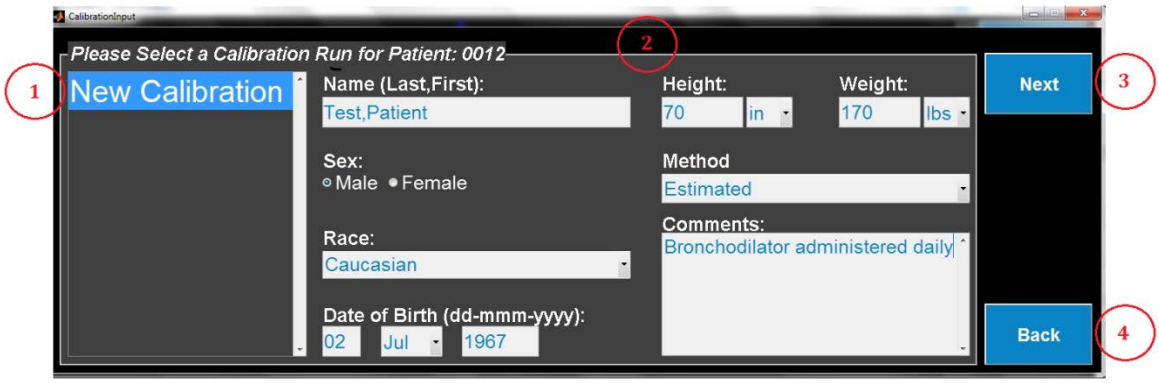

Figure 4 Patient Selection User Interface. Items on the user interface for patient selection.

Label	Button/ Field	Function
1	New Calibration	This will be the only option for a new patient.
2	Required Information	All fields are required. Those listed on the left (name, sex, race, date of birth) cannot be edited after initial entry. Those fields on the right (height, weight, method, comments) can be edited. Method is a dropbox containing options for "estimated" or "measured". Pick one in order to designate the method that was used for acquiring height and weight.
3	Next	Brings user to calibration screen.
4	Back	Brings user back to the initial monitoring screen.

The calibration screen will prompt the user to click Start and begin collecting data for minute ventilation or tidal volume and respiratory rate (Fig. 5). The fields on the right will remain disabled until the collection period is over and the progress bar shows that data acquisition is complete. At that time, the user can input the collected parameter(s) and click Next to go to the calibrated monitoring screen.

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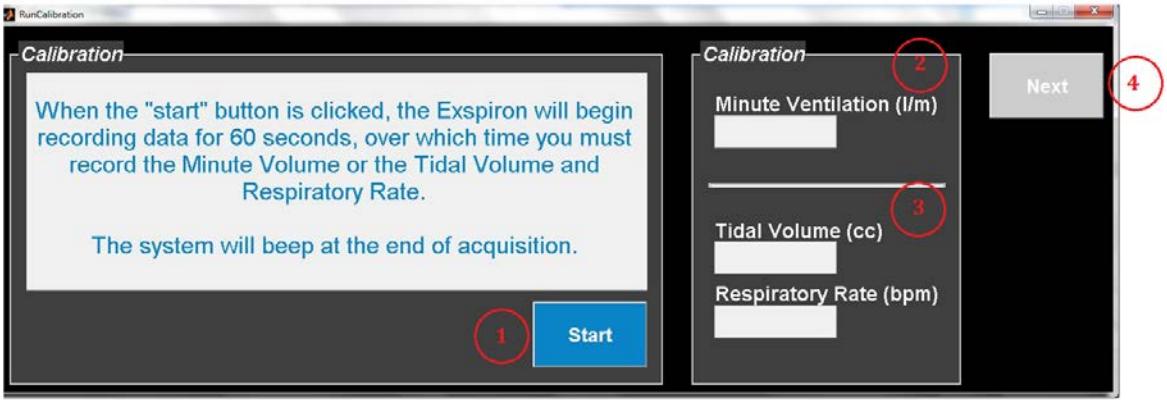

Figure 5 Calibration screen. After inputting the calibration parameters, the ExSpiron will start acquiring data.

Label	Button/Field	Function
1	Start	Begin collecting data for calibration (60 seconds).
2	Minute Ventilation	User can enter the calculated minute ventilation for calibration.
3	Tidal Volume & Respiratory Rate	User can enter tidal volume and respiratory rate for calibration.
4	Next	Brings user to monitoring screen; remains disabled until calibration has completed.

Selecting a Calibration Setting for an Existing Patient

The default screen is used for selecting existing patients (Fig. 6). The data entry fields become available when the operator selects a patient by clicking on an entry in the Patient List. Refer to the list below to navigate the Patient Selection UI.

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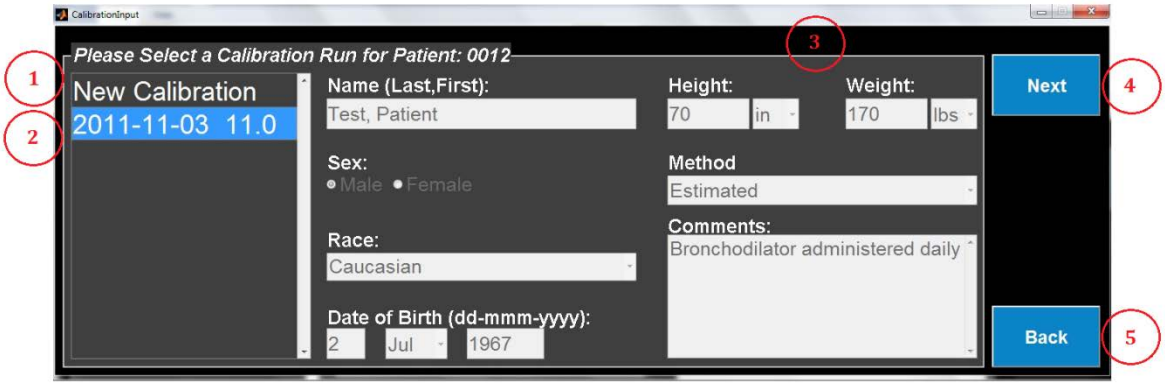

Figure 6 Calibration Selection for Existing Patient.

Label	Button/Field	Function
1	New Calibration	Selecting this for an existing patient allows the user to create a new calibration setting.
2	Existing Calibration Setting	Existing calibration settings are listed by date and minute ventilation. Select one to set calibration to that setting.
3	Changeable fields	In creating a new calibration setting, the user can edit the height, weight, method, and comments fields.
4	Next	Brings user to calibrated monitoring screen.
5	Back	Returns user to initial monitoring screen.

Navigating the Monitoring Session

After the desired patient has been selected, the user will be brought to the monitoring screen (Fig. 7). The graphs will automatically populate with the calibrated respiratory curve and values and trends for TV, RR, and MV. The buttons at the right allow the user to navigate away from the monitoring screen, either to start a new monitoring session, view trends, or the run minute-long tests.

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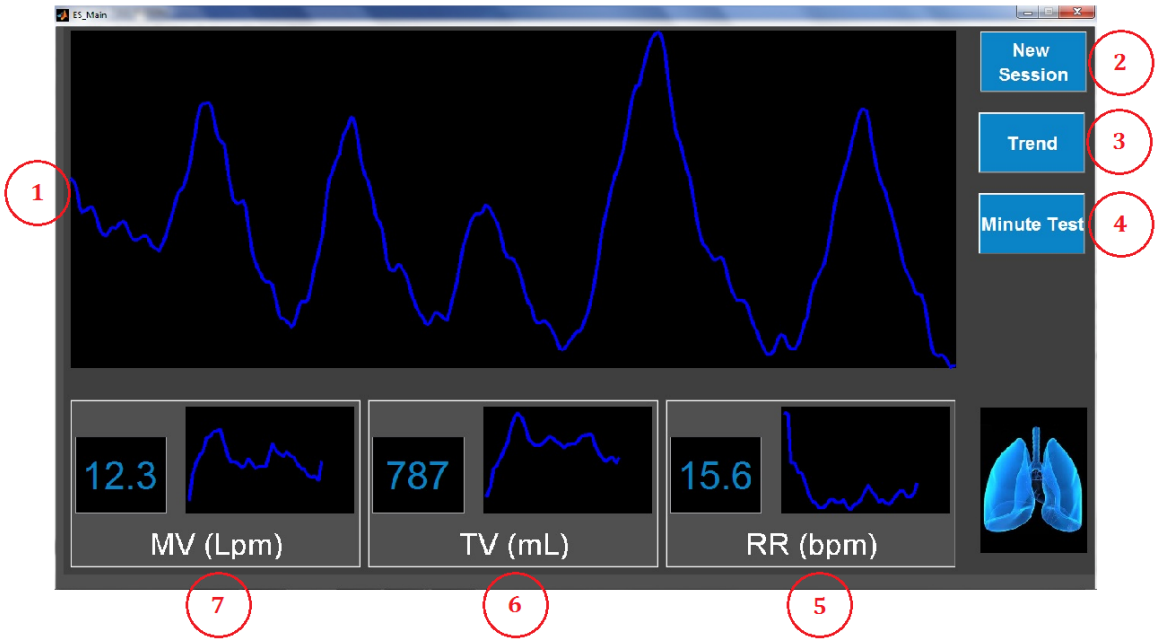

Figure 5 Monitoring Screen. Displays the calibrated respiratory curve and parameters.

Label	Button/Field	Function
1	Respiratory Curve	Tracks current respiratory curve in near real-time in 30-second blocks.
2	New Session	Allows the user to select a new or different patient for monitoring.
3	Trend	Brings user to trending screen.
4	Minute Test	Allows user to run discrete 60-second tests.
5	Respiratory Rate (RR)	Demonstrates graphical representation of RR over the past 60 minutes and provides current RR value.
6	Tidal Volume (TV)	Demonstrates graphical representation of TV over the past 60 minutes and provides current TV value.
7	Minute Ventilation (MV)	Demonstrates graphical representation of MV over the past 60 minutes and provides current MV value.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Reviewing Patient Trends

The "Trends" tab graphically displays sequential measurements captured within the twenty-four hours of the current session (Fig. 7). Clicking this tab changes the display to show plots for respiratory rate, minute ventilation, and tidal volume. Above the plots is a dropdown menu which is used to select the time interval for the data in the table. Above the trending graphs is a horizontal scroll bar representing time. Move the scroll bar left or right to look at trends throughout the patient's monitoring period. Above the scroll bar is a schematic illustrating in blue when periods of ***ExSpiron***™ monitoring.

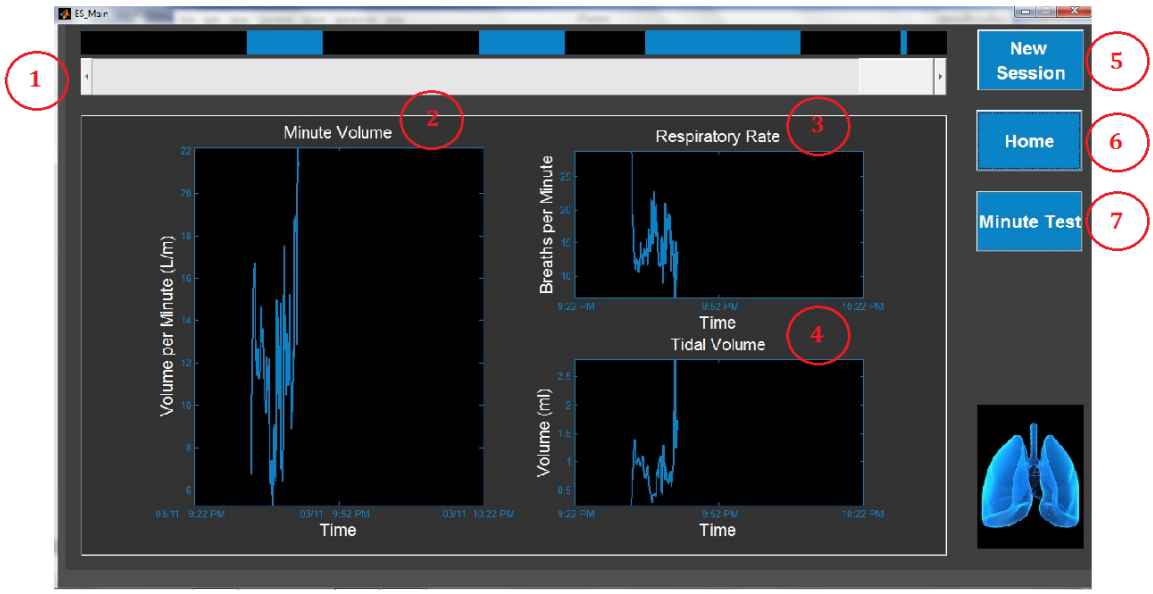

Figure 6 The Trends Tab. Respiratory rate (RR), minute volume (MV), and tidal volume (TV) trends graphs are plotted versus time.

Label	Field	Function
1	Scroll Bar	Moving the scroll (corresponds with time) will display trending graphs for those time periods.
2	MV Trending Graph	MV trends over 60 minutes.
3	RR Trending Graph	RR trends over 60 minutes.
4	TV Trending Graph	TV trends over 60 minutes.
5	New Session	Brings user back to patient ID screen.

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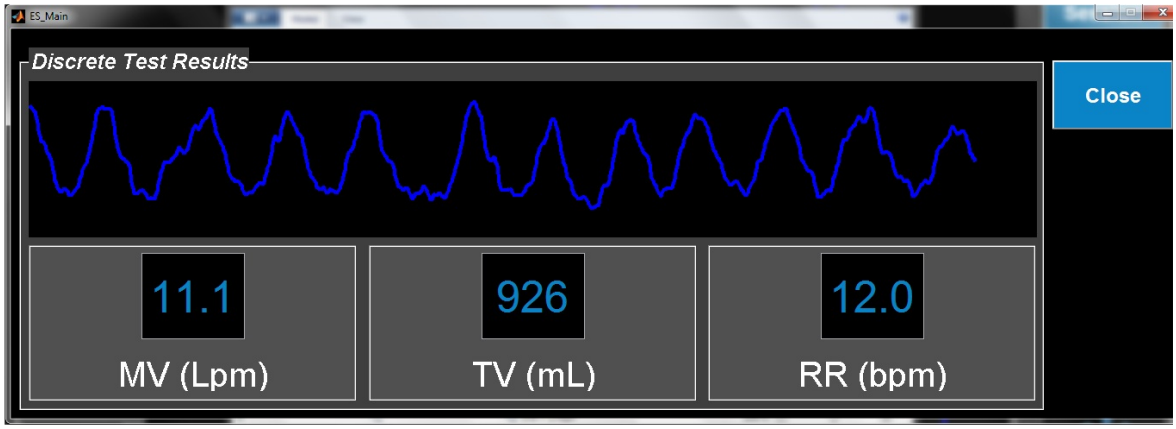
6	Home	Brings user back to the monitoring screen.
7	Minute Test	Allows user to run discrete 60-second tests.

Performing Minute Tests

Clicking on the Minute Test button will temporarily disable the monitoring screen. The progress bar demonstrates that the ***ExSpiron*™** is collecting data for 60 seconds. After the minute test has completed, the results are given as shown below. Click Close to exit the results screen and return to the regular monitoring screen.



Clinical Procedure

The following flow chart details the general procedure for clinical use of the ***ExSpiron*™**.

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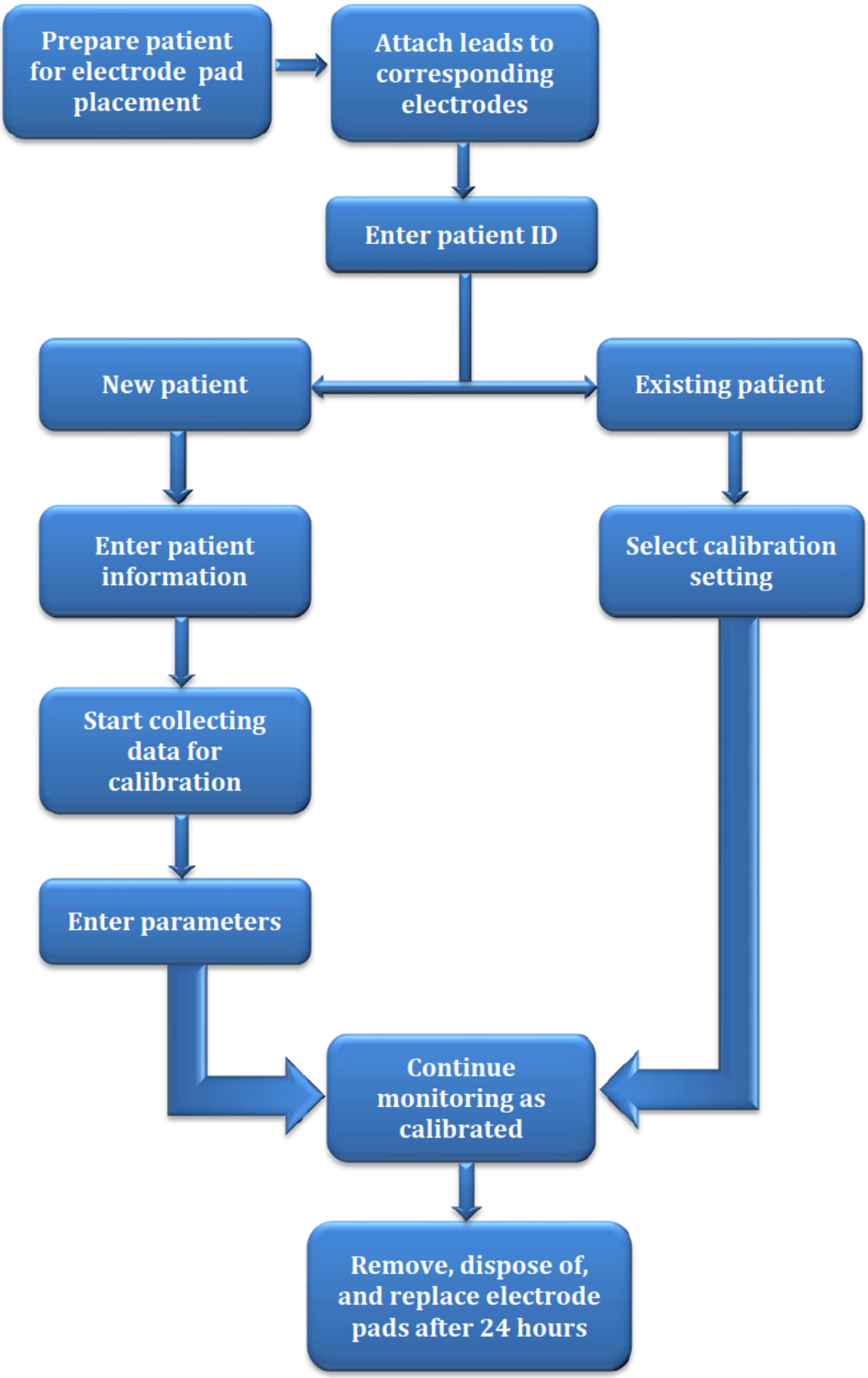

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Figure 7 Clinical Procedure Flow Chart. Start from patient selection to work through a complete monitoring session.

Signal Quality

Lack of adequate signal quality can result in a "flat line" displayed on the panel screen. Flat lining can be a result of the following:

- Electrodes that are not in full contact with the patient's skin. Replace the electrode pads with new ones and record the event. Hair and sweat can affect the ability of the electrode pads to stick to the skin. Routine hospital preparation for electrode placement, such as abrasive cleansing or shaving of the area should be followed to avoid issues such as these. Electrodes are to be used no longer than 24 hours, but can be replaced sooner when necessary.
- Leads that are not properly attached to the electrodes. Check lead-electrode attachment.
- Incorrect matching of electrode to lead. Check that the correct colored lead is attached to the correct electrode.
- Poor signal quality. Check that electrodes were attached in correct configuration. Anatomical differences can also cause poor signal quality.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Understanding ExSpiron Readings

The following information should be used as informational purposes only and not for use of the ***ExSpiron*™** as a diagnostic tool.

Respiratory Rate

Respiratory Rate is defined as the number of breaths per minute. Respiratory Rate can be classified as normal, abnormally fast (tachypnea), abnormally slow (bradypnea), or nonexistent (apnea).

Tidal Volume

Tidal Volume is the total volume of air displaced between normal inspiration and expiration when extra effort is not applied.

Minute Ventilation

Minute Ventilation is the total volume of air displaced between normal inspiration and expiration over the duration of one minute. It can also be calculated as the product of tidal volume X respiratory rate.

Table 1 Normal Ranges of Respiratory Parameters.

Value	Normal Range	Description
Respiratory Rate	12-18 breaths/min	Breaths per minute
Tidal Volume	Dependent on gender and height. See graphs and tables below.	Milliliters per single breath
Minute Ventilation	RR x TV	Liters of aired breathed in one minute

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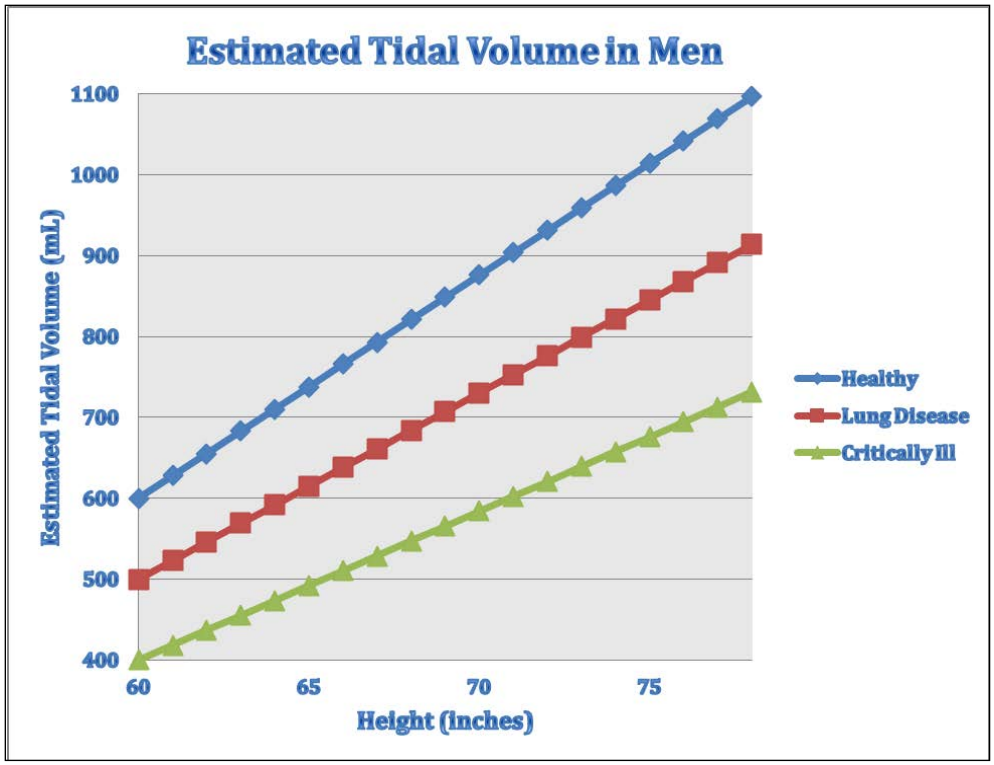
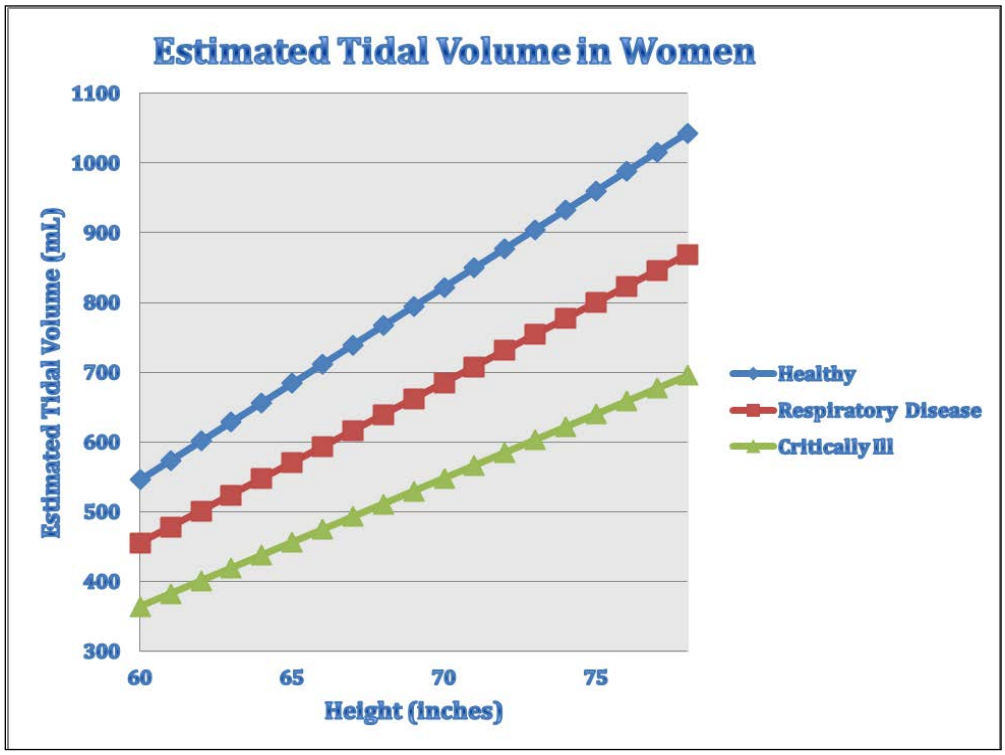


Graph 1 Estimated tidal volume in men based on height.



Graph 2 Estimated tidal volume in women based on height.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Appendix A Accessories

Accessory	Model #
Exspiron™ Disposable Electrode Pads	200-010
Exspiron™ Power Supply	200-020

Appendix B Specifications

Size	Computer Module	11.9" (H) x 8.7"(W) x 1.7" (D) 6.5" (H) x 4.5" (W) x 1.5" (D)
Weight		(Less than ten pounds)
Operating conditions		32° – 95° F 20% - 80% non-condensing humidity
Storage and transport conditions		-4° – 112° F 20% - 80% non-condensing humidity

The ***Exspiron™*** Power Supply is a switching power supply with input range:
100-240 V ~ 47-63 Hz 1.35 A

Standards compliance:
IEC 60601-1 ,

- Class 1 protection against electric shock.
- IPX2 protection against fluid ingress
- Type BF applied part, defibrillator proof
- Continuous duty cycle
- Not suitable for use with flammable anesthetics

IEC 60601-1-2
FCC Certification

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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14. Sterilization and Shelf Life

B4 [redacted]

[redacted]

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15. Biocompatibility

The only ExSpiron applied parts are the electrodes, six of which make up the electrode subsystem.

B4 [redacted]

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

B4 Software Testing

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17. Electromagnetic Compatibility and Electrical Safety

Before ExSpiron™ is released for commercial shipment, the system will be tested for conformance to:

- IEC 60601-1:2005, 3d edition, Medical Electrical Equipment - Part 1: General Requirements for Safety

- IEC 60601-1-2:2001 with Amendment 1:2004 Medical Electrical Equipment - Part 1-2: General Requirements for Safety - Collateral standard: Electromagnetic Compatibility - Requirements and Tests

The entire ExSpiron™ operates on power from the B4 [redacted] power adaptor connected to mains power. There is no battery power. B4 [redacted] subsystem is independently certified compliant to IEC 60601-1. See the product data sheet for the computers on the next four pages. Respiratory Motion's testing will confirm that the entire device is compliant to IEC 60601-1. In particular:

- Class 1 protection against electric shock, operating from a specified supply.
- IPX2 protection against fluid
- Type BF applied part, defibrillator proof
- Continuous duty cycle
- Not suitable for use with flammable anesthetics

For IEC 60601-1-2, ExSpiron™ will comply with Class A emissions and to non-life-supporting levels for immunity.

B4 [redacted], states that they meet or exceed AAMI specifications for monitoring electrodes, presumably including ANSI/AAMI EC12.

The patient cable and patient leads will conform to FDA's Performance Standard for Electrode Lead Wires and Patient Cables, 21 CFR 898, and to ANSI/AAMI EC53: 1995/(R)2008 – ECG Cables and Wires

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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18. Performance Testing – Bench

(For bench safety testing, see section 9, Reliance on Standards.)

Bench performance testing has focused on usability. Respiratory Motion (RM) has consulted with anesthesiologists, intensive care nurses, respiratory therapists, surgeons, and emergency department physicians to develop usability requirements. RM software developers, engineers, and clinical specialists worked with users to design a functional, clinically appropriate user interface. Users "walked through" typical clinical use scenarios, tracing the use of product features. Users simulated manipulation of the monitor controls, display, and lead components to confirm requirements for labeling and user interface. The goal is to make ExSpiron™ use intuitive, reducing reliance on user memory, vigilance, and need to reference the user manual.

In the initial walk-throughs, RM assessed user manual content and training needs. Mock-ups were constructed and revised based on user feedback. Lead design and placement were reviewed with the clinicians to determine optimal configuration consistent with conventions and natural mappings. Clinicians reviewed software design and display output to determine primary and frequently used functions, and to simplify and streamline the user interface for ease of use and optimal functionality in hospital settings. Visible graphics and familiar, typical language simplify the user interface and user actions, e.g., the number of controls per screen. ExSpiron™ follows use and expectations similar to those of existing hospital equipment to reduce confusion and associated risks.

To identify usability hazards and assess risks, RM conducted simulated use studies (as well as the clinical trials described in section 20, Performance Testing – Clinical). Hospital floor and patient room layouts and clinical workflow were considered and assessed. Strategies to mitigate and control risks encountered in the clinical setting were developed.

Validation of usability requirements, consistent with IEC 62366, will be completed prior to commercial distribution of ExSpiron™.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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19. Performance Testing – Animal

Not applicable. There was no animal testing.

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20. Performance Testing – Clinical

ClinicalTrial.gov requirements do not apply because the clinical study does not compare health outcomes. The study compares measurements made with the ExSpiron™ and the predicate device to determine relative measurement performance.

Clinical Study Objectives

A study was performed with volunteer human subjects to demonstrate performance equivalence in comparison to the predicate device. An ancillary objective was confirmation of performance of the graphical display, a feature not included in the predicate device, by comparison to the graphical display of a diagnostic spirometer that has the feature. (Note: ExSpiron™ is not classified as a diagnostic spirometer.)

- The study demonstrated performance of the ExSpiron system as compared to the Wright Respirometer by simultaneously collecting data from both devices.
- The ExSpiron was calibrated to the Wright Respirometer on Day 1. Measurements were collected from both devices for each participant on Day 1 and Day 2 and were analyzed to determine accuracy and precision.
- As an ancillary study, since the Wright Respirometer cannot provide a graphical display of the data, a SpiroAir-LT spirometer (SpiroAir-LT, Morgan Scientific, Haverhill, MA) was also used in order to visually compare the ExSpiron data to a known spirometry standard. Results of the ancillary study are found in the section titled *Comparison of Graphics Displays* on page 20-7

Study Protocol

The goal of this clinical study was to show the performance of the ExSpiron system in measuring minute ventilation (MV), respiratory rate (RR) and tidal volume (TV). Twenty-four subjects from a broad ambulatory population were recruited. Male and female subjects of varied ethnicities and with a broad range of heights, weights, and BMIs were recruited for this study. Subjects with substantive cardiopulmonary co-morbidities were included. The ExSpiron ™ six-lead system was used to measure thoracic bioimpedance as compared to the Wright Respirometer, an FDA-approved spirometer in current clinical use. All data collection was performed by two specifically trained clinical technicians, each with previous hands-on experience with both devices.

Protocol for Minute Tests using Wright nSpire Respirometer

B4 [redacted] *Protocol*

- [redacted] B4 [redacted]
- [redacted]

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B4 [redacted]

6. To gather the values for TV, MV and RR from the Wright Respirometer, the technician recorded the TV for each breath measured by the Wright Respirometer, the MV shown on the Wright Respirometer at the end of the test and the counted RR. ExSpiron™ data was electronically captured. A respiratory curve, TV (average), RR and MV were displayed in near-real time and stored digitally.

   (Note: the predicate device for the breathing frequency monitor function, a Philips monitor, was not used. "Predicate" RR data was determined by counting cycles within the 60-second interval. The "stop watch" comparison was discussed in pre-IDE communications.)

7. The ExSpiron™ displayed the normalized (scaled to 60 seconds) values for TV (average), MV, and RR as well as the exact length of time for which the trial ran.

8. The subject was instructed to cease the test immediately if any unusual symptoms were noted. If technical difficulties occurred (such as mouthpiece leakage, computer malfunction or nose-clip displacement) the subject was asked to repeat one or more 60 second tests.

9. Participants were asked to leave the electrode pads on until their return visit the following day. They were also asked not to bathe or allow the electrodes to get too wet or sweaty to the best of their ability.

Day 2 Protocol

1. On the second day, measurements were taken using electrode pads placed on Day 1. If any electrodes were "falling off" or not firmly affixed, they were replaced.

2. Previous calibration from Day 1 was used, i.e. no new calibration was performed.

3. The same testing procedure was followed as on Day 1 (Steps 5-8) with a second group of ten 60-second measurement sets recorded.

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4. Once the second test is completed on Day 2, the electrodes are removed and skin is checked for irritation. All disposables are discarded.

Summary of Results

Here we provide the results of our predicate study that support substantial equivalence of the ExSpiron™ when compared with the Wright/Haloscale Respirometer.

We demonstrated that the ExSpiron™ had clinically useful measurements of minute ventilation (MV), tidal volume (TV) and respiratory rate (RR), substantially equivalent to the Wright/Haloscale Respirometer.

- Overall percent accuracy for MV, TV and RR were 10.7, 10.4 and 2.0 respectively.
- Overall percent precision for MV, TV and RR were 10.5, 10.3 and 2.0 respectively.

We demonstrated that ExSpiron™ measurements were similar on Day 1 and Day 2 of the study, confirming that the device successfully maintains calibration over a 24-hour period, with similar accuracy and precisions on both days.

- MV percent accuracy / precision (10.4 / 10.2 and 10.9 / 10.8) for Day 1 and Day 2 respectively
- TV percent accuracy / precision (9.8 / 9.7 and 11.0 / 10.8) Day 1 and Day 2 respectively
- RR percent accuracy / precision (2.4 / 2.3 and 1.6 / 1.6) Day 1 and Day 2 respectively

Study Population

Subjects varied in age, ethnicity, and anthropometrics. Pertinent co-morbidities included asthma, chronic obstructive pulmonary disease (COPD), obstructive sleep apnea, congestive heart failure and chronic renal insufficiency. Twenty-four subjects enrolled in the study. However, four subjects were excluded. The ExSpiron failed to calibrate with one subject due to insufficient signal quality, therefore data was not collected. (ExSpiron™ automatically monitors signal quality and provides an error message warning the operator of poor signal quality.) Three subjects did not return within the allotted timeframe for the second session of the study. Twenty subjects completed the study according to protocol. Tables 1 and 2 show the demographics of the subject cohort who completed the study according to protocol.

Table 1 - Subject Cohort Demographics

Demographic	n (%)
Male	9 (45)
Female	11 (55)
White	16 (80)
Black	2 (10)
Asian	2 (10)

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Table 2 Subject Cohort Anthropometrics

Anthropometric	Range	Mean	Standard Deviation
Age (years)	20-84	49.1	±18.7
Height (inches)	60-71	65.9	±3.2
Weight (pounds)	117-233	164.0	±36.3
BMI	19. 9-43.2	26.6	±6.3

Predicate

Because the ExSpiron™ uses a human bioimpedance measurement to calculate volumes, it cannot be evaluated in the same way as a standard spirometer, which is tested by injecting a known volume of air. Therefore, we compare the ExSpiron™ to simultaneously collected spirometer volumes in a human subject. The monitoring spirometer predicate used in this study is the Wright /Haloscale Respirometer (nSpire Health, Inc., Longmont, CO, USA). Its user manual reports that the devices are calibrated to deliver 2% accuracy for continuous flow at 16 l/min and 5-10% accuracy for continuous flow at 60 l/min[i]. These values are based on bench testing data. However, continuous flow ratings are not indicative of how the device performs in human use, where flow rates are highly variable and never continuous. In settings designed to simulate clinical testing, the Wright Respirometer shows an average accuracy of approximately 12% with errors as high as 20%[ii,iii]. The Wright/Haloscale Respirometer predicate itself is not truly a "gold standard". Predicate error contributes to the results of the comparison study error analysis. The reported ExSpiron errors hence only provide the upper limit on ExSpiron measurement error characteristics, since a part of the uncertainties can be attributed to the predicate.

Data Analysis

ExSpiron and Wright Respirometer (predicate) measurements were compared in the following two ways:

1. Results based on the currently accepted definitions of bias, precision and accuracy presented in this summary and elaborated on *Additional Analysis of Data*.

2. Results based on the historically important standard of the intra-class correlation coefficient (ICC) developed by R.A Fisher[iv] presented in *Additional Analysis of Data*.

B4 [redacted]

[redacted] B4 [redacted]

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In the analysis below: “Day” describes “Day 1” or “Day2”; “test” describes each 60 second measurement set of ExSpiron and Wright Respirometer data; “subject” describes each person completing the study with data on both Day 1 and Day 2.

Data analyses were approached in the following 6 ways:

1. across all 20 tests for all subjects from both days,
2. across all 10 tests for all subjects from “Day 1”,
3. across all 10 tests for all subjects from “Day 2”,
4. per subject using an average of the 20 tests from both days,
5. per subject using an average of the 10 tests from “Day 1”, and
6. per subject using an average of the 10 tests for “Day 2”.

A summary of these results is provided below with greater detail to be found in Appendix B.

Precision, Bias, and Accuracy

The statistical calculations for bias, precision and accuracy are based on the ExSpiron™ relative errors, calculated as follows:

Error = natural log(ExSpiron™ measurement / Predicate measurement)

Relative errors are used because the parameters being measured in this study (MV, TV and RR) are constantly changing, and relative errors have uniform significance over the whole range of measurement variations. The logarithmic scale is used because it gives equal weight to errors which vary by the same factor above or below the true value. This generally corresponds to clinical considerations.

The measured parameters, “bias”, “precision” and “accuracy” values, were calculated over different test subsets: all tests, “Day 1” for all subjects, “Day 2” for all subjects, and for each subject separately.

We use the following definitions:

- “bias” is a mean value of all errors in the selected subset,
- “precision” is the standard deviation of the errors , and
- “accuracy” is the square root of the mean squared error

Mean values for bias, precision and accuracy for all tests are presented in Table 3.

Table 3 - Percentage Bias, Precision and Accuracy on Days 1 and 2 Combined

	Minute Ventilation	Tidal Volume	Respiratory Rate
Bias	-2. 1	-1.9	-0.2
Precision	10.5	10.3	2.0
Accuracy	10.7	10.4	2.0

Mean values of bias, precision and accuracy for each individual subject are presented in Appendix B.

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The bias, precision and accuracy calculations demonstrate clinical relevance of the results and substantial equivalence of the ExSpiron™ to the Wright/Haloscale Respirometer predicate.

Stability over 24 Hours

Bias, precision and accuracy were also calculated independently for Day 1 and Day 2. Table 4 shows results calculated for Day 1, and Table 5 shows results calculated for Day 2.

Table 4 - Percentage Bias, Precision and Accuracy on Day 1

	Minute Ventilation	Tidal Volume	Respiratory Rate
Bias	-2.3	-1.7	-0.6
Precision	10. 2	9.7	2.3
Accuracy	10.4	9.8	2.4

Table 5 – Percentage Bias, Precision and Accuracy on Day 2

	Minute Ventilation	Tidal Volume	Respiratory Rate
Bias	-1.9	-2.0	0.2
Precision	10.8	10.8	1.6
Accuracy	10.9	11.0	1.6

As shown in the Tables 4 and 5, accuracy, precision and bias remains stable 24 hours after calibration, demonstrating continued substantial equivalence to the predicate and clinical utility over this period.

Figure 1 shows ExSpiron™ values for all 400 tests (20 subjects, 10 tests per day, 2 days) plotted against the values calculated using the predicate.

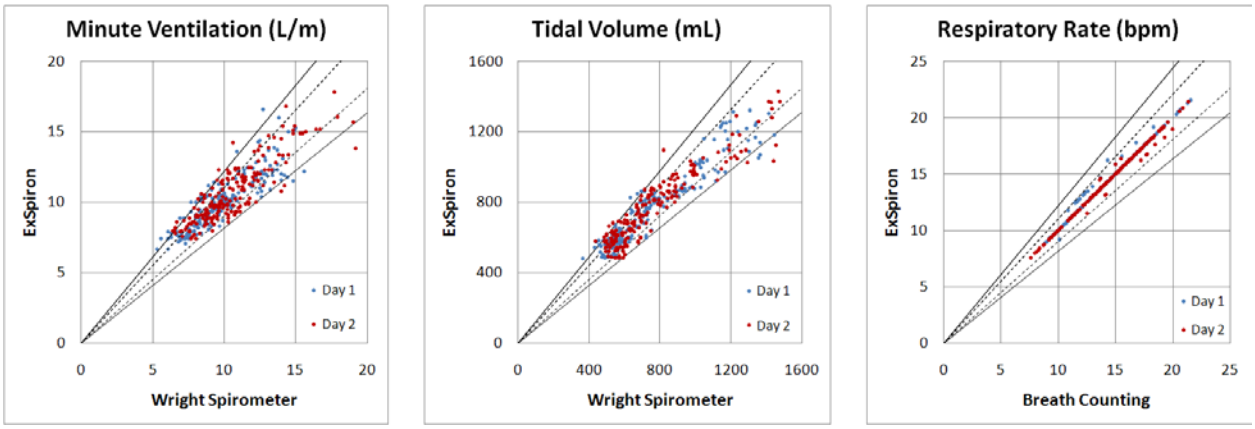

Figure 1 - ExSpiron Outputs vs. Spirometer Calculations

In Figure 1, the solid lines represent 20% relative error. These charts demonstrate relevant clinical accuracy of the ExSpiron where 93.2% of the minute ventilation tests were within 20% accuracy. Regarding tidal volume, 95.0% of the tests fell within 20% accuracy, and 100% of respiratory rate measurements were within 20% accuracy as compared to the Wright/Haloscale Respirometer predicate.

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Conclusion

The results of the ExSpiron™ 24 hour study comparing against the Wright/Haloscale Respirometer predicate demonstrate that the ExSpiron™ device delivers results with substantially equivalent accuracy (10.7% for minute ventilation and 10.4% for tidal volume) in human subject testing. The accuracy of respiratory rate measurements compared to manual counting was 2.0%. This supports the clinical relevance and substantial equivalence of the ExSpiron™ at baseline and for a period of up to 24 hours.

Comparison of Graphic Displays

The ExSpiron™ presents respiratory volume data collected over time in the form of a respiratory curve. There is no similar feature on the predicate device, the Wright Respirometer. The ExSpiron™ graphic display was compared to that of the SpiroAir-LT, Morgan Scientific, Haverhill, MA). The SpiroAir-LT is not a predicate device because it is a diagnostic spirometer, as opposed to a monitoring spirometer. It cannot be used continuously for longer than 30 seconds because of its closed breathing circuit.

The last three subjects of the study were asked to breathe both normally and "erratically" into a filtered mouthpiece connected to the SpiroAir-LT to evaluate the correlation under various conditions between ExSpiron respiratory curves and SpiroAir-LT curves. Each of the three subjects were asked to complete eight breathing trials consisting of one calibration run, four normal breathing runs, and three erratic breathing runs. Because of the closed breathing circuit in the SpiroAir-LT spirometer, tests were run for approximately 30 seconds. ExSpiron™ data were calibrated using the SpiroAir-LT calibration run. The SpiroAir-LT was set at approximately six liters when beginning a test run so that there was sufficient air in the drum for the subject to breathe. Because of this, each run has an arbitrary offset from zero. For comparison, volume data from the ExSpiron™ and SpiroAir-LT were centered around zero to remove the arbitrary offset.

Pearson correlations were computed for each run, yielding an average correlation of 0.967 across all runs (0.966 for normal breathing and 0.969 for erratic breathing). Figure 2 shows example respiratory curves for normal and erratic breathing from the ExSpiron and SpiroAir-LT. The graph on the right represents the correlation between ExSpiron™ curves and the spirometer curves.

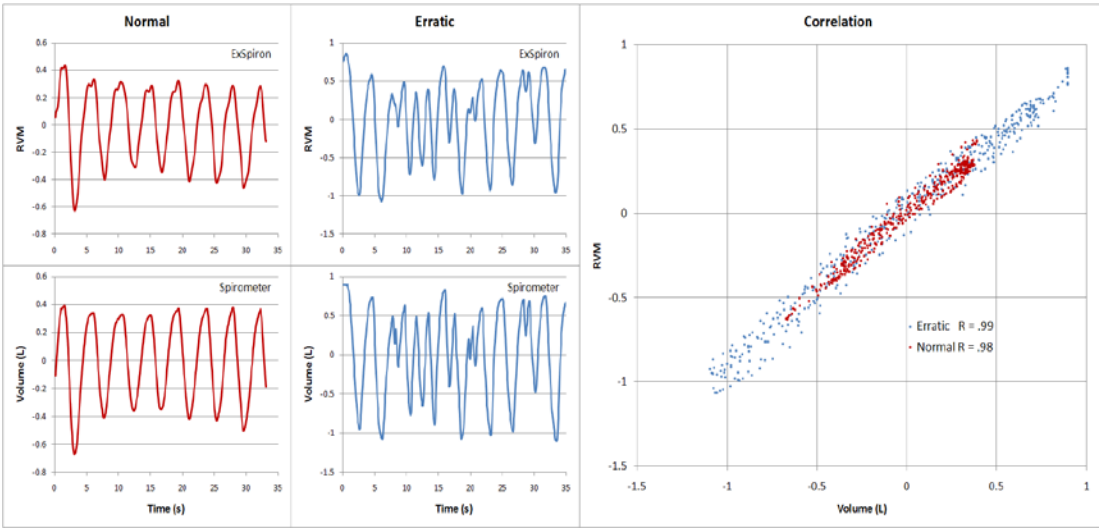

Figure 2- Normal and Erratic Respiratory Curves for the ExSpiron and the SpiroAir-LT

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The high degree of correlation between ExSpiron™ respiratory curves and SpiroAir-LT curves confirms ExSpiron™'s capability to track and display respiratory curves.

Additional Analysis of Data

This section provides a more detailed assessment of accuracy and bias, additional graphic assessments, considerations in calibrating the data, and assessment using the intra-class correlation coefficient (ICC). It also provides ancillary supporting data and analysis of the respiratory curve with visual presentation.

ExSpiron™ and predicate measurements were compared in two ways, the first using currently accepted definitions of bias and accuracy and the second using the important standard of the intra-class correlation coefficient (ICC) developed by R.A.Fisher[vi]. Both approaches draw on analysis of variance (ANOVA) wherein total variation is decomposed into sources, between variation and within variation. When divided by the associated degrees of freedom we obtain the mean square between (MSB) and the mean-square within (MSW) variations.

The first approach establishes the level of bias, precision and accuracy. The second approach uses ANOVA models for the data that produce estimates of the ICC and an assessment of the role of the factor Day, which represents the amount of time between calibration and measurement. If the factor Day is 1, time since calibration is less than 1 hour, and if the factor Day is 2, time since calibration is approximately 24 hours.

Bias, Precision and Accuracy

Data were acquired in two sessions, on Day 1 and Day 2, with approximately 24 hours separating them. Bias, precision and accuracy were calculated for each subject for each session, then for each subject over both sessions. The relatively constant levels of accuracy and precision calculated on Day 1 and Day 2 demonstrates continued validity of calibration and clinical relevance over a 24-hour period.

Formulae for calculating relative error, bias, precision and accuracy can be found in the "Summary of Results" section.

The following tables present the values of bias, precision, and accuracy (as percentages) for each of MV (Table 6), TV (Table 7) and RR (Table 8). They are presented as per subject and per subject per day calculated over the whole set of tests, as well as separately broken out into Day 1 tests and Day 2 tests.

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Table 6 - Bias, Accuracy and Precision of Minute Ventilation Calculations (Percentage)

	Days 1 and 2			Day 1			Day 2		
	Bias	Precision	Accuracy	Bias	Precision	Accuracy	Bias	Precision	Accuracy
1	1.8	13.2	13.0	-3.1	11.5	11.2	6.1	13.7	14.4
2	-6.1	4.5	7.5	-3.8	4.0	5.4	-8.4	3.9	9.2
3	3.9	4.3	5.7	6.7	2.9	7.3	1.1	3.5	3.5
4	11.2	8.0	13.7	17.8	4.7	18.4	4.7	4.2	6.1
5	1.2	9.6	9.5	-1.6	12.3	11.7	3.9	5.4	6.4
6	-7.7	7.0	10.2	-4.1	5.1	6.4	-11.2	7.0	13.0
7	-2.8	4.8	5.5	-1.4	4.5	4.5	-4.3	5.0	6.4
8	-8.4	7.3	11.0	-8.4	8.7	11.9	-8.4	5.7	10.0
9	-4.7	7.8	8.9	-5.2	3.6	6.2	-4.3	10.7	11.0
10	-5.0	10.5	11.4	-7.3	11.9	13.5	-2.7	8.9	8.9
11	10.9	6.7	12.7	6.3	3.0	6.9	15.5	6.2	16.6
12	-7.1	7.1	9.9	-4.6	8.5	9.3	-9.6	4.7	10.6
13	-7.6	9.4	11.9	-8.9	7.4	11.4	-6.1	11.6	12.5
14	1.0	3.7	3.7	0.8	3.3	3.3	1.2	4.1	4.1
15	-16.2	5.8	17.2	-17.3	7.6	18.7	-15.1	2.8	15.3
16	2.5	7.7	7.9	1.2	4.0	4.0	3.8	10.2	10.4
17	8.5	7.7	11.3	3.6	6.8	7.4	13.5	4.9	14.2
18	-10.7	9.6	14.3	-9.7	8.7	12.7	-11.7	10.8	15.6
19	2.0	5.2	5.5	2.3	6.7	6.7	1.8	3.4	3.7
20	-8.1	9.3	12.2	-8.0	10.1	12.5	-8.1	9.0	11.8

Table 7 - Bias Accuracy and Precision of Tidal Volume Calculations (Percentage)

	Days 1 and 2			Day 1			Day 2		
	Bias	Precision	Accuracy	Bias	Precision	Accuracy	Bias	Precision	Accuracy
1	1.8	13.3	13.0	-3.0	11.4	11.2	6.2	13.8	14.5
2	-6.6	4.5	7.9	-3.8	4.0	5.3	-9.3	3.2	9.8
3	3.9	4.4	5.8	6.8	3.0	7.4	1.1	3.7	3.7
4	11.6	8.2	14.1	18.5	4.2	19.0	4.7	4.4	6.2
5	2.7	8.6	8.8	1.8	10.9	10.5	3.5	5.9	6.6
6	-9.1	6.9	11.3	-4.6	3.9	5.9	-13.5	6.3	14.8
7	-2.4	4.9	5.3	-1.3	4.3	4.2	-3.4	5.4	6.2
8	-8.1	6.9	10.6	-7.9	8.2	11.1	-8.5	5.4	9.9
9	-5.5	7.6	9.2	-6.2	2.6	6.7	-4.8	10.7	11.2
10	-5.0	10.3	11.2	-7.4	11.8	13.4	-2.6	8.6	8.5
11	10.7	6.7	12.5	6.2	3.0	6.8	15.3	6.2	16.4
12	-6.4	7.2	9.5	-3.6	8.8	9.1	-9.2	3.7	9.8
13	-7.0	9.1	11.3	-9.0	7.3	11.3	-4.8	10.9	11.3
14	1.1	3.6	3.6	1.0	3.3	3.3	1.2	4.0	4.0
15	-13.9	6.4	15.2	-12.8	8.5	15.1	-15.0	2.8	15.3
16	2.5	7.7	7.9	1.3	4.1	4.1	3.7	10.2	10.4
17	8.5	7.7	11.3	3.7	7.0	7.6	13.2	5.0	14.1
18	-11.0	9.4	14.3	-9.0	9.6	12.8	-12.9	9.3	15.6
19	2.2	5.2	5.5	2.3	6.7	6.7	2.0	3.6	3.9
20	-7.0	7.9	10.4	-5.8	7.1	8.9	-8.2	8.9	11.7

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Table 8 - Bias Accuracy and Precision of Respiratory Rate Calculations (Percentage)

	Days 1 and 2			Day 1			Day 2		
	Bias	Precision	Accuracy	Bias	Precision	Accuracy	Bias	Precision	Accuracy
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.4	1.9	1.9	0.0	0.0	0.0	0.8	2.6	2.6
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	-0.4	1.7	1.7	-0.8	2.4	2.4	0.0	0.0	0.0
5	-1.5	3.4	3.7	-3.5	3.7	4.9	0.5	1.6	1.6
6	1.6	2.6	3.0	0.6	1.8	1.8	2.7	2.9	3.8
7	-0.3	1.3	1.3	0.0	0.0	0.0	-0.6	1.8	1.8
8	-0.3	1.4	1.4	-0.6	1.9	1.9	0.0	0.0	0.0
9	0.8	2.4	2.5	0.9	3.0	3.0	0.6	1.9	1.9
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	-0.6	2.0	2.0	-0.7	2.2	2.2	-0.6	1.8	1.8
13	-0.7	2.0	2.1	0.0	0.0	0.0	-1.4	2.8	3.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	-2.5	3.7	4.4	-4.7	4.0	6.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.4	2.8	2.7	-0.7	2.2	2.2	1.3	3.0	3.1
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	-1.2	3.1	3.3	-2.3	4.2	4.6	0.0	0.0	0.0

Mean absolute values of bias, precision, and accuracy were also calculated over all subjects, using the following formulae, with results shown in Table 9.

Mean Absolute Bias = mean of absolute values of bias over all subjects
Mean Precision = mean value of precision over all subjects
Mean Accuracy = mean value of accuracy over all subject

Instead of averaging over all tests, if we use the averages of the 20 tests per individual subject presented above in Tables 6-8 to derive these mean values for bias, precision and accuracy, we obtain the results in Table 9. Similar results derived from different methodologies supports the validity of the conclusions.

Table 9 - Mean Values for Bias, Precision and Accuracy (Averaged over Individual Subjects)

Parameter	Mean Absolute Bias	Mean Precision	Mean Accuracy
MV	6.4	7.5	10.2
TV	6.3	7.3	9.9
RR	0.5	1.4	1.5

Figures 3, 4, and 5 show the output from the ExSpiron™ for each 60-second test for each subject compared to the test output from the predicate on Day 1, Day 2 and Days 1 and 2 combined. This represents 200 tests for Day 1 (10 tests for each of 20 subjects on each day), 200 tests for Day 2, and 400

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tests in the combined data set. Day 1 tests are represented by blue points and Day 2 tests are represented by red points. The dotted lines delineate 10% accuracy and the solid lines delineate 20% accuracy.

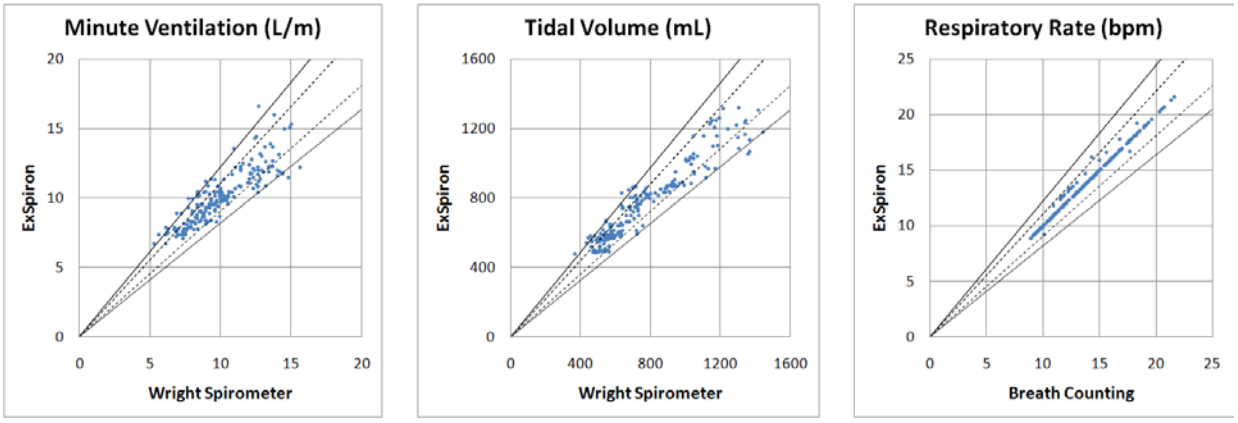

Figure 3 - Respiratory Metrics by Test, Day 1

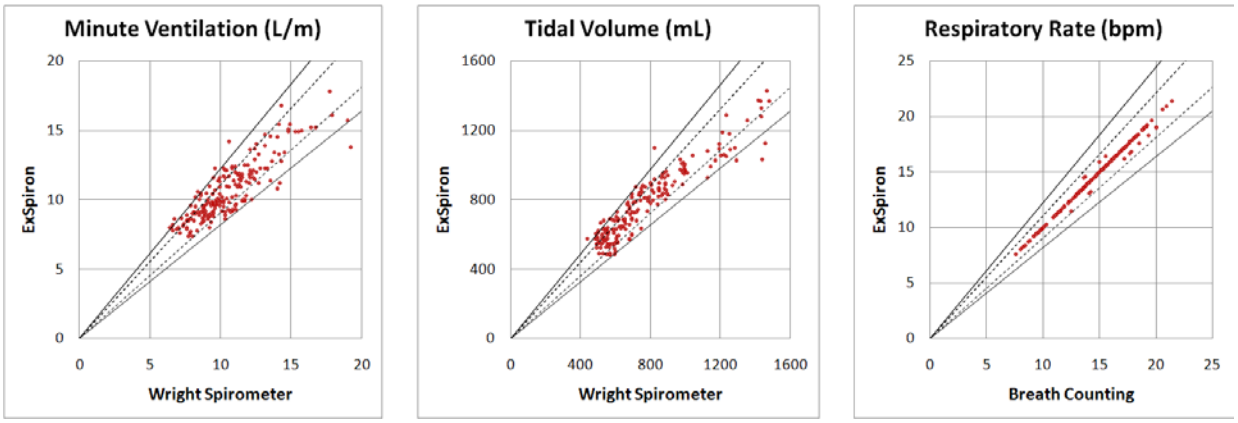

Figure 4 - Respiratory Metrics by Test, Day 2

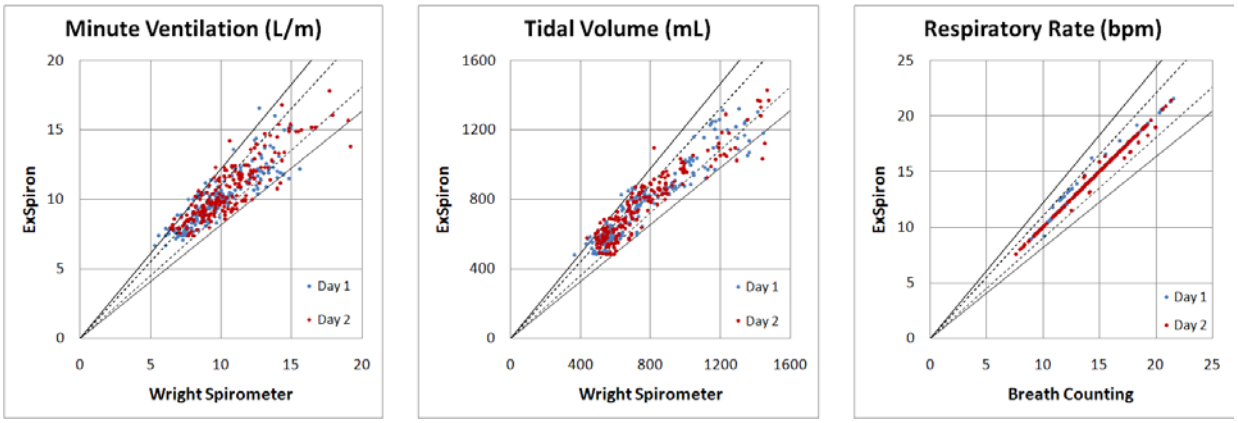

Figure 5 - Respiratory Metrics by Test, Days 1 and 2

As shown in Figure 5, 93% of MV measurements, 95% of TV measurements and 100% of RR measurements are within 20% accuracy.

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Data in Figures 6 and 7 represent mean values computed for MV, TV and RR for each individual subject for each day (Day 1 and Day 2), figure 7 overlays data from Day 1 and Day 2. Each point represents the mean value of the 10 tests performed on each subject. Mean values for each subject on Day 1 are represented by blue points and mean values for each subject on 2 tests are represented by red points. Again, the dotted lines delineate 10% accuracy and the solid lines delineate 20%.

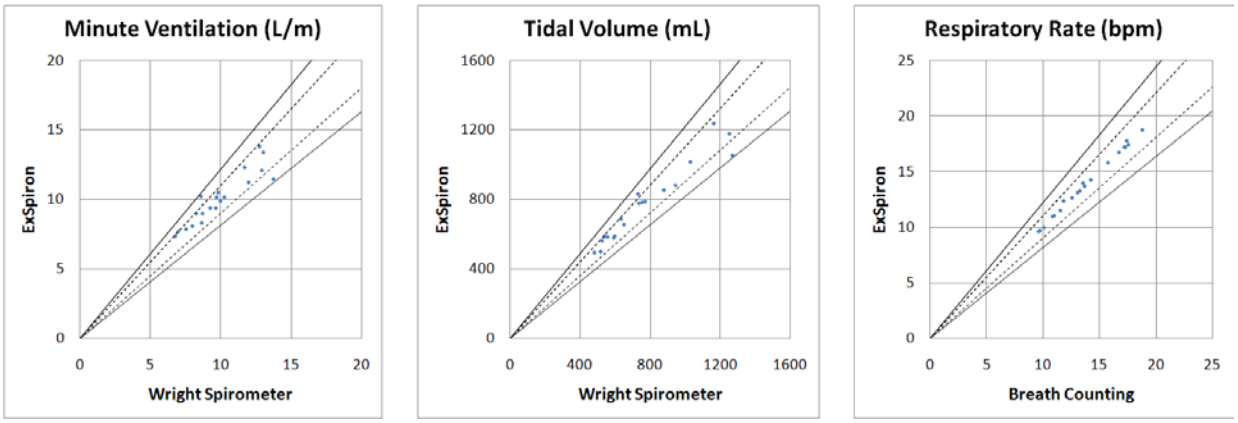

Figure 6 - Mean Respiratory Metrics by Subject on Day 1

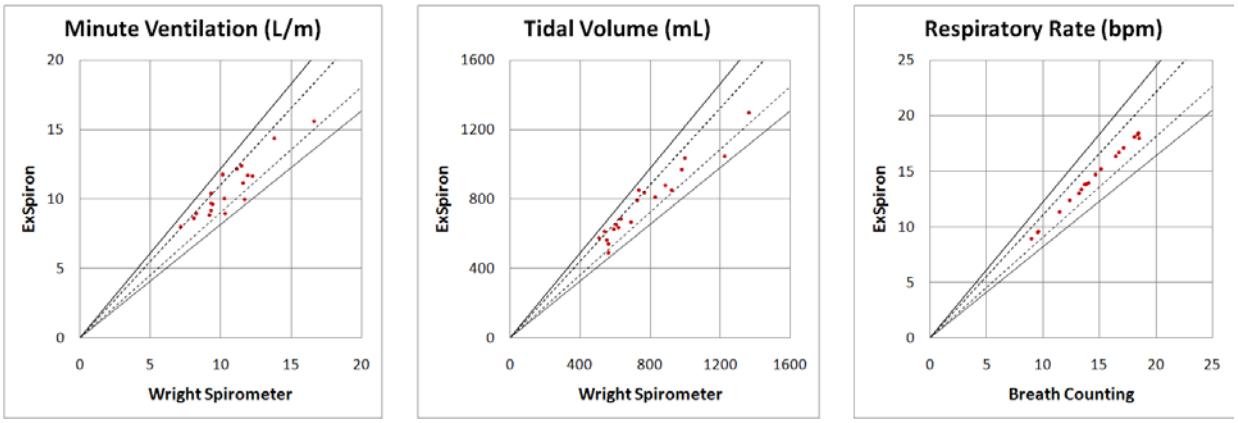

Figure 7 - Mean Respiratory Metrics by Subject on Day 2

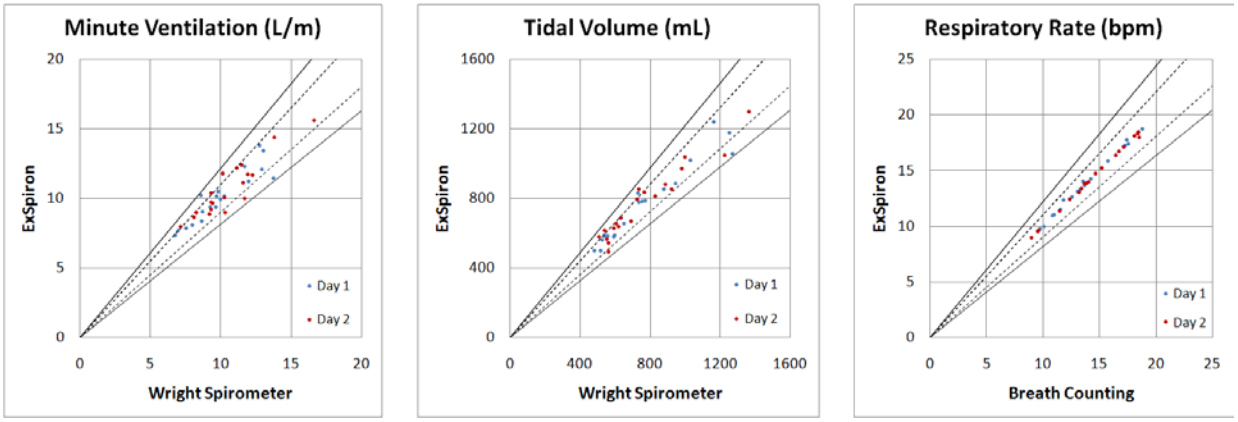

Figure 8 - Mean Respiratory Metrics by Subject, Days 1 and 2

When the mean values of the ten measurements per session are compared, 90% of MV measurements, 90% of TV measurements and 100 % of RR measurements fall within 10% accuracy. 100% of MV measurements and 100% of TV measurements fall within 20% accuracy.

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Intra-class Correlation

An ANOVA analysis was done after restoring the raw scale of the data (removing log-transform)

The Pearson correlation and intra-class correlation coefficient (ICC) were used to assess the overall associations between Wright spirometer and ExSpiron. A repeated measures ANOVA model was used to calculate the ICC with each pair of measurements regarded as a repeated measure. In the setting of ANOVA where n = 2 for pairs,

MSB = mean square between pairs variation,

MSW = mean square within pairs variation, and with n = 2

ICC ~ (MSB – MSW)/(MSB + MSW).

This simplification arises in the one-way ANOVA model[vii]. Note that ICC = 1 only if MSW = 0; that is, the values within each pair are equal. The Pearson correlation is one whenever the measurements are linearly related, a far less restrictive assumption.

The ICC compares variation between subjects to variation within subjects. Two ANOVA models were studied. First, we pooled the data over the two days and modeled only the paired measurement, referred to as 'no model' in the table below. Second, we studied variation between days 1 and 2 using the factor 'Day' as a fixed effect.

Table 6 - Pearson and Intra-class Correlations in two Repeated Measures ANOVA Models

Observation	Pearson	ICC - No Model	ICC - Day
Minute Ventilation	0.877	0.858	0.865
Tidal Volume	0.948	0.934	0.936
Respiratory Rate	0.996	0.996	0.996

The overall Pearson and ICC-associations between the predicate and ExSpiron was near 0.86 for MV, near 0.94 for TV, and greater than 0.99 for RR. The factor 'Day' had no effect of the ICC measure of agreement, indicating that the factor 'Day' did not affect accuracy. Correlation values close to 1.0 indicate the MSW is very small, about zero, relative to MSB, as in the case MSW = 0 and ICC = 1. The factor 'Day' in the MV and RR models day was highly significant but had a small effect altering the response by 0.5 units. In the TV model the estimated Day effect was not significant P = 0.23.

Normalizing the ExSpiron and the Wright Respirometer

To gather the values for TV (average), MV and RR from the spirometer for each breathing trial, the technician first recorded the MV shown on the Wright Respirometer at the end of the trial. During each trial, the technician read off each TV readings into a voice recorder. After the test completed, the technician transcribed the sequential TV readings into a spreadsheet as listed in the voice recording and the average TV was calculated. Each TV represented one breath. By counting the number of TV readings, the technician determined the number of breaths taken (RR).

Due to differences in functionality of the ExSpiron™ and the Wright Respirometer, values taken from each during this study needed to be normalized to be compared correctly and to minimize error. Since the spirometer only records exhalations, by stopping exactly at 60 seconds, the final breath could be truncated or excluded altogether depending on where in the breath the minute ended. In order to avoid this problem and record all full breaths, the ExSpiron™ continued to record data until the technician ended the test.

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The technician ended each test after the last breath was completed. This "extra" time was recorded by ExSpiron™ and used to normalize the values to 60-seconds for all values from both devices. This allowed for the most accurate comparison of data from the two devices.

[i] nSpire Health Ltd. Wright/Haloscale Respirometer: Operating Instructions. Hertford, England; 1986.
[ii] Isley AH, Hart JD, Withers RT, Roberts JG. Evaluation of five small turbine-type respirometers used in adult anesthesia. J ClinMonit. 1993, 9: 196-201.
[iii] Wernerus H, Silva G, Wanner A. Accuracy of Drager and Wright ventilation meters. Respiratory Care. 1978, 23(9): 856-859.
[iv] Fisher R. Statistical Methods for Search Workers. Edinburgh: Oliver and Boyd, 1925.
[v] Snedecor GW and Cochran W, Statistical Methods 5th ed. equation 10.20.1 Ames, Iowa: Iowa State University Press, 1956.
[vi] Fisher R. *Statistical Methods for Search Workers*. Edinburgh: Oliver and Boyd, 1925.
[vii] Snedecor GW and Cochran W, Statistical Methods 5th ed. equation 10.20.1 Ames, Iowa: Iowa State University Press, 1956.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Food and Drug Administration
Office of Device Evaluation &
Office of In Vitro Diagnostics

COVER SHEET MEMORANDUM

From: Reviewer Name Chan. Lee

Subject: 510(k) Number K120087/S1

To: The Record T.H.

Please list CTS decision code _____

- ☐ Refused to accept (Note: this is considered the first review cycle, See Screening Checklist http://eroom.fda.gov/eRoomReg/Files/CDRH3/CDRHPremarketNotification510kProgram/0_5631/Screening%20Checklist%207%202%2007.doc)
- ☐ Hold (Additional Information or Telephone Hold).
- ☐ Final Decision (SE, SE with Limitations, NSE (select code below), Withdrawn, etc.).

Not Substantially Equivalent (NSE) Codes

☐	NO	NSE for lack of predicate
☐	NI	NSE for new intended use
☐	NQ	NSE for new technology that raises new questions of safety and effectiveness
☐	NU	NSE for new intended use AND new technology raising new questions of safety and effectiveness
☐	NP	NSE for lack of performance data
☐	NS	NSE no response
☐	NL	NSE for lack of performance data AND no response
☐	NM	NSE pre-amendment device call for PMAs (515i)
☐	NC	NSE post-amendment device requires PMAs
☐	NH	NSE for new molecular entity requires PMA
☐	TR	NSE for transitional device

Please complete the following for a final clearance decision (i.e., SE, SE with Limitations, etc.):		YES	NO
Indications for Use Page	*Attach IFU*		
510(k) Summary /510(k) Statement	*Attach Summary*		
Truthful and Accurate Statement.	*Must be present for a Final Decision*		
Is the device Class III?			
If yes, does firm include Class III Summary?	*Must be present for a Final Decision*		
Does firm reference standards? (If yes, please attach form from http://www.fda.gov/opacom/morechoices/fdaforms/FDA-3654.pdf)			
Is this a combination product? (Please specify category _____, see http://eroom.fda.gov/eRoomReg/Files/CDRH3/CDRHPremarketNotification510kProgram/0_413b/COMBINATION%20PRODUCT%20ALGORITHM%20(REVISED%203-12-03).DOC			
Is this a reprocessed single use device? (Guidance for Industry and FDA Staff – MDUFMA - Validation Data in 510(k)s for Reprocessed Single-Use Medical Devices, http://www.fda.gov/cdrh/ode/guidance/1216.html)			
Is this device intended for pediatric use only?			
Is this a prescription device? (If both prescription & OTC, check both boxes.)			
Did the application include a completed FORM FDA 3674, Certification with Requirements of ClinicalTrials.gov Data Bank?			
Is clinical data necessary to support the review of this 510(k)?			
For United States-based clinical studies **only**: Did the application include a completed FORM FDA 3674, *Certification with Requirements of ClinicalTrials.gov Data Bank*? (If study was			

3

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conducted in the United States, and FORM FDA 3674 was not included or incomplete, then applicant must be contacted to obtain completed form.)

Does this device include an Animal Tissue Source?

All Pediatric Patients age<=21

Neonate/Newborn (Birth to 28 days)

Infant (29 days -< 2 years old)

Child (2 years -< 12 years old)

Adolescent (12 years -< 18 years old)

Transitional Adolescent A (18 - <21 years old) Special considerations are being given to this group, different from adults age ≥ 21 (different device design or testing, different protocol procedures, etc.)

Transitional Adolescent B (18 -<= 21; No special considerations compared to adults => 21 years old)

Nanotechnology

Is this device subject to the Tracking Regulation? (Medical Device Tracking Guidance, http://www.fda.gov/cdrh/comp/guidance/169.html) *Contact OC.*

Regulation Number **Class*** **Product Code**

(*If unclassified, see 510(k) Staff)

Additional Product Codes:

Review: (Branch Chief) BRDB (Branch Code) 9/20/12 (Date)

Final Review: (Division Director) (Date)

4

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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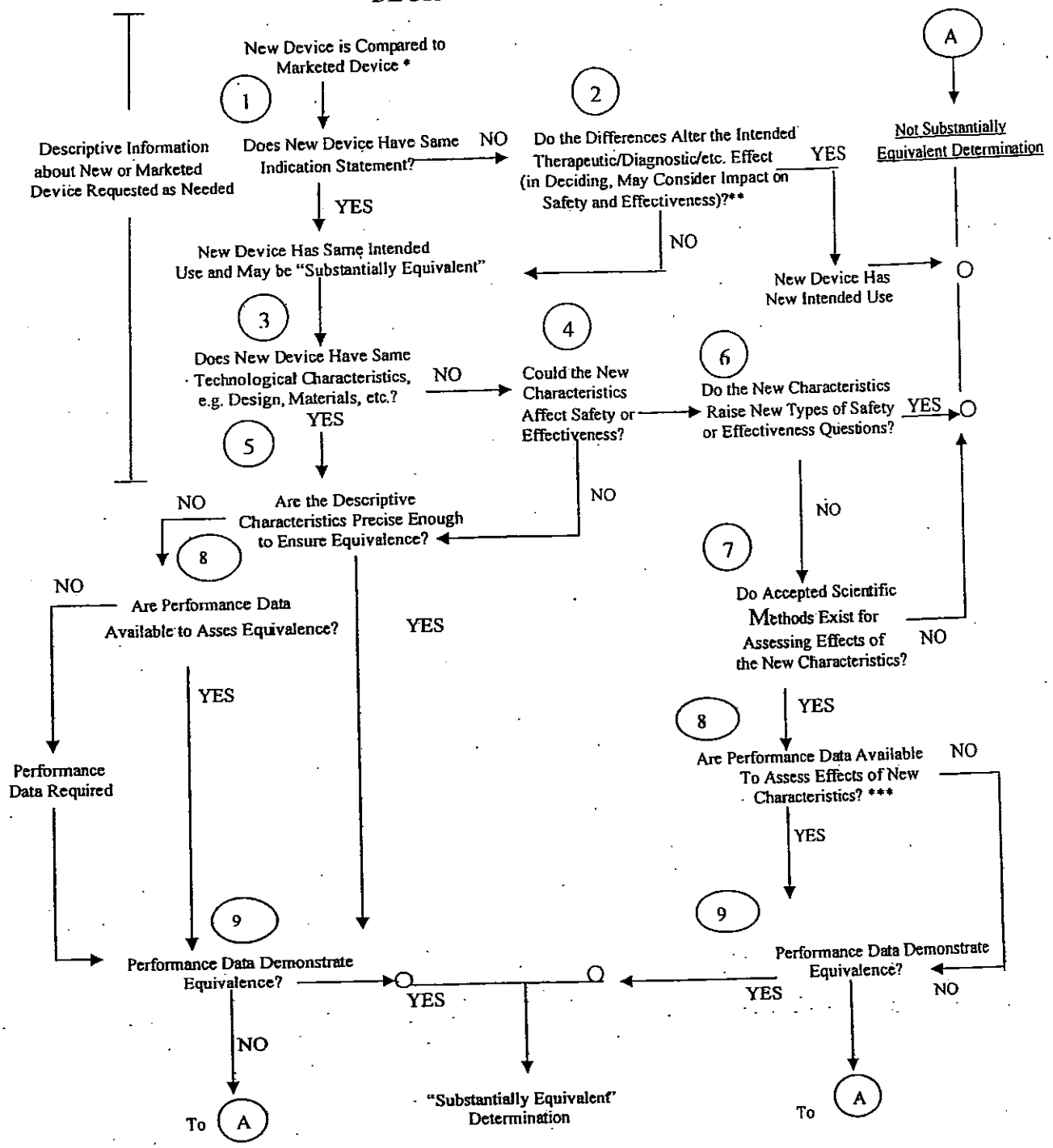
510(k) "SUBSTANTIAL EQUIVALENCE" DECISION-MAKING PROCESS



* 510(k) Submissions compare new devices to marketed devices. FDA requests additional information if the relationship between marketed and "predicate" (pre-Amendments or reclassified post-Amendments) devices is unclear.

** This decision is normally based on descriptive information alone, but limited testing information is sometimes required.

*** Data maybe in the 510(k), other 510(k)s, the Center's classification files, or the literature.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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DEPARTMENT OF HEALTH AND HUMAN SERVICES **MEMORANDUM**

Food and Drug Administration
Office of Device Evaluation
9200 Corporate Boulevard
Rockville, MD 20850

Premarket Notification 510(k) Review
Traditional

K120087

ON TELEPHONE HOLD (September 20, 2012)

Date: September 20, 2012
To: The Record
From: Chan Lee, Electrical Engineer

Office: ODE
Division: DAGID/ARDB

510(k) Holder: Respiratory Motion, Inc.
Device Name: ExSpiron
Contact: Mr. Chas Burr
Phone: (781) 789-1646
Fax: (781) 723-2422
Email: chas_burr@alum.mit.edu

I. Purpose and Submission Summary

The 510(k) holder would like to introduce ExSpiron into interstate commerce.

The proposed device is a respiratory monitor. It uses bioelectrical impedance measurement from electrodes to approximate the following: lung volume; tidal volume; minute ventilation; and respiratory rate.

Pre-IDE I110201

The sponsor submitted a Pre-IDE I110201 in preparation of this 510(k) application. In that Pre-IDE, the sponsor asked three questions. First was about split predicate devices. Second was about comparison of fundamental technology to predicate devices. Third was about test methodology to verify performance specifications.

II. Administrative Requirements

		Yes	No	N/A
Indications for Use page (Indicate if: Prescription or OTC)	***Prescription Use Only***	X		
Truthful and Accuracy Statement	***Included in Section 6***	X		
510(k) Summary or 510(k) Statement	***Summary is included in Section 5***	X		

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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		Yes	No	N/A
Standards Form	***Included in Section***	X		

III. Device Description

		Yes	No	N/A
Is the device life-supporting or life sustaining?			X	
Is the device an implant (implanted longer than 30 days)?			X	
Does the device design use software?		X		
Is the device sterile?			X	
Is the device reusable (not reprocessed single use)? Are "cleaning" instructions included for the end user?	***Computer is reusable*** ***Electrode is single use only***	X	X	

The proposed device is a respiratory monitor. A picture of the proposed device is shown in Figure 1. It uses bioelectrical impedance measurement from electrodes to approximate the following: lung volume; tidal volume; minute ventilation; and respiratory rate.

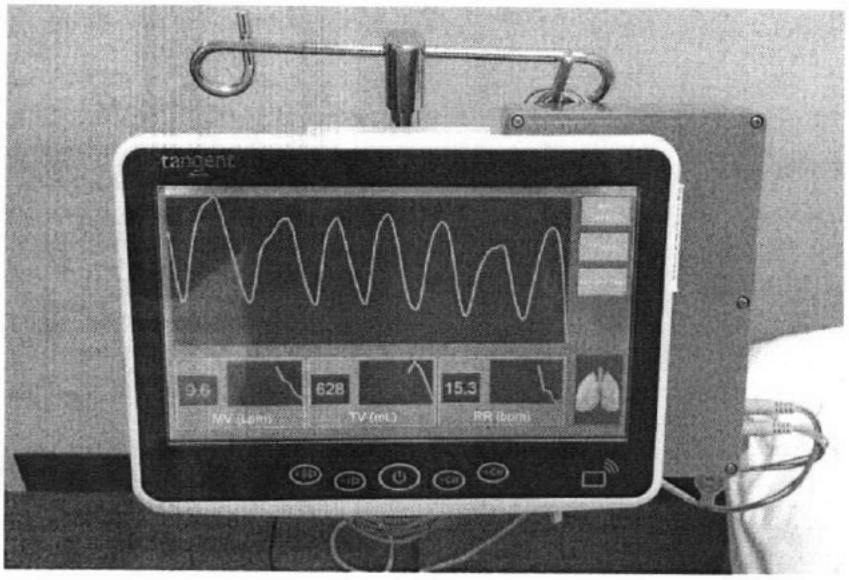

Figure 1 - Picture of Proposed Device

The proposed device is composed of three components:

- B4 [redacted]
- *Impedance Meter:* Interface between the computer and electrodes.
- *Cable and Electrodes:* Connects to patient for bioimpedance measurement.

IV. Indications for Use

The Indications For Use (IFU) statement of the proposed device is as follows.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Revision history of the proposed Indications For Use statement is shown in Table 1. Statements that have been modified or removed are underlined.

Table 1 – Proposed IFU Revision History

Revision	*IFU Statement*	*Notes*
Original	ExSpiron is indicated for use by healthcare professionals in healthcare facilities, such as post-operative care and critical care units, to monitor breathing in patients with potential respiratory compromise. ExSpiron is a non-invasive system that graphically displays lung volume against time and reports an approximate value of: • Tidal volume, • Respiratory rate, and • Minute ventilation. ExSpiron measurements are used as an adjunct to other clinical information sources to determine respiratory status and appropriate therapy.	From Section 4. Intended patient population is not well specified. Included clinical claims which were not validated.
S001	ExSpiron is indicated for use by healthcare professionals in healthcare facilities, such as post-operative care and critical care units, to monitor breathing in adult (at least 21 years of age) patients with potential respiratory compromise. ExSpiron is a non-invasive system that graphically displays lung volume against time and reports an approximate value of: • Tidal volume, • Respiratory rate, and • Minute ventilation. ExSpiron measurements are used as an adjunct to other clinical information sources to determine respiratory status and appropriate therapy.	From Appendix 1-1. Update IFU contains intended patient population and clinical claims which were not validated.
S002	TBD	

510(k) Summary Review

The sponsor has provided a complete 510(k) Summary in Section 5 of the original submission.

		YES	NO	N/A
Required Elements for 510(k) Summary (21 CFR 807.92)				
	Clearly labeled "510(k) Summary"	X		
	Submitter's name, address, phone #, a contact person	X		
	Date the summary was prepared	X		
	The name of the device/trade name/common name/classification name	X		
	An identification of the legally marketed Predicate	X		
	Description of the subject device	X		
	Statement of intended use (identical to indications for use)	X		
nological characteris	If same, a summary of comparison of technological characters	X		

		If different, a summary of how do they compare to the Predicate	X		
	Performance Data	Brief discussion of non-clinical data submitted, referenced, or relied on	X		
		Brief discussion of clinical data submitted, referenced, or relied on, including: • Description upon whom the device was tested, • Data obtained from the tests and especially: • Adverse events and complications • Other information for SE determination	X		
		Conclusion that data demonstrate SE	X		
Required Elements for 510(k) Statement (21 CFR 807.93)					
	Signed verbatim statement				X

V. Predicate Device Comparison

The sponsor identified the two split predicate devices. One is for the intended use (Wright Haloscale Spirometer), and the other is for the technology (Intellivue). In the Pre-IDE I110201, lead reviewer Ms. Amy LeVelle of ARDB stated that the split predicate devices were acceptable.

- For product code BZK, monitoring spirometer, the ExSpiron is compared to the nSpire Wright/Haloscale Respirometer, marketed by nSpire Health, Inc. of Longmont, CO. FDA cleared the nSpire respirometer in 510(k) K 091853.
- For product code BZQ, breathing frequency monitor, the ExSpiron is compared to the Philips MPn0 Intellivue Patient Monitors, marketed by Philips Healthcare. FDA cleared the Intellivue monitor in 510(k) K060541.

VI. Labeling

Labeling Recommendations	*Yes*	*No*	*N/A*
Does the submission contain proposed labels, labeling, and advertisements sufficient to describe the device, its intended use, and the directions for use? (Labels include the information affixed directly to the device or its container or packaging. Labeling also includes professional or patient package inserts, and any other information that accompanies the device.)	X		
Does the labeling describe the intended uses?	X		
Does the labeling include adequate directions for use?	X		
Does the labeling include a prescription statement (21 CFR 801.109)?	X		
Labeling should include a list of device specifications including: reservoir volume, flow rates and profiles (if applicable), accuracy, residual volume, and the operational conditions (e.g., temperature, pressure, fluid viscosity) under which these are valid.	X		
Are route(s) of administration described as indicated in the statement of intended use?	X		
Does the labeling include comprehensive directions for preparation and use for all possible functions of the device?	X		
Has the sponsor provided a copy of patient instructions for use if the device is intended for home use, or would reasonably be expected to be used in a home setting?	X		

9

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Does the device include appropriate MR/CT/ultrasound labeling?			X

Labeling has been provided which includes instructions for use and an appropriate prescription statement as required by 21 CFR 801.109(b).

VII. Sterilization/Shelf Life/Reuse

In Section 14 of the original submission, the sponsor stated that the proposed device is not provided sterile. B4 [redacted]

VIII. Biocompatibility

Only the electrodes in the proposed device contact the patient. B4 [redacted]

IX. Software

Version: **1.03.01**

Level of Concern: **Moderate**

		Yes	No
Software description:	***Refer to Section 16-2***	X	
Device Hazard Analysis:	***Refer to Section 16-3***	X	
Software Requirements Specifications:	***Refer to Section 16-18***	X	
Architecture Design Chart:	***Refer to Section 16-21***	X	
Design Specifications:	***Refer to Section 16-24***	X	
Traceability Analysis/Matrix:	***Refer to Section 16-35***	X	
Development:	***Refer to Section 16-44***	X	
Verification & Validation Testing:	***Refer to Section 16-46***	X	
Revision level history:	***Refer to Section 16-51***	X	
Unresolved anomalies:	***Refer to Section 16-50***	X	

In Section 16, the sponsor provided software documentation. The sponsor classified the proposed device as Moderate level of concern. This reviewer agrees with the sponsor because the clinician is likely to rely on other vital signs to determine clinical decisions.

X. Electromagnetic Compatibility and Electrical, Mechanical and Thermal Safety

In Section 17, the sponsor stated that they will conform to various standards. However, the sponsor should provide completed test report prior to seeking 510(k) clearance.

In Supplement 1, the sponsor provided complete electromagnetic compatibility (EMC) and electrical safety testing according to IEC 60601-1 and IEC 60601-1-2 which are FDA recognized standards. This reviewer found that the proposed device passed testing. This reviewer does not have additional questions for the sponsor.

XI. Performance Testing – Bench

The sponsor provide software verificaiton and validation test report in Section 16-46 of the original submission.

XII. Performance Testing – Animal

The sponsor did not provide animal testing. This reviewer believes that animal testing is not necessary in order to determine substantial equivalence to the predicate devices.

XIII. Performance Testing – Clinical

The proposed device uses electrode sensors to measure bioimpedance. Performance bench testing may be sufficient to verify and validate the operating performance specifications such as resistance, current, and voltage measurements. However, the clinical output is dependant on actual measurement of a human body which may not be adequately modeled. Therefore, this reviewer believes that clinical study is necessary to verify and validate the intended use and clinical claims of the proposed device.

The sponsor provided clinical study in Section 20 of the original submission. This reviewer consulted Dr. Deborah Shure of ARDB for clinical review and Dr. Arkendra De of OSB for statistical review.

Clinical Study

Dr. Shure found the study to be inadequate. Dr. Shure identified the following deficiencies in her review memo.

- Intended duration of use for electrode pads.
- Detailed patient inclusion and exclusion criteria.
- No sample size justification.
- Demographic and anthropomorphic information was insufficient.
- The analysis of the clinical data is difficult to understand.

Statistical Analysis

Dr. De found the analysis to be inadequate and stated the following in his review memo:

> *"Using numerical values provided by the sponsor, FDA reached different conclusions about the clinical study than the sponsor. Additional information and explanation are requested from the sponsor. After talking with the clinician on February 22, 2012, a few remarks have been added to this review."*

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

XIV. Substantial Equivalence Discussion

	Yes	No	
1. Same Indication Statement?	X		If **YES** = Go To 3
2. Do Differences Alter The Effect Or Raise New Issues of Safety Or Effectiveness?			If **YES** = Stop **NSE**
3. Same Technological Characteristics?		X	If **YES** = Go To 5
4. Could The New Characteristics Affect Safety Or Effectiveness?		X	If **YES** = Go To 6
5. Descriptive Characteristics Precise Enough?		X	If **NO** = Go To 8 If **YES** = Stop **SE**
6. New Types Of Safety Or Effectiveness Questions?			If **YES** = Stop **NSE**
7. Accepted Scientific Methods Exist?			If **NO** = Stop **NSE**
8. Performance Data Available?	X		If **NO** = Request Data
9. Data Demonstrate Equivalence?			Final Decision:

Note: See http://eroom.fda.gov/eRoomReq/Files/CDRH3/CDRHPremarketNotification510kProgram/0_4148/FLOWCHART%20DECISION%20TREE%20.DOC for Flowchart to assist in decision-making process. Please complete the following table and answer the corresponding questions. "Yes" responses to questions 2, 4, 6, and 9, and every "no" response requires an explanation.

1. *Explain how the new indication differs from the predicate device's indication:*

Both the predicate devices and proposed device are intended to measure various respiratory measurements.

2. *Explain why there is or is not a new effect or safety or effectiveness issue:*

3. *Describe the new technological characteristics:*

The fundamental technology of various components in the proposed device is not new. However, the electrodes are used for bioimpedance measurement to monitor respiratory functions. The sponsor cited split predicate for both intended use and technology. In previous Pre-IDE submission, ARDB recommended that the split predicates are acceptable.

4. *Explain how new characteristics could or could not affect safety or effectiveness:*

5. *Explain how descriptive characteristics are not precise enough:*

The sponsor should verify and validate their clinical performance specifications on human test subjects.

6. *Explain new types of safety or effectiveness question(s) raised or why the question(s) are not new:*

7. *Explain why existing scientific methods can not be used:*

8. *Explain what performance data is needed:*

9. *Explain how the performance data demonstrates that the device is or is not substantially equivalent:*

XV. Deficiencies

A summary of deficiency questions and follow-up questions are shown in Table 2.

Table 2 – Summary Deficiency Questions and Follow-Up

1st Deficiency Letter Question	*Notes*	*Response*	*2nd Deficiency Letter Question*	*Response*
1	Prescription use	***Adequate***		
2	Conformance to standards and testing	***Adequate***		
3	Electrodes	***Adequate***		
4	Human factors study	***Adequate***		
5	Intended patient population	***Adequate***		
6	Inclusion and exclusion criteria	***Adequate***		
7	Duration of use	***Adequate***		
8	Age range	***Adequate***		
9	Intended patient population	***Adequate***		
10	Sample size justification	***Adequate***		
11	Analysis of data	***Adequate***		
12	Correlation coefficient	***Adequate***		
13	Predicate device comparison	***Adequate***		
14	Bland-Altman plots	***Adequate***		
15	Measurement scale and analysis	***Adequate***		
16	Sample size justification	***Adequate***		
	Labeling Claims	***Inadequate***	1, 2, 3, 4, 5	

First Deficiencies

The following deficiencies were sent to the sponsor in an email on March 30, 2012.

1. You provided Indications For Use statement page in Section 4. However, you did not indicate whether your proposed device is prescription use or over-the-counter use. Please clarify and provide an updated Indications For Use statement page.

Adequate Response: The sponsor stated that the proposed device is prescription use only. The sponsor provided updated IFU statement page.

2. In Section 9 and 17, you stated that your proposed device will conform to standards and validation testing. Please be advised that we expect all testing to be completed prior to 510(k) clearance. Therefore, please provide completed test report and data on your proposed device in its final finished form.

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Adequate Response: The sponsor provided complete EMC and electrical safety testing according to IEC 60601-1 and IEC 60601-1-2. The proposed device met all test requirements.

3. In Section 15, you stated that "The electrodes are Kendall Meditrace 850 Foam ECG Radiolucent Electrodes, manufactured by Covidien."

   a. Please specify the 510(k) clearance number for the electrodes.

   b. Please clarify whether you made any modifications to the electrodes identified above.

   c. If you made any modifications to the electrodes in the predicate device, then please provide detailed description of all modifications. In addition, please provide biocompatibility testing.

Adequate Response: The sponsor clarified that the electrodes were cleared in B4 [redacted]. The sponsor also clarified that they made no modifications to the cleared electrodes.

4. In Section 18, you stated that "Bench performance testing has focused on usability." However, you did not provide human factors study data. Please provide human factor study on your final finished product according to FDA recognized standard "AAMI / ANSI HE75:2009, Human factors engineering - Design of medical devices". Please provide all labeling and training programs for your proposed device.

Adequate Response: The sponsor stated that the purpose of usability study was to validate that the users did not have difficulty using the proposed device. The sponsor provide usability test reports in Appendix 4-1. This reviewer found that the 10 test subjects were able to complete the training and assigned tasks without reporting difficulties.

Clinical

5. You have not provided sufficient information to evaluate potential limitations to the use or accuracy of the device with respect to clinical conditions or the presence of other equipment. Please address how issues of device function that may occur in the presence of very high or very low respiratory rates, morbid obesity, dehydration, anasarca, hypotension, and implanted or temporary neurostimulators or pacers. If there are other conditions or devices that may affect the performance of the device, please include them as well in your discussion. Please be aware that the adequacy of the clinical trial population cannot be assessed without such information.

6. Please provide clinical and statistical justification as to how your patient inclusion and exclusion criteria are representative of the entire intended patient population.

7. The clinical trial studied the device over a 24 hour period, but the device description does not provide information about the upper limits of duration of use of the electrode pads. Because testing should be done over the expected duration of use, please provide information about the upper limit of use of the electrode pads.

8. The Indications for Use statement does not specify an age range for intended use, but the clinical trial was conducted in subjects 20 years of age and older. Please modify the Indications for Use statement to indicate the age ranges for which the device may be used. If the age range is greater than that provided in the clinical testing, please be aware that additional testing may be needed to support the claim.

9. The 20 patients were selected to represent various ethnicity, disease states, and BMI values, but you have not provided specific information. Please provide line data in tabular form for each subject with respect to the selection variables.

10. You have not provided a sample size justification for the 20 patient trial. Please provide a sample size justification.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

11. The analyses of percentage accuracy, precision, and bias of an unusually derived metric (natural log of the ratio of the device to the predicate measurements) are difficult to interpret clinically. Please provide an analysis of the results in terms of sensitivity, specificity, positive predictive values, and negative predictive value.

Statistical

12. On page 20-13, you stated that the factor day had no effect on the intra-class correlation coefficient. One of the limitations with the intra-class correlation coefficient is that "estimates (as with all correlation coefficients) are dependent on the range of the measuring scale; the wider the range, the better the result." (from Müller and Büttner Stat. in Med., Vol. 13, 2465-2476 (1994)). FDA conducted its own analysis using bootstrap of the absolute difference for minute ventilation and tidal volume. Numerical results from tables 6 and 7 on page 20-9 were used for the calculations. FDA analyses incorporated results at the subject level. Below are the results, all of which are statistically significant.

    - Accuracy between days 1 and 2 for minute ventilation: average absolute difference of 4.12%, with a 95% confidence interval of [3.10%, 5.55%]
    - Precision between days 1 and 2 for minute ventilation: 2.9% for the average absolute difference of precision with 95% confidence interval of [1.99%, 3.76%]
    - Accuracy between days 1 and 2 for tidal volume: average absolute difference of 4.105%, with 95% confidence interval of [2.73%, 5.63%]
    - Precision between days 1 and 2 for tidal volume: average absolute difference of 2.91%, with 95% confidence interval of [2.05%, 3.87%]

    In light of these results, it is unclear that the device performs comparably on different days, especially with respect to minute ventilation and tidal volume. Please comment on these results.

13. On page 20-7, a three subject study is described which the ExSpiron is compared to the SpiroAir-LT in order to determine whether the graphical display can track respiratory curves accurately. Using only three subjects is a small sample size, rendering any generalizations to the entire intended use population questionable. Also, the SpiroAir-LT was used to calibrate the ExSpiron, which may introduce bias. It is also unclear that only the SpiroAir-LT will be used for calibration in routine clinical practice. In addition to addressing these concerns, please provide plots which superimpose the tracings from the SpiroAir-LT and ExSpiron on the same graph, with clear legends that clearly depict the device producing each tracing.

14. Please provide Bland-Altman plots comparing the ExSpiron against the Wright Respometer, separately for each subject and combined. Please see Bland and Altman The Lancet Volume 327, Issue 8476, 8 February 1986, Pages 307–310 for more information about Bland-Altman plots.

15. The calculation method used for quantifying the bias, precision, and accuracy (shown on page 20-5) is not a standard statistical method. Rather than using the logarithm scale, which could be difficult to interpret, please provide the bias, precision, and accuracy on the original raw measurement scale. If there are important medical or clinical decision points that are used in clinical practice, please incorporate these clinical decision points into the analysis of the ExSpiron against the predicate. These points can be incorporated by calculating sensitivity and false positive rate for the clinical study. To incorporate the correlated measurements (i.e. multiple measurements made on the same subject), please consider using bootstrap. For more information about bootstrap, please see Davison and Hinkley (1997) Bootstrap Methods and Their Application.

16. On page 20-3, you stated that 20 subjects were used for the clinical study. Please provide justification for this sample size. From a statistical perspective, it is difficult to understand why this is sufficient.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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XVI. Contact History

Contact history with the sponsor is shown in Table 3.

Table 3 - Contact History

Contact Type	*Date*	*Sponsor's Response*	*Note*
Email	March 30, 2012	***September 14, 2012***	First Deficiency Letter
Email	September 20, 2012	***TBD***	Second Deficiency Letter

XVII. Recommendation

I recommend that the file be placed on telephone hold.

Substantial equivalence cannot be determined because the sponsor made clinical claims in the labeling without supporting evidence.

Regulation Number: 21 CFR 868.2375
Regulation Name: Breathing frequency monitor
Regulatory Class: Class II
Product Code: BZQ

Chan Lee

September 20, 2012
Date

Dr. Lex Schultheis, ARDB Branch Chief

September 20, 2012
Date

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Lee, Chan

From: Lee, Chan
Sent: Thursday, September 20, 2012 3:45 AM
To: 'chas_burr@alum.mit.edu'
Cc: Nguyen, Anh
Subject: Respiratory Motion ExSpiron (K120087/S001) Additional Information Request

Respiratory Motion, Inc.
Mr. Chas Burr
Consultant
11 Mystic Avenue
Winchester, MA 01890
chas_burr@alum.mit.edu

Re: K120087/S001
Trade Name: ExSpiron
Dated: September 13, 2012
Received: September 14, 2012

Dear Mr. Burr,

We have reviewed your Section 510(k) premarket notification of intent to market the device referenced above. We cannot determine if the device is substantially equivalent to a legally marketed predicate device based solely on the information you provided. To complete the review of your submission, we require your response to the following deficiencies.

1. In your 510(k) Summary page, you stated that the Morgan Spirometer is the "gold standard". However, the Morgan Spirometer is not the "gold standard" because it cannot be used as a continuous monitor. Your proposed device is intended to be used as a continuous monitor. Thus Morgan Spirometer is not an appropriate direct comparator to your proposed device. Please remove your claim that the Morgan Spirometer is the gold standard from your submission. Please provide updated copies of 510(k) Summary page and labeling.

2. In your Indications For Use (IFU) statement, you stated that your proposed device can "monitor breathing in patients with potential respiratory compromise". However, your clinical study did not identify or evaluate specific respiratory compromises in patients. Therefore, please remove the statement "with potential respiratory compromise" from your submission. Please provide updated IFU statement page, 510(k) Summary page, and labeling.

3. In your Indications For Use (IFU) statement, you stated that the measurements from your proposed device are used "to determine respiratory status and appropriate therapy." However, your proposed device is a monitor and not a diagnostic device. In addition, you did not provide clinical study that evaluates how the user used your proposed device to determine respiratory status and appropriate therapy. Therefore, please remove the statement "to determine respiratory status and appropriate therapy" from your submission. Please provide updated IFU statement page, 510(k) Summary page, and labeling.

4. You provided promotional claims in Appendix 4-5. However, you made clinical claims about your proposed device without providing supporting evidence from your clinical study. Therefore, please remove the clinical claims identified below from your promotional claims. Please provide updated promotional claims for review.

   a. You stated that "ExSpiron can monitor breathing in adult patients with respiratory compromise or potential respiratory compromise." However, your clinical study did not identify or evaluate specific respiratory compromises in patients.

   b. You stated that "ExSpiron assists in monitoring at-risk patients in near real-time." However, your clinical study did not identify or evaluate specific at-risk patients.

   c. You stated that "ExSpiron helps improve the standard of respiratory monitoring because it displays MV, TV, and RR over time." However, your clinical study did not evaluate how your proposed device improved the standard of respiratory monitoring.

   d. You stated that "ExSpiron can help physicians identify patients with inadequate breathing." However, your clinical

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study did not evaluate how your proposed device helped care providers identify patients with inadequate breathing.

e. You stated that "ExSpiron can assist physicians' decision-making by providing respiratory status data." However, your clinical study did not evaluate how your proposed assisted care providers in their decision making process.

5. In your promotional claims in Appendix 4-5, you stated that "ExSpiron is easy to use." You conducted usability testing on 10 test subjects. However, the test reports provided limited granularity regarding user task performance and limited user commentary regarding ease of use. Therefore, please remove the claim "easy to use" from your submission. Please provide updated promotional claims.

The deficiencies identified above represent the issues that we believe need to be resolved before our review of your 510(k) submission can be successfully completed. In developing the deficiencies, we carefully considered the statutory criteria as defined in Section 513(i) of the Federal Food, Drug, and Cosmetic Act (Act) for determining substantial equivalence of your device.

You may not market this device until you have provided adequate information described above and required by 21 CFR 807.87(l), and you have received a letter from FDA allowing you to do so. If you market the device without conforming to these requirements, you will be in violation of the Act. You may, however, distribute this device for investigational purposes to obtain clinical data if needed to establish substantial equivalence. Clinical investigations of this device must be conducted in accordance with the investigational device exemption (IDE) regulations (21 CFR 812).

This email signifies notification to you that your file has been placed on hold. If the information, or a request for an extension of time, is not received within 30 days, we will consider your premarket notification to be withdrawn and your submission will be deleted from our system. If you submit the requested information after 30 days it will be considered and processed as a new 510(k)(21 CFR 807.87(l)); therefore, all information previously submitted must be resubmitted so that your new 510(k) is complete. For guidance on 510(k) actions, please see our guidance document entitled, "FDA and Industry Actions on Premarket Notification (510(k)) Submissions: Effect on FDA Review Clock and Performance Assessment" at
http://www.fda.gov/downloads/MedicalDevices/DeviceRegulationandGuidance/GuidanceDocuments/UCM089738.pdf

If the submitter does submit a written request for an extension, FDA will permit the 510(k) to remain on hold for up to a maximum of 180 days from the date of the additional information request.

The purpose of this document is to assist agency staff and the device industry in understanding how various FDA and industry actions that may be taken on 510(k)s should affect the review clock for purposes of meeting the Medical Device User Fee and Modernization Act. .

The requested information, or a request for an extension of time, should reference your above 510(k) number and should be submitted in duplicate to:

U.S. Food and Drug Administration
Center for Devices and Radiological Heath
Document Mail Center – WO66-0609
10903 New Hampshire Avenue
Silver Spring, MD 20993

If you have any questions concerning the contents of the letter, please contact Chan Lee at (301) 796-6267. If you need information or assistance concerning the IDE regulations, please contact the Division of Small Manufacturers, International and Consumer Assistance at its toll-free number (800) 638-2041 or at (301) 796-7100, or at its Internet address http://www.fda.gov/MedicalDevices/ResourcesforYou/Industry/default.htm.

Please respond as soon as possible to acknowledge receipt of this email.

Sincerely,

Chan O. Lee
Regulatory Reviewer
Food and Drug Administration
Center for Devices and Radiological Health

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WO66-2543
10903 New Hampshire Avenue
Silver Spring, MD 20993
Phone: (301) 796-6267
Email: chan.lee@fda.hhs.gov

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DEPARTMENT OF HEALTH & HUMAN SERVICES Public Health Service

Division of Anesthesia, General Hospital, Infection Control, and Dental Products (DAGID)
Anesthesia and Respiratory Devices Branch (ARDB)
Center for Devices and Radiation Health
Food and Drug Administration
Silver Spring, MD 20993 Tel: 301 796 5580 Fax: 301 796 8109

RESPONSE TO CONSULT REQUEST

Date: Wednesday, September 19, 2012

From: Anh Nguyen, M.D., MBA, ODE/DAGID/ARDB

To: Chan Lee, Lead Reviewer, ODE/DAGID/ARDB

Re: 510(k) Application: K120087 / S001 -ExSpiron
Respiratory Motion, Inc.

Device Name:
ExSpiron Respiratory Monitor

Proposed Indication For Use:
"ExSpiron™ is indicated for use by healthcare professionals in healthcare facilities, such as post-operative care and critical care units, to monitor breathing in adult (at least 21 years old) patients with potential respiratory compromise.

ExSpiron™ is a non-invasive system that graphically displays lung volume against time and reports an approximate value of:
- Tidal volume,
- Respiratory rate, and
- Minute ventilation

ExSpiron™ measurements are used as an adjunct to other clinical information sources to determine respiratory status and appropriate therapy."

Question:
Evaluate the Sponsor's responses to FDA questions received to DMC 9/14/2012.

Summary Recommendations:
Performance validation in terms of accuracy and precision to measure respiratory parameters such as 1) respiratory rate, 2) tidal volume, and 3) minute ventilation, has been the large concern throughout the entire review of this premarket application. In Pre-IDE discussion, the Wright spirometer was accepted as a clinical reference standard. The Wright spirometer is prone to have 20% error. Further testing was performed to

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demonstrate equivalence between the Wright spirometer and the Morgan spirometer. The testing demonstrated similar results. Compared to both the Wright and Morgan, the Exspiron device has tested with approximately 10% error. Combined, the Exspiron has a potential for 32% error (1.2 x 1.1) compared to actual. This degree of error can mask acute clinical concerns during active patient care.

This risk for error with the Exspiron is greater than measurement tools within mechanical ventilators. Electromagnetic valves within ventilators have a degree of precision in the order of 5% compared with measured values (data from Hamilton Medical). Flow measurements have a precision of < 10%. The volume values reported by the ventilators can thus vary from 50 to 100 ml for a set tidal volume of 1,000 ml.

The proposed device does not have alarms. However, it is unclear if such alarms would be useful in the proposed device, because the potentially high error rate can mask relevant clinical signs. A device with a potential 30% error rate would need further performance data to justify clinical claims. This 510(k) application has been reviewed in the context of only a tool-based claim (trend monitor).

Promotional labeling for clinical claims are to be excluded at this time.

Labeling for "ease-of-use" should be excluded at this time, because the usability test reports currently appear inadequate regarding their resolution to assess that factor.

Executive Summary:

The sponsor applied for 510(k) premarket application in January 2012. The device is a Bioimpedance measurement system. It consists of a stabilized high frequency current generator connected to the outer two electrodes. Two measurement channels convert the resulting voltage signal to digital form. Each channel consists of a pair of electrodes placed between the two "source" electrodes, and an adaptive circuit to condition the signal. Firmware performs signal acquisition and relays data to the panel PC. The signal output is a measurement of tidal volume, respiratory rate, and calculated minute ventilation. The device has a 10% measurement error when compared to the predicate device, which is also error-prone (20%).

The review team recommended a file hold in March 2012, because of multiple clinical and statistical deficiencies.

In May, a response was submitted, but FDA rejected it because it inappropriately requested to change from a Traditional 510(k) to an Abbreviated 510(k). This September response replaces the May response in total. This response includes material from the May response that has not changed, additional material added based on conversations with FDA reviewers, and some material that has changed from the May response.

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Materials Reviewed:

1. Sponsor responses September 13, 2012

Review:

***Tool-based Claims:*

Page 10 Submission Materials:

"Because ExSpiron is intended to monitor, not to diagnose, the study's purpose is to demonstrate that ExSpiron's measurement performance is comparable to a clinically viable predicate device. The inclusion/exclusion criteria provide a broad sampling of subjects over which to demonstrate measurement performance."

Page 13 Submission materials:

"Sensitivity, specificity, positive predictive value, and negative predictive value are meaningful in terms of diagnosis. The ExSpiron's intended use is monitoring of respiratory measurements to be used as an adjunct to other clinical information. An analysis of diagnostic power is not consistent with the intended use."

From IFU:

"ExSpiron is indicated for use by healthcare professionals in healthcare facilities, such as post-operative care and critical care units, to monitor breathing in patients with potential respiratory compromise.

ExSpiron is a non-invasive system that graphically displays lung volume against time and reports an approximate value of:

- Tidal volume,
- Respiratory rate, and
- Minute ventilation.

ExSpiron measurements are used as an adjunct to other clinical information sources to determine respiratory status and appropriate therapy."

Reviewer Comment:

The Sponsor should explicitly label the device within its tool-based context.
This tool-based claim is seen, as per the Sponsor response as well as previous discussion in teleconference. The IFU will require revision to remove implied clinical claims.

- The phrase in IFU: "*monitor breathing in patients with potential respiratory compromise,*" should be removed.
- The phrase "*to determine respiratory status and appropriate therapy,*" should be removed.

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**Page 3 Submission Materials:

4. *In Section 18, you stated that "Bench performance testing has focused on usability." However, you did not provide human factors study data. Please provide human factor study on your final finished product according to FDA recognized standard "AAMI / ANSI HE75:2009, Human factors engineering - Design of medical devices". Please provide all labeling and training programs for your proposed device.*

At the time of the original 510(k), the usability testing had been used to determine usability requirements. Usability requirements were included in the System Requirements. User Error hazards were included in the Risk Management Plan (pages 16-7 and 16-8 of the original submission). The usability requirements and user error hazards were reviewed to develop the usability validation protocol and test record form in Appendix 4-1.

Technical usability content is found in the User Manual (Appendix 4-2). The Training Outline
(Appendix 4-3) describes the training performed by RMI authorized personnel.

Final usability validation was performed at RMI's clinical test facility. Test users, who did not have previous experience with ExSpiron, included:

- 5 Anesthesiologists
- 1 Cardiothoracic surgeon
- 1 Critical care physician
- 2 ICU nurses
- 1 ER nurse

Test results showed no difficulties or failures with the final ExSpiron device and training. The ease of use results from use similarities with other common monitoring devices, a user interface designed to match typical user workflow, and documentation and training that address unique ExSpiron features. The ten test reports are provided in Appendix 4-4.

Promotional claims are listed in Appendix 4-5.

Reviewer Comment:
The data exhibited within the test report only has 10 users, instead of 15 as recommended by the Human Factors Guidance. The 3 criteria used to assess ease of use or task performance (OK, Failure, Difficulty) is nonspecific. Also there was no participant comment. Though all the forms in test report appendix 4-4 stated "OK", it does not signal necessarily that the device is "easy to use."

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Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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The promotional labeling regarding ease-of-use should be removed. It is unclear to me if the human factors testing is performed correctly.

**Promotional Labeling (Appendix 4-5):

- ExSpiron can monitor breathing in adult patients with respiratory compromise or potential respiratory compromise.
- ExSpiron assists in monitoring at-risk patients in near real-time.
- ExSpiron is non-invasive, point-of-care, and quantitative.
- ExSpiron provides quantitative measurement of:
  - Minute Ventilation (MV)
  - Tidal Volume (TV)
  - Respiratory Rate (RR)
- ExSpiron can measure MV, TV, and RR in non-ventilated patients.
- ExSpiron displays measurement values both numerically and graphically, displaying trend data.
- ExSpiron can quantify a patient's respiratory status and provide trending data in their respiratory parameters.
- MV, TV, and RR are important parameters for assessment of respiratory status. ExSpiron helps improve the standard of respiratory monitoring because it displays MV, TV, and RR over time. Changes in values over time can be compared.
- ExSpiron can help physicians identify patients with inadequate breathing.
- ExSpiron reports measurement in a user-friendly format.
- ExSpiron can assist physicians' decision-making by providing respiratory status data.
- ExSpiron is easy to use.

Reviewer Comment:
The proposed device is intended with a tool-based claim. Promotional labeling regarding improvement in clinical care, diagnostic potential, use with at-tick patients should be removed. The ease-of-use claim, without a valid human factors study, may not be justified.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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***Page 132 Submission Material (Wright spirometer and Morgan spirometer):*

The Wright spirometer was found to have accuracy with respect to the gold standard consistent with the
Wright spirometer's accuracy of 3-4%, claimed in its 510(k) Summary and labeling. Data for the Wright- Morgan comparison study, including Bland-Altman charts, are found in Appendix B. The table below shows the measurement performance results of the two studies and calculated measurement performance for the ExSpiron monitor compared to the gold standard Wright spirometer. The calculations for the calculated measurement performance results are described in Appendix C.

	Bias	Accuracy
ExSpiron – Wright (original 510(k) study)	2.1%	10.7%
Wright – Morgan (gold standard study)	0.4%	3.9%
ExSpiron – Morgan (calculated per Appendix C)	-1.7%	9.9%

Reviewer Comment:
The Sponsor has provided additional performance data describing similarity between the Morgan and the Wright spirometers. In previous Pre-IDE discussion, the Wright was allowed to be used a reference standard, though it is a "point-in-time" monitor, compared to the proposed device, which is a "continuous monitor."

The better reference standard would have been a predicate *which is also a continuous monitor, that has clinical utility.* A tidal volume monitor within a mechanical ventilator is used for clinical evaluation such as mechanical ventilator setting adjustment, wean, and extubation. As a reference standard, it would have allowed better resolution regarding the dynamic range of the device, and demonstrated clear clinical meaningfulness. The error rate on a mechanical ventilator is less than 10%, which is advantageous in the context of its ability to be a continuous monitor.

The Sponsor has provided additional demonstrating equivalence between ExSpiron and both the Wright at Morgan devices. This performance data would be sufficient only for tool-based claims.

Deficiencies noted:

1. Intended Use: As per discussion and within your responses, the Exspiron is intended to monitor, and not to diagnose. As a trend monitor, your proposed device has a tool-based claim. Please revise your labeling to remove clinical claims (direct or implied) within your Indication For Use. Specifically, please revise the IFU labeling:

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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a. removing "*monitor breathing in patients with potential respiratory compromise,*" and
b. removing "*to determine respiratory status and appropriate therapy.*"

2. You have provided draft promotional labeling information for your device in Appendix 4-5 of the September 13 submission. Please remove the clinical claims (direct and implied) within this and all labeling. Please provide revised versions of your labeling for further review. Specifically, the following claims should be removed within the submitted promotional literature:

   a. ExSpiron can monitor breathing in adult patients with respiratory compromise or potential respiratory compromise.

   b. ExSpiron assists in monitoring at-risk patients in near real-time.

   c. MV, TV, and RR are important parameters for assessment of respiratory status. ExSpiron helps improve the standard of respiratory monitoring because it displays MV, TV, and RR over time. Changes in values over time can be compared.

   d. ExSpiron can help physicians identify patients with inadequate breathing.

   e. ExSpiron can assist physicians' decision-making by providing respiratory status data.

3. You have provided usability validation by providing data from 10 users. The test reports provided provide limited granularity regarding user task performance, as well as very limited user commentary regarding ease of use. However promotional labeling states, "ExSpiron is easy to use." Please provide further performance data regarding usability, justifying this claim.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Food and Drug Administration
Office of Device Evaluation &
Office of In Vitro Diagnostics

COVER SHEET MEMORANDUM

From: Reviewer Name Pho Chan Lee

Subject: 510(k) Number K120087

To: The Record

Please list CTS decision code TH

☐ Refused to accept (Note: this is considered the first review cycle, See Screening Checklist http://eroom.fda.gov/eRoomReq/Files/CDRH3/CDRHPremarketNotification510kProgram/0_5631/Screening%20Checklist%207%202%2007.doc)

☒ Hold (Additional Information or Telephone Hold).

☐ Final Decision (SE, SE with Limitations, NSE (select code below), Withdrawn, etc.).

Not Substantially Equivalent (NSE) Codes

☐	NO	NSE for lack of predicate
☐	NI	NSE for new intended use
☐	NQ	NSE for new technology that raises new questions of safety and effectiveness
☐	NP	NSE for lack of performance data
☐	NM	NSE requires PMA
☐	NS	NSE no response
☐	NH	NSE for another reason

Please complete the following for a final clearance decision (i.e., SE, SE with Limitations, etc.):		YES	NO
Indications for Use Page	*Attach IFU*		
510(k) Summary /510(k) Statement	*Attach Summary*		
Truthful and Accurate Statement.	*Must be present for a Final Decision*		
Is the device Class III?			
If yes, does firm include Class III Summary?	*Must be present for a Final Decision*		
Does firm reference standards? (If yes, please attach form from http://www.fda.gov/opacom/morechoices/fdaforms/FDA-3654.pdf)			
Is this a combination product? (Please specify category _____, see http://eroom.fda.gov/eRoomReq/Files/CDRH3/CDRHPremarketNotification510kProgram/0_413b/COMBINATION%20PRODUCT%20ALGORITHM%20(REVISED%203-12-03).DOC			
Is this a reprocessed single use device? (Guidance for Industry and FDA Staff – MDUFMA - Validation Data in 510(k)s for Reprocessed Single-Use Medical Devices, http://www.fda.gov/cdrh/ode/guidance/1216.html)			
Is this device intended for pediatric use only?			
Is this a prescription device? (If both prescription & OTC, check both boxes.)			
Did the application include a completed FORM FDA 3674, Certification with Requirements of ClinicalTrials.gov Data Bank?			
Is clinical data necessary to support the review of this 510(k)?			
For United States-based clinical studies **only**: Did the application include a completed FORM FDA 3674, *Certification with Requirements of ClinicalTrials.gov Data Bank*? (If study was conducted in the United States, and FORM FDA 3674 was not included or incomplete, then applicant must be contacted to obtain completed form.)			
Does this device include an Animal Tissue Source?			
All Pediatric Patients age<=21			

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Rev. 5/12/11

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Neonate/Newborn (Birth to 28 days)			
Infant (29 days -< 2 years old)			
Child (2 years -< 12 years old)			
Adolescent (12 years -< 18 years old)			
Transitional Adolescent A (18 - <21 years old) Special considerations are being given to this group, different from adults age ≥ 21 (different device design or testing, different protocol procedures, etc.)			
Transitional Adolescent B (18 -<= 21; No special considerations compared to adults => 21 years old)			
Nanotechnology			
Is this device subject to the Tracking Regulation? (Medical Device Tracking Guidance, http://www.fda.gov/cdrh/comp/guidance/169.html)	*Contact OC.*		

Regulation Number **Class*** **Product Code**

(*If unclassified, see 510(k) Staff)

Additional Product Codes:

Review: (Branch Chief) MRDS (Branch Code) 3/30/12 (Date)

Final Review: (Division Director) (Date)

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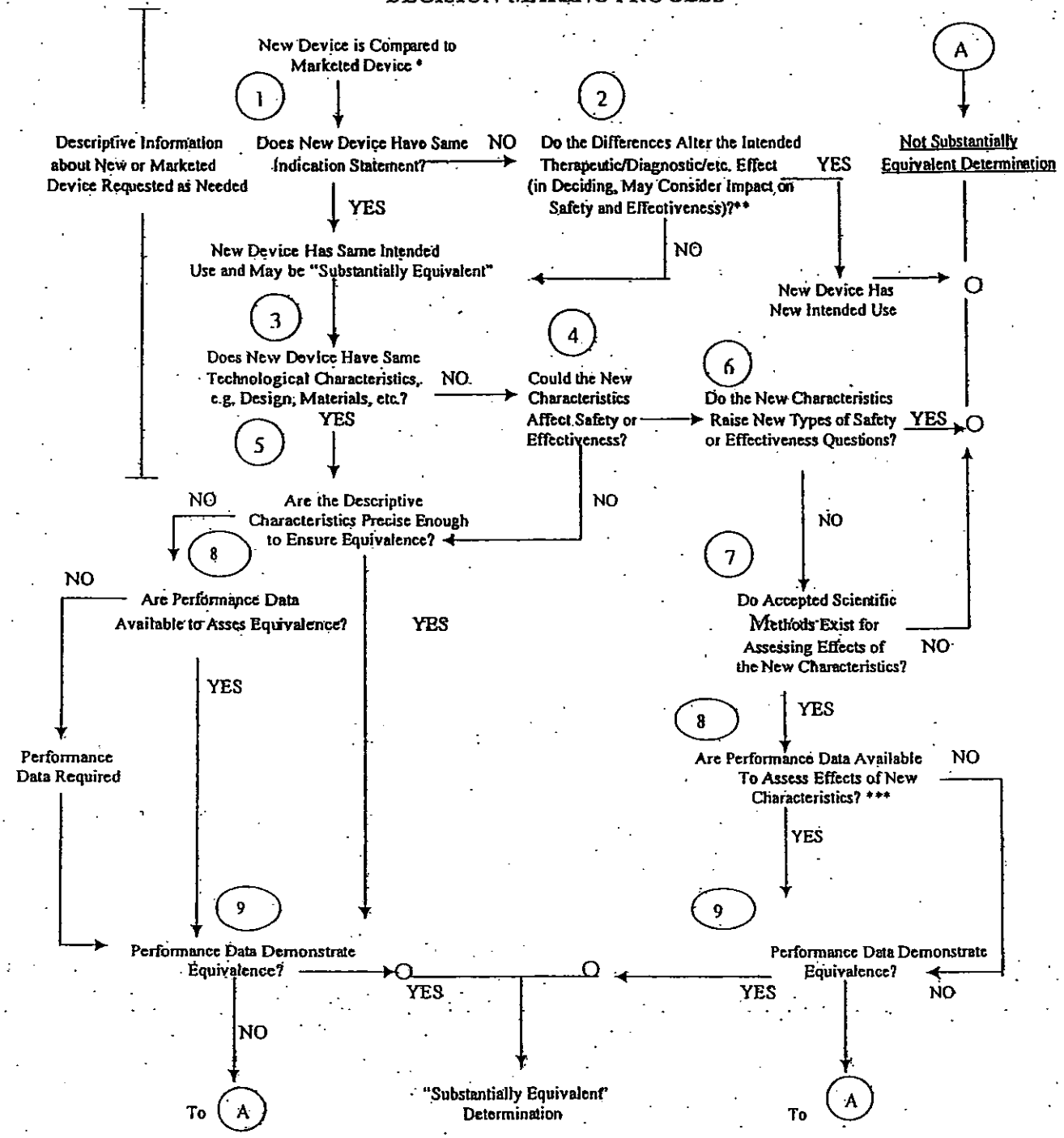
510(k) "SUBSTANTIAL EQUIVALENCE" DECISION-MAKING PROCESS



* 510(k) Submissions compare new devices to marketed devices. FDA requests additional information if the relationship between marketed and "predicate" (pre-Amendments or reclassified post-Amendments) devices is unclear.

** This decision is normally based on descriptive information alone, but limited testing information is sometimes required.

*** Data maybe in the 510(k), other 510(k)s, the Center's classification files, or the literature.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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DEPARTMENT OF HEALTH AND HUMAN SERVICES **MEMORANDUM**

Food and Drug Administration
Office of Device Evaluation
9200 Corporate Boulevard
Rockville, MD 20850

Premarket Notification 510(k) Review
Traditional

K120087

ON TELEPHONE HOLD (March 30, 2012)

Date: March 30, 2012
To: The Record
From: Chan Lee, Electrical Engineer

Office: ODE
Division: DAGID/ARDB

510(k) Holder: Respiratory Motion, Inc.
Device Name: ExSpiron
Contact: Mr. Chas Burr
Phone: (781) 789-1646
Fax: (781) 723-2422
Email: chas_burr@alum.mit.edu

I. Purpose and Submission Summary

The 510(k) holder would like to introduce ExSpiron into interstate commerce.

The proposed device is a respiratory monitor. It uses bioelectrical impedance measurement from electrodes to approximate the following: lung volume; tidal volume; minute ventilation; and respiratory rate.

Pre-IDE I110201

The sponsor submitted a Pre-IDE I110201 in preparation of this 510(k) application. In that Pre-IDE, the sponsor asked three questions. First was about split predicate devices. Second was about comparison of fundamental technology to predicate devices. Third was about test methodology to verify performance specifications.

II. Administrative Requirements

		Yes	No	N/A
Indications for Use page (Indicate if: Prescription or OTC)	***Prescription Use Only***	X		
Truthful and Accuracy Statement	***Included in Section 6***	X		
510(k) Summary or 510(k) Statement	***Summary is included in Section 5***	X		

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		Yes	No	N/A
Standards Form	***Included in Section***	X		

III. Device Description

		Yes	No	N/A
Is the device life-supporting or life sustaining?			X	
Is the device an implant (implanted longer than 30 days)?			X	
Does the device design use software?		X		
Is the device sterile?			X	
Is the device reusable (not reprocessed single use)? Are "cleaning" instructions included for the end user?	***Computer is reusable*** ***Electrode is single use only***	X	X	

The proposed device is a respiratory monitor. A picture of the proposed device is shown in Figure 1. It uses bioelectrical impedance measurement from electrodes to approximate the following: lung volume; tidal volume; minute ventilation; and respiratory rate.

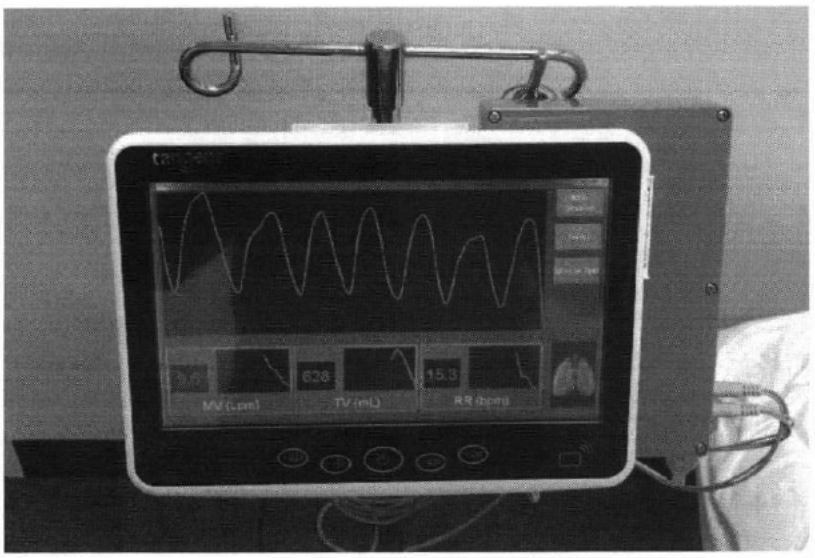

Figure 1 - Picture of Proposed Device

The proposed device is composed of three components:

- B4 [redacted]
- *Impedance Meter:* Interface between the computer and electrodes.
- *Cable and Electrodes:* Connects to patient for bioimpedance measurement.

IV. Indications for Use

The Indications For Use (IFU) statement of the proposed device is as follows.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Revision history of the proposed Indications For Use statement is shown in Table 1. Statements that have been modified or removed are underlined.

Table 1 – Proposed IFU Revision History

Revision	*IFU Statement*	*Notes*
Original	ExSpiron is indicated for use by healthcare professionals in healthcare facilities, such as post-operative care and critical care units, to monitor breathing in patients with potential respiratory compromise. ExSpiron is a non-invasive system that graphically displays lung volume against time and reports an approximate value of: • Tidal volume, • Respiratory rate, and • Minute ventilation. ExSpiron measurements are used as an adjunct to other clinical information sources to determine respiratory status and appropriate therapy.	From Section 4.
S001	TBD	

510(k) Summary Review

The sponsor has provided a complete 510(k) Summary in Section 5 of the original submission.

			YES	NO	N/A
Required Elements for <u>510(k) Summary</u> (21 CFR 807.92)					
	Clearly labeled "510(k) Summary"		X		
	Submitter's name, address, phone #, a contact person		X		
	Date the summary was prepared		X		
	The name of the device/trade name/common name/classification name		X		
	An identification of the legally marketed Predicate		X		
	Description of the subject device		X		
	Statement of intended use (identical to indications for use)		X		
	Technological characteristics	If same, a summary of comparison of technological characters	X		
		If different, a summary of how do they compare to the Predicate	X		
	Performance Data	Brief discussion of non-clinical data submitted, referenced, or relied on	X		
		Brief discussion of clinical data submitted, referenced, or relied on, including: • Description upon whom the device was tested, • Data obtained from the tests and especially: • Adverse events and complications • Other information for SE determination	X		

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		Conclusion that data demonstrate SE	X		
Required Elements for 510(k) Statement (21 CFR 807.93)					
	Signed verbatim statement				X

V. Predicate Device Comparison

The sponsor identified the two split predicate devices. One is for the intended use (Wright Haloscale Spirometer), and the other is for the technology (Intellivue). In the Pre-IDE I110201, lead reviewer Ms. Amy LeVelle of ARDB stated that the split predicate devices were acceptable.

- For product code BZK, monitoring spirometer, the ExSpiron is compared to the nSpire Wright/Haloscale Respirometer, marketed by nSpire Health, Inc. of Longmont, CO. FDA cleared the nSpire respirometer in 510(k) K 091853.
- For product code BZQ, breathing frequency monitor, the ExSpiron is compared to the Philips MPn0 Intellivue Patient Monitors, marketed by Philips Healthcare. FDA cleared the Intellivue monitor in 510(k) K060541.

VI. Labeling

Labeling Recommendations	*Yes*	*No*	*N/A*
Does the submission contain proposed labels, labeling, and advertisements sufficient to describe the device, its intended use, and the directions for use? (Labels include the information affixed directly to the device or its container or packaging. Labeling also includes professional or patient package inserts, and any other information that accompanies the device.)	X		
Does the labeling describe the intended uses?	X		
Does the labeling include adequate directions for use?	X		
Does the labeling include a prescription statement (21 CFR 801.109)?	X		
Labeling should include a list of device specifications including: reservoir volume, flow rates and profiles (if applicable), accuracy, residual volume, and the operational conditions (e.g., temperature, pressure, fluid viscosity) under which these are valid.	X		
Are route(s) of administration described as indicated in the statement of intended use?	X		
Does the labeling include comprehensive directions for preparation and use for all possible functions of the device?	X		
Has the sponsor provided a copy of patient instructions for use if the device is intended for home use, or would reasonably be expected to be used in a home setting?	X		
Does the device include appropriate MR/CT/ultrasound labeling?			X

Labeling has been provided which includes instructions for use and an appropriate prescription statement as required by 21 CFR 801.109(b).

VII. Sterilization/Shelf Life/Reuse

In Section 14 of the original submission, the sponsor stated that the proposed device is not provided sterile. B4 [redacted]

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VIII. Biocompatibility

[redacted] B4

IX. Software

Version: **1.03.01**			
Level of Concern: **Moderate**			
		Yes	No
Software description:	***Refer to Section 16-2***	X	
Device Hazard Analysis:	***Refer to Section 16-3***	X	
Software Requirements Specifications:	***Refer to Section 16-18***	X	
Architecture Design Chart:	***Refer to Section 16-21***	X	
Design Specifications:	***Refer to Section 16-24***	X	
Traceability Analysis/Matrix:	***Refer to Section 16-35***	X	
Development:	***Refer to Section 16-44***	X	
Verification & Validation Testing:	***Refer to Section 16-46***	X	
Revision level history:	***Refer to Section 16-51***	X	
Unresolved anomalies:	***Refer to Section 16-50***	X	

In Section 16, the sponsor provided software documentation. The sponsor classified the proposed device as Moderate level of concern. This reviewer agrees with the sponsor because the clinician is likely to rely on other vital signs to determine clinical decisions.

X. Electromagnetic Compatibility and Electrical, Mechanical and Thermal Safety

In Section 17, the sponsor stated that they will conform to various standards.

XI. Performance Testing – Bench

In Section 18, the sponsor stated that usability was the focus of bench testing.

XII. Performance Testing – Animal

The sponsor did not provide animal testing. This reviewer believes that animal testing is not necessary in order to determine substantial equivalence to the predicate devices.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

XIII. Performance Testing – Clinical

The proposed device uses electrode sensors to measure bioimpedance. Performance bench testing may be sufficient to verify and validate the operating performance specifications such as resistance, current, and voltage measurements. However, the clinical output is dependant on actual measurement of a human body which may not be adequately modeled. Therefore, this reviewer believes that clinical study is necessary to verify and validate the intended use and clinical claims of the proposed device.

The sponsor provided clinical study in Section 20 of the original submission. This reviewer consulted Dr. Deborah Shure of ARDB for clinical review and Dr. Arkendra De of OSB for statistical review.

Clinical Study

Dr. Shure found the study to be inadequate. Dr. Shure identified the following deficiencies in her review memo.

- Intended duration of use for electrode pads.
- Detailed patient inclusion and exclusion criteria.
- No sample size justification.
- Demographic and anthropomorphic information was insufficient.
- The analysis of the clinical data is difficult to understand.

Statistical Analysis

Dr. De found the analysis to be inadequate and stated the following in his review memo:

> *"Using numerical values provided by the sponsor, FDA reached different conclusions about the clinical study than the sponsor. Additional information and explanation are requested from the sponsor. After talking with the clinician on February 22, 2012, a few remarks have been added to this review."*

XIV. Substantial Equivalence Discussion

	Yes	No	
1. Same Indication Statement?	X		If **YES** = Go To 3

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Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

2. Do Differences Alter The Effect Or Raise New Issues of Safety Or Effectiveness?			If **YES** = Stop **NSE**
3. Same Technological Characteristics?	X		If **YES** = Go To 5
4. Could The New Characteristics Affect Safety Or Effectiveness?		X	If **YES** = Go To 6
5. Descriptive Characteristics Precise Enough?		X	If **NO** = Go To 8 If **YES** = Stop **SE**
6. New Types Of Safety Or Effectiveness Questions?			If **YES** = Stop **NSE**
7. Accepted Scientific Methods Exist?			If **NO** = Stop **NSE**
8. Performance Data Available?		X	If **NO** = Request Data
9. Data Demonstrate Equivalence?			Final Decision:

Note: See http://eroom.fda.gov/eRoomReq/Files/CDRH3/CDRHPremarketNotification510kProgram/0_4148/FLOWCHART%20DECISION%20TREE%20.DOC for Flowchart to assist in decision-making process. Please complete the following table and answer the corresponding questions. "Yes" responses to questions 2, 4, 6, and 9, and every "no" response requires an explanation.

1. *Explain how the new indication differs from the predicate device's indication:*

Both the predicate devices and proposed device are intended to measure various respiratory measurements.

2. *Explain why there is or is not a new effect or safety or effectiveness issue:*

3. *Describe the new technological characteristics:*

The fundamental technology of various components in the proposed device is not new. However, the electrodes are used for bioimpedance measurement to monitor respiratory functions. The sponsor cited split predicate for both intended use and technology. In previous Pre-IDE submission, ARDB recommended that the split predicates are acceptable.

4. *Explain how new characteristics could or could not affect safety or effectiveness:*

5. *Explain how descriptive characteristics are not precise enough:*

The sponsor should verify and validate their clinical performance specifications on human test subjects.

6. *Explain new types of safety or effectiveness question(s) raised or why the question(s) are not new:*

7. *Explain why existing scientific methods can not be used:*

8. *Explain what performance data is needed:*

9. *Explain how the performance data demonstrates that the device is or is not substantially equivalent:*

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XV. Deficiencies

A summary of deficiency questions and follow-up questions are shown in Table 2.

Table 2 – Summary Deficiency Questions and Follow-Up

1st Deficiency Letter Question	*Notes*	*Response*	*2nd Deficiency Letter Question*	*Response*
1	Prescription use	*TBD*		
2	Conformance to standards and testing	*TBD*		
3	Electrodes	*TBD*		
4	Human factors study	*TBD*		
5	Intended patient population	*TBD*		
6	Inclusion and exclusion criteria	*TBD*		
7	Duration of use	*TBD*		
8	Age range	*TBD*		
9	Intended patient population	*TBD*		
10	Sample size justification	*TBD*		
11	Analysis of data	*TBD*		
12	Correlation coefficient	*TBD*		
13	Predicate device comparison	*TBD*		
14	Bland-Altman plots	*TBD*		
15	Measurement scale and analysis	*TBD*		
16	Sample size justification	*TBD*		

First Deficiencies

The following deficiencies were sent to the sponsor in an email on March 30, 2012.

1. You provided Indications For Use statement page in Section 4. However, you did not indicate whether your proposed device is prescription use or over-the-counter use. Please clarify and provide an updated Indications For Use statement page.

2. In Section 9 and 17, you stated that your proposed device will conform to standards and validation testing. Please be advised that we expect all testing to be completed prior to 510(k) clearance. Therefore, please provide completed test report and data on your proposed device in its final finished form.

3. B B4 [redacted]

   [redacted]

   b. Please clarify whether you made any modifications to the electrodes identified above.

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Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

c. If you made any modifications to the electrodes in the predicate device, then please provide detailed description of all modifications. In addition, please provide biocompatibility testing.

4. In Section 18, you stated that "Bench performance testing has focused on usability." However, you did not provide human factors study data. Please provide human factor study on your final finished product according to FDA recognized standard "AAMI / ANSI HE75:2009, Human factors engineering - Design of medical devices". Please provide all labeling and training programs for your proposed device.

Clinical

5. You have not provided sufficient information to evaluate potential limitations to the use or accuracy of the device with respect to clinical conditions or the presence of other equipment. Please address how issues of device function that may occur in the presence of very high or very low respiratory rates, morbid obesity, dehydration, anasarca, hypotension, and implanted or temporary neurostimulators or pacers. If there are other conditions or devices that may affect the performance of the device, please include them as well in your discussion. Please be aware that the adequacy of the clinical trial population cannot be assessed without such information.

6. Please provide clinical and statistical justification as to how your patient inclusion and exclusion criteria are representative of the entire intended patient population.

7. The clinical trial studied the device over a 24 hour period, but the device description does not provide information about the upper limits of duration of use of the electrode pads. Because testing should be done over the expected duration of use, please provide information about the upper limit of use of the electrode pads.

8. The Indications for Use statement does not specify an age range for intended use, but the clinical trial was conducted in subjects 20 years of age and older. Please modify the Indications for Use statement to indicate the age ranges for which the device may be used. If the age range is greater than that provided in the clinical testing, please be aware that additional testing may be needed to support the claim.

9. The 20 patients were selected to represent various ethnicity, disease states, and BMI values, but you have not provided specific information. Please provide line data in tabular form for each subject with respect to the selection variables.

10. You have not provided a sample size justification for the 20 patient trial. Please provide a sample size justification.

11. The analyses of percentage accuracy, precision, and bias of an unusually derived metric (natural log of the ratio of the device to the predicate measurements) are difficult to interpret clinically. Please provide an analysis of the results in terms of sensitivity, specificity, positive predictive values, and negative predictive value.

Statistical

12. On page 20-13, you stated that the factor day had no effect on the intra-class correlation coefficient. One of the limitations with the intra-class correlation coefficient is that "estimates (as with all correlation coefficients) are dependent on the range of the measuring scale; the wider the range, the better the result." (from Müller and Büttner Stat. in Med., Vol. 13, 2465-2476 (1994)). FDA conducted its own analysis using bootstrap of the absolute difference for minute ventilation and tidal volume. Numerical results from tables 6 and 7 on page 20-9 were used for the calculations. FDA analyses incorporated results at the subject level. Below are the results, all of which are statistically significant.

    - Accuracy between days 1 and 2 for minute ventilation: average absolute difference of 4.12%, with a 95% confidence interval of [3.10%, 5.55%]
    - Precision between days 1 and 2 for minute ventilation: 2.9% for the average absolute difference of precision with 95% confidence interval of [1.99%, 3.76%]

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- Accuracy between days 1 and 2 for tidal volume: average absolute difference of 4.105%, with 95% confidence interval of [2.73%, 5.63%]
- Precision between days 1 and 2 for tidal volume: average absolute difference of 2.91%, with 95% confidence interval of [2.05%, 3.87%]

In light of these results, it is unclear that the device performs comparably on different days, especially with respect to minute ventilation and tidal volume. Please comment on these results.

13. On page 20-7, a three subject study is described which the ExSpiron is compared to the SpiroAir-LT in order to determine whether the graphical display can track respiratory curves accurately. Using only three subjects is a small sample size, rendering any generalizations to the entire intended use population questionable. Also, the SpiroAir-LT was used to calibrate the ExSpiron, which may introduce bias. It is also unclear that only the SpiroAir-LT will be used for calibration in routine clinical practice. In addition to addressing these concerns, please provide plots which superimpose the tracings from the SpiroAir-LT and ExSpiron on the same graph, with clear legends that clearly depict the device producing each tracing.

14. Please provide Bland-Altman plots comparing the ExSpiron against the Wright Respometer, separately for each subject and combined. Please see Bland and Altman The Lancet Volume 327, Issue 8476, 8 February 1986, Pages 307–310 for more information about Bland-Altman plots.

15. The calculation method used for quantifying the bias, precision, and accuracy (shown on page 20-5) is not a standard statistical method. Rather than using the logarithm scale, which could be difficult to interpret, please provide the bias, precision, and accuracy on the original raw measurement scale. If there are important medical or clinical decision points that are used in clinical practice, please incorporate these clinical decision points into the analysis of the ExSpiron against the predicate. These points can be incorporated by calculating sensitivity and false positive rate for the clinical study. To incorporate the correlated measurements (i.e. multiple measurements made on the same subject), please consider using bootstrap. For more information about bootstrap, please see Davison and Hinkley (1997) Bootstrap Methods and Their Application.

16. On page 20-3, you stated that 20 subjects were used for the clinical study. Please provide justification for this sample size. From a statistical perspective, it is difficult to understand why this is sufficient.

XVI. Contact History

Contact history with the sponsor is shown in Table 3.

Table 3 - Contact History

Contact Type	*Date*	*Sponsor's Response*	*Note*
Email	March 30, 2012	*TBD*	First Deficiency Letter

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Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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XVII. Recommendation

I recommend that the file be placed on telephone hold.

Substantial equivalence cannot be determined because the sponsor did not provide adequate clinical data in support of the clinical performance specifications.

Regulation Number: 21 CFR 868.2375
Regulation Name: Breathing frequency monitor
Regulatory Class: Class II
Product Code: BZQ

Mayur Patel for Chan Lee
Chan Lee

March 30, 2012
Date

Dr. Lex Schultheis, ARDB Branch Chief

March 30, 2012
Date

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Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Lee, Chan

From: Lee, Chan
Sent: Friday, March 30, 2012 10:57 AM
To: 'chas_burr@alum.mit.edu'
Subject: Respiratory Motion ExSpiron (K120087) Additional Information Request

Respiratory Motion, Inc.
Mr. Chas Burr
Consultant
11 Mystic Avenue
Winchester, MA 01890
chas_burr@alum.mit.edu

Re: K120087
Trade Name: ExSpiron
Dated: January 3, 2012
Received: January 11, 2012

Dear Mr. Burr,

We have reviewed your Section 510(k) premarket notification of intent to market the device referenced above. We cannot determine if the device is substantially equivalent to a legally marketed predicate device based solely on the information you provided. To complete the review of your submission, we require your response to the following deficiencies.

1. You provided Indications For Use statement page in Section 4. However, you did not indicate whether your proposed device is prescription use or over-the-counter use. Please clarify and provide an updated Indications For Use statement page.

2. In Section 9 and 17, you stated that your proposed device will conform to standards and validation testing. Please be advised that we expect all testing to be completed prior to 510(k) clearance. Therefore, please provide completed test report and data on your proposed device in its final finished form.

[redacted] B4 [redacted]

[redacted]

   b. Please clarify whether you made any modifications to the electrodes identified above.

   c. If you made any modifications to the electrodes in the predicate device, then please provide detailed description of all modifications. In addition, please provide biocompatibility testing.

4. In Section 18, you stated that "Bench performance testing has focused on usability." However, you did not provide human factors study data. Please provide human factor study on your final finished product according to FDA recognized standard "AAMI / ANSI HE75:2009, Human factors engineering - Design of medical devices". Please provide all labeling and training programs for your proposed device.

Clinical

5. You have not provided sufficient information to evaluate potential limitations to the use or accuracy of the device with respect to clinical conditions or the presence of other equipment. Please address how issues of device function that may occur in the presence of very high or very low respiratory rates, morbid obesity, dehydration, anasarca, hypotension, and implanted or temporary neurostimulators or pacers. If there are other conditions or devices that may affect the performance of the device, please include them as well in your discussion. Please be aware that the adequacy of the clinical trial population cannot be assessed without such information.

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Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

6. Please provide clinical and statistical justification as to how your patient inclusion and exclusion criteria are representative of the entire intended patient population.

7. The clinical trial studied the device over a 24 hour period, but the device description does not provide information about the upper limits of duration of use of the electrode pads. Because testing should be done over the expected duration of use, please provide information about the upper limit of use of the electrode pads.

8. The Indications for Use statement does not specify an age range for intended use, but the clinical trial was conducted in subjects 20 years of age and older. Please modify the Indications for Use statement to indicate the age ranges for which the device may be used. If the age range is greater than that provided in the clinical testing, please be aware that additional testing may be needed to support the claim.

9. The 20 patients were selected to represent various ethnicity, disease states, and BMI values, but you have not provided specific information. Please provide line data in tabular form for each subject with respect to the selection variables.

10. You have not provided a sample size justification for the 20 patient trial. Please provide a sample size justification.

11. The analyses of percentage accuracy, precision, and bias of an unusually derived metric (natural log of the ratio of the device to the predicate measurements) are difficult to interpret clinically. Please provide an analysis of the results in terms of sensitivity, specificity, positive predictive values, and negative predictive value.

Statistical

12. On page 20-13, you stated that the factor day had no effect on the intra-class correlation coefficient. One of the limitations with the intra-class correlation coefficient is that "estimates (as with all correlation coefficients) are dependent on the range of the measuring scale; the wider the range, the better the result." (from Müller and Büttner Stat. in Med., Vol. 13, 2465-2476 (1994)). FDA conducted its own analysis using bootstrap of the absolute difference for minute ventilation and tidal volume. Numerical results from tables 6 and 7 on page 20-9 were used for the calculations. FDA analyses incorporated results at the subject level. Below are the results, all of which are statistically significant.

    - Accuracy between days 1 and 2 for minute ventilation: average absolute difference of 4.12%, with a 95% confidence interval of [3.10%, 5.55%]
    - Precision between days 1 and 2 for minute ventilation: 2.9% for the average absolute difference of precision with 95% confidence interval of [1.99%, 3.76%]
    - Accuracy between days 1 and 2 for tidal volume: average absolute difference of 4.105%, with 95% confidence interval of [2.73%, 5.63%]
    - Precision between days 1 and 2 for tidal volume: average absolute difference of 2.91%, with 95% confidence interval of [2.05%, 3.87%]

    In light of these results, it is unclear that the device performs comparably on different days, especially with respect to minute ventilation and tidal volume. Please comment on these results.

13. On page 20-7, a three subject study is described which the ExSpiron is compared to the SpiroAir-LT in order to determine whether the graphical display can track respiratory curves accurately. Using only three subjects is a small sample size, rendering any generalizations to the entire intended use population questionable. Also, the SpiroAir-LT was used to calibrate the ExSpiron, which may introduce bias. It is also unclear that only the SpiroAir-LT will be used for calibration in routine clinical practice. In addition to addressing these concerns, please provide plots which superimpose the tracings from the SpiroAir-LT and ExSpiron on the same graph, with clear legends that clearly depict the device producing each tracing.

14. Please provide Bland-Altman plots comparing the ExSpiron against the Wright Respometer, separately for each subject and combined. Please see Bland and Altman The Lancet Volume 327, Issue 8476, 8 February 1986, Pages 307–310 for more information about Bland-Altman plots.

15. The calculation method used for quantifying the bias, precision, and accuracy (shown on page 20-5) is not a standard statistical method. Rather than using the logarithm scale, which could be difficult to interpret, please provide the bias, precision, and accuracy on the original raw measurement scale. If there are important medical or clinical decision points that are used in clinical practice, please incorporate these clinical decision points into the analysis of the ExSpiron against the predicate. These points can be incorporated by calculating sensitivity and false positive rate for the clinical study. To incorporate the correlated measurements (i.e. multiple measurements made on the same

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

subject), please consider using bootstrap. For more information about bootstrap, please see Davison and Hinkley (1997) Bootstrap Methods and Their Application.

16. On page 20-3, you stated that 20 subjects were used for the clinical study. Please provide justification for this sample size. From a statistical perspective, it is difficult to understand why this is sufficient.

The deficiencies identified above represent the issues that we believe need to be resolved before our review of your 510(k) submission can be successfully completed. In developing the deficiencies, we carefully considered the statutory criteria as defined in Section 513(i) of the Federal Food, Drug, and Cosmetic Act (Act) for determining substantial equivalence of your device.

You may not market this device until you have provided adequate information described above and required by 21 CFR 807.87(l), and you have received a letter from FDA allowing you to do so. If you market the device without conforming to these requirements, you will be in violation of the Act. You may, however, distribute this device for investigational purposes to obtain clinical data if needed to establish substantial equivalence. Clinical investigations of this device must be conducted in accordance with the investigational device exemption (IDE) regulations (21 CFR 812).

This email signifies notification to you that your file has been placed on hold. If the information, or a request for an extension of time, is not received within 30 days, we will consider your premarket notification to be withdrawn and your submission will be deleted from our system. If you submit the requested information after 30 days it will be considered and processed as a new 510(k)(21 CFR 807.87(l)); therefore, all information previously submitted must be resubmitted so that your new 510(k) is complete. For guidance on 510(k) actions, please see our guidance document entitled, "FDA and Industry Actions on Premarket Notification (510(k)) Submissions: Effect on FDA Review Clock and Performance Assessment" at
http://www.fda.gov/downloads/MedicalDevices/DeviceRegulationandGuidance/GuidanceDocuments/UCM089738.pdf

If the submitter does submit a written request for an extension, FDA will permit the 510(k) to remain on hold for up to a maximum of 180 days from the date of the additional information request.

The purpose of this document is to assist agency staff and the device industry in understanding how various FDA and industry actions that may be taken on 510(k)s should affect the review clock for purposes of meeting the Medical Device User Fee and Modernization Act. .

The requested information, or a request for an extension of time, should reference your above 510(k) number and should be submitted in duplicate to:

U.S. Food and Drug Administration
Center for Devices and Radiological Heath
Document Mail Center – WO66-0609
10903 New Hampshire Avenue
Silver Spring, MD 20993

If you have any questions concerning the contents of the letter, please contact Chan Lee at (301) 796-6267. If you need information or assistance concerning the IDE regulations, please contact the Division of Small Manufacturers, International and Consumer Assistance at its toll-free number (800) 638-2041 or at (301) 796-7100, or at its Internet address http://www.fda.gov/MedicalDevices/ResourcesforYou/Industry/default.htm.

Please respond as soon as possible to acknowledge receipt of this email.

Sincerely,

Chan O. Lee
Regulatory Reviewer
Food and Drug Administration
Center for Devices and Radiological Health
WO66-2543
10903 New Hampshire Avenue
Silver Spring, MD 20993
Phone: (301) 796-6267

Email: chan.lee@fda.hhs.gov

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OFFICE OF DEVICE EVALUATION
510(k) Clinical Review

From: Deborah Shure, MD
ODE/DAGID/ARDB

To: Chan Lee
ODE/DAGID/ARDB

CC: Chan Lee
Lester Schultheis, MD, PhD
Arkendra De
Kwame Ulmer

Subject: **K120087**
Device: ExSpiron™
Sponsor: Respiratory Motion, Inc.

Date: Cover letter dated January 3, 2012; clock started January 11, 2012

RECOMMENDATION: Additional information requested

SUMMARY: The device is a respiratory monitor intended for continuous monitoring of respiratory rate, tidal volume, and minute ventilation in patients with potential respiratory compromise in in-patient settings such as post-operative and critical care units. The device uses bioimpedence technology to derive the parameters reported and provides a visual numeric and graphic display on a PC panel. The split predicates, one for function and technology (Intellivue) and one for function (Wright Haloscale Spirometer) are acceptable.

Insufficient information has been provided about the device and the clinical trial to adequately assess the clinical trial data. Major issues to be addressed include:

- The device was studied for 24 hours, but the device description does not state the intended duration of use of the electrode pads. Testing should cover the expected duration of use of the device.
- The Indications for Use statement does not specify an age range and the bioimpedance predicate (Intellivue) is cleared for neonates through adults. The sponsor will need to clarify the intended age range and provide testing in the intended population.
- The sponsor should address potential limitations to the use or accuracy of the technology (i.e., vary low or very high respiratory rates, morbid obesity, dehydration, anasarca, hypotension, implanted neurostimulators, etc.) and provide adequate evidence of effectiveness under all conditions, or provide warnings and exclusions. In addition, because the device was tested in non-hospitalized volunteers,

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the testing may not reflect effectiveness under actual conditions of use, including interference from other equipment.

- No sample size justification for the clinical trial was provided.
- Demographic and anthropomorphic information was insufficiently detailed to assess adequacy of representation of various parameters in the study. Line data would be needed.
- The analysis of the clinical data is difficult to understand. It is a based on an unusual metric proposed by the sponsor: percentage accuracy, precision, and bias of a relative error, defined as the natural log of the ratio of the device measurement to the predicate measurement. This metric is not standard and not interpretable in clinical terms. It would be preferable to provide sensitivity, specificity, positive and negative predictive values.

I defer to the lead reviewer, but, clinically, it appears that the limited three subject study of the graphic display may not be necessary. It seems that the technology to convert digital information to a graphical display is so standard that simple bench testing may suffice.

DEVICE

The device consists of a current generator unit, a Windows 7 based PC Panel, and single use electrode pads. It uses bioimpedance technology to derive respiratory related measurements: tidal volume, minute ventilation, and respiratory rate. The PC Panel provides a graphical display of the parameters measured. B4 [redacted].

INDICATIONS FOR USE

The Indications for Use statement is as follows:

ExSpiron is indicated for use by healthcare professionals in healthcare facilities, such as post-operative care and critical care units, to monitor breathing in patients with potential respiratory compromise.

ExSpiron is a non-invasive system that graphically displays lung volume against time and reports an approximate value of:

- **Tidal volume,**
- **Respiratory rate, and**
- **Minute ventilation.**

ExSpiron measurements are used as an adjunct to other clinical information sources to determine respiratory status and appropriate therapy.

PREDICATES

Two predicates are cited related to technology and function.

- nSpire (Wright Haloscale Spirometer) K091853
  This device is cited for function – a respiratory monitor measuring tidal volume and minute ventilation. It does not use the same technology as the ExSpiron device.
- Philips Intellivue Monitor (K060541)
  This device is cited for technology and function. It uses bioimpedance to measure respiratory rate. This device is cleared for use in neonates through adults.

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Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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CLINICAL STUDY

A clinical trial was performed in 2 non-hospitalized volunteers who were selected to represent "varied ethnicities" and a "broad range of heights, weights, and BMIs". Subjects with cardiopulmonary co-morbidities were included. Data were collected by two technicians trained in the use of both the ExSpiron and the Wright Spirometer. Electrodes were attached and initial measurements were obtained. Subjects were instructed to return the following day for repeat measurements. Ten sets of measurements were acquired on each subject on Day 1 and Day 2. Tidal volume and minute ventilation were simultaneously assessed with the ExSpiron device and a Wright Haloscale Spirometer. Respiratory rate was assessed by a stop watch for comparison to the ExSpiron because the Wright's device does not show respiratory rate. Of note, the ExSpiron device was not tested in comparison to the Intellivue predicate which only assessed respiratory rate.

A separate study was performed using three subjects breathing normally and "erratically" to demonstrate similar graphical waveforms on the display monitor compared to an FDA cleared portable spirometer display (SpiroAir-LT).

The objectives of the 20 patient study were to compare the ExSpiron measurements to those obtained with the Wright Haloscale Spirometer measurement of tidal volume and minute ventilation and the stopwatch measurement of respiratory rate. Differences between Day 1 and Day 2 were to be analyzed.

As noted in the SUMMARY, the sponsor has defined a novel metric as the basis of the analyses. The metric, called the Error, is the natural log of the ratio of the Device Measurement divided by the Predicate Measurement. Results are reported as percentage accuracy, precision, and bias of the Error (natural log of the ratio).

REVIEWER COMMENTS

Please see SUMMARY above for reviewer comments.

ADDITIONAL INFORMATION REQUESTED

Item #1: You have not provided sufficient information to evaluate potential limitations to the use or accuracy of the device with respect to clinical conditions or the presence of other equipment. Please address how issues of device function that may occur in the presence of very high or very low respiratory rates, morbid obesity, dehydration, anasarca, hypotension, and implanted or temporary neurostimulators or pacers. If there are other conditions or devices that may affect the performance of the device, please include them as well in your discussion. Please be aware that the adequacy of the clinical trial population cannot be assessed without such information.

Item #2: The clinical trial studied the device over a 24 hour period, but the device description does not provide information about the upper limits of duration of use of the electrode pads. Because testing should be done over the expected duration of use, please provide information about the upper limit of use of the electrode pads.

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Item #3: The Indications for Use statement does not specify an age range for intended use, but the clinical trial was conducted in subjects 20 years of age and older. Please modify the Indications for Use statement to indicate the age ranges for which the device may be used. If the age range is greater than that provided in the clinical testing, please be aware that additional testing may be needed to support the claim.

Item #4: The 20 patients were selected to represent various ethnicities, disease states, and BMI values, but you have not provided specific information. Please provide line data in tabular form for each subject with respect to the selection variables.

Item #5: You have not provided a sample size justification for the 20 patient trial. Please provide a sample size justification.

Item #6: The analyses of percentage accuracy, precision, and bias of an unusually derived metric (natural log of the ratio of the device to the predicate measurements) is difficult to interpret clinically. Please provide an analysis of the results in terms of sensitivity, specificity, positive predictive values, and negative predictive value.

Deborah Shure, MD
February 23, 2012

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Date: February 22, 2012 (originally sent on January 27, 2012)
From: Arkendra De, Mathematical Statistician, OSB/DBS/DDB
To: Chan Lee, Electrical Engineer, ODE/DAGID/ARDB
Subject: Statistical Review of 510(k) K120087, ExSpiron by Respiratory Motion, Inc.

Summary
Using numerical values provided by the sponsor, FDA reached different conclusions about the clinical study than the sponsor. Additional information and explanation are requested from the sponsor. After talking with the clinician on February 22, 2012, a few remarks have been added to this review.

Intended Use (quoted from sponsor): "ExSpiron is indicated for use by healthcare professionals in healthcare facilities, such as postoperative care and critical care units, to monitor breathing in patients with potential respiratory compromise.

ExSpiron is a non-invasive system that graphically displays lung volume against time and reports an approximate value of:
• Tidal volume (TV),
• Respiratory rate (RR), and
• Minute ventilation (MR)."

Principle of Method (quoted from sponsor): "ExSpiron measurements are used as an adjunct to other clinical information sources to determine respiratory status and appropriate therapy.

The ExSpiron™ is a respiratory monitor that consists of:

- Bioimpedance measurement system:
  A stabilized high frequency current generator connected to the outer two electrodes. Two measurement channels convert the resulting voltage signal to digital form. Each channel consists of a pair of electrodes placed between the two "source" electrodes and an adaptive circuit to condition the signal. Firmware performs signal acquisition and relays data to the panel PC.
- Panel PC:
  A Windows 7 PC that performs signal processing and calibration, and runs the graphical user interface (GUI). The PC takes user input from the touch screen through a virtual keyboard and mouse. The GUI is used for recording patient data and displaying the respiratory trace as well as scalar values and trends for minute volume, tidal volume, and respiratory rate.
  - Single Patient Use ExSpiron Electrode Lead Set: An electrode set containing two electrode pads to be placed on the torso. It delivers current and records impedance measurements. The electrode lead set is also used to perform subsystem checks prior to patient measurements."

Clinical Study (quoted from sponsor):

"Clinical Study Objectives

A study was performed with volunteer human subjects to demonstrate performance equivalence in comparison to the predicate device. An ancillary objective was confirmation of performance of the graphical display, a feature not included in the predicate device, by comparison to the

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graphical display of a diagnostic spirometer that has the feature. (Note: ExSpiron™ is not classified as a diagnostic spirometer.)

• The study demonstrated performance of the ExSpiron system as compared to the Wright Respirometer by simultaneously collecting data from both devices.

• The ExSpiron was calibrated to the Wright Respirometer on Day 1. Measurements were collected from both devices for each participant on Day 1 and Day 2 and were analyzed to determine accuracy and precision.

• As an ancillary study, since the Wright Respirometer cannot provide a graphical display of the data, a SpiroAir-LT spirometer (SpiroAir-LT, Morgan Scientific, Haverhill, MA) was also used in order to visually compare the ExSpiron data to a known spirometry standard. Results of the ancillary study are found in the section titled *Comparison of Graphics Displays* on page 20-7"

"(Clinical) Study Protocol

The goal of this clinical study was to show the performance of the ExSpiron system in measuring minute ventilation (MV), respiratory rate (RR) and tidal volume (TV). Twenty-four subjects from a broad ambulatory population were recruited. Male and female subjects of varied ethnicities and with a broad range of heights, weights, and BMIs were recruited for this study. Subjects with substantive cardiopulmonary co-morbidities were included. The ExSpiron ™ six-lead system was used to measure thoracic bioimpedance as compared to the Wright Respirometer, an FDA-approved spirometer in current clinical use. All data collection was performed by two specifically trained clinical technicians, each with previous hands-on experience with both devices.

Protocol for Minute Tests using Wright Respirometer

B4 *Protocol*

B4 [redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

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(By permitting the completion of the last breath and calculating minute ventilation in this fashion, the procedure corrects for gross inaccuracies because the Wright Respirometer only counts exhalations.)

6. To gather the values for TV, MV and RR from the Wright Respirometer, the technician recorded the TV for each breath measured by the Wright Respirometer, the MV shown on the Wright Respirometer at the end of the test and the counted RR. ExSpiron™ data was electronically captured. A respiratory curve, TV (average), RR and MV were displayed in near-real time and stored digitally."

"(Note: the predicate device for the breathing frequency monitor function, a Philips monitor, was not used. "Predicate" RR data was determined by counting cycles within the 60-second interval. The "stop watch" comparison was discussed in pre-IDE communications.)

7. The ExSpiron™ displayed the normalized (scaled to 60 seconds) values for TV (average), MV, and RR as well as the exact length of time for which the trial ran.

8. The subject was instructed to cease the test immediately if any unusual symptoms were noted. If technical difficulties occurred (such as mouthpiece leakage, computer malfunction or nose-clip displacement) the subject was asked to repeat one or more 60 second tests.

9. Participants were asked to leave the electrode pads on until their return visit the following day. They were also asked not to bathe or allow the electrodes to get too wet or sweaty to the best of their ability."

"Day 2 Protocol

1. On the second day, measurements were taken using electrode pads placed on Day
   1. If any electrodes were "falling off" or not firmly affixed, they were replaced.
2. Previous calibration from Day 1 was used, i.e. no new calibration was performed.
3. The same testing procedure was followed as on Day 1 (Steps 5-8) with a second group of ten 60- second measurement sets recorded.
4. Once the second test is completed on Day 2, the electrodes are removed and skin is checked for irritation. All disposables are discarded."

"(Clinical) Study Population

Subjects varied in age, ethnicity, and anthropometrics. Pertinent co-morbidities included asthma, chronic obstructive pulmonary disease (COPD), obstructive sleep apnea, congestive heart failure and chronic renal insufficiency. Twenty-four subjects enrolled in the study. However, four subjects were excluded. The ExSpiron failed to calibrate with one subject due to insufficient signal quality, therefore data was not collected. (ExSpiron™ automatically monitors signal quality and provides an error message warning the operator of poor signal quality.) Three subjects did not return within the allotted timeframe for the second session of

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the study. Twenty subjects completed the study according to protocol. Tables 1 and 2 show the demographics of the subject cohort who completed the study according to protocol."

Table 1 - Subject Cohort Demographics

Demographic	n (%)
Male	9 (45)
Female	11 (55)
White	16 (80)
Black	2 (10)
Asian	2 (10)

Table 2 Subject Cohort Anthropometrics

Anthropometric	Range	Mean	Standard Deviation
Age (years)	20-84	49.1	±18.7
Height (inches)	60-71	65.9	±3.2
Weight (pounds)	117-233	164.0	±36.3
BMI	19. 9-43.2	26.6	±6.3

"Data Analysis

ExSpiron and Wright Respirometer (predicate) measurements were compared in the following two ways:

1. Results based on the currently accepted definitions of bias, precision and accuracy presented in this summary and elaborated on *Additional Analysis of Data.*

2. Results based on the historically important standard of the intra-class correlation coefficient (ICC) developed by R.A Fisher[iv] presented in *Additional Analysis of Data.*

Both approaches draw on analysis of variance (ANOVA) wherein total variation is decomposed into sources, between variation and within variation[v]. When divided by the associated degrees of freedom we obtain the mean square between (MSB) and the mean-square within (MSW) variations. Our principal approach establishes the level of bias, precision and accuracy. The secondary ICC approach provides a classical measure of accuracy and provides an assessment of the effect that the date of the recording has on the result.

The data that were collected and analyzed for predicate testing were comprised of 10 sequential tests of approximately 60 second duration for each subject on each day, Day 1 and Day 2, for a total of 20 tests. Each "60 second test" was analyzed for MV (Minute Ventilation), TV (Tidal Volume), and RR (Respiratory Rate).

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Data analyses were approached in the following 6 ways:

1. across all 20 tests for all subjects from both days,
2. across all 10 tests for all subjects from 'Day 1',
3. across all 10 tests for all subjects from 'Day 2',
4. per subject using an average of the 20 tests from both days,
5. per subject using an average of the 10 tests from 'Day 1', and
6. per subject using an average of the 10 tests for 'Day 2'."

"Precision, Bias, and Accuracy

The statistical calculations for bias, precision and accuracy are based on the ExSpiron™ relative errors, calculated as follows:

Error = natural log(ExSpiron™ measurement / Predicate measurement)

Relative errors are used because the parameters being measured in this study (MV, TV and RR) are constantly changing, and relative errors have uniform significance over the whole range of measurement variations. The logarithmic scale is used because it gives equal weight to errors which vary by the same factor above or below the true value. This generally corresponds to clinical considerations.

The measured parameters, "bias", "precision" and "accuracy" values, were calculated over different test subsets: all tests, "Day 1" for all subjects, "Day 2" for all subjects, and for each subject separately.

We use the following definitions:

- 'bias' is a mean value of all errors in the selected subset,
- 'precision' is the standard deviation of the errors , and
- 'accuracy' is the square root of the mean squared error"

"Overall percent accuracy for MV, TV and RR were 10.7, 10.4 and 2.0 respectively.
Overall percent precision for MV, TV and RR were 10.5, 10.3 and 2.0 respectively.

MV percent accuracy / precision (10.4 / 10.2 and 10.9 / 10.8) for Day 1 and Day 2 respectively
TV percent accuracy / precision (9.8 / 9.7 and 11.0 / 10.8) Day 1 and Day 2 respectively
RR percent accuracy / precision (2.4 / 2.3 and 1.6 / 1.6) Day 1 and Day 2 respectively"

Table 4 - Percentage Bias, Precision and Accuracy on Day 1

	Minute Ventilation	Tidal Volume	Respiratory Rate
Bias	-2.3	-1.7	-0.6
Precision	10. 2	9.7	2.3
Accuracy	10.4	9.8	2.4

Table 5 – Percentage Bias, Precision and Accuracy on Day 2

	Minute Ventilation	Tidal Volume	Respiratory Rate
Bias	-1.9	-2.0	0.2
Precision	10.8	10.8	1.6
Accuracy	10.9	11.0	1.6

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Conclusion

1. The sponsor states on page 20-13 that the factor day had no effect on the intraclass correlation coefficient. One of the limitations with the intraclass correlation coefficient is that "estimates (as with all correlation coefficients) are dependent on the range of the measuring scale; the wider the range, the better the result." (from Müller and Büttner Stat. in Med., Vol. 13, 2465-2476 (1994)). FDA conducted its own analysis using bootstrap of the absolute difference for minute ventilation and tidal volume. Numerical results from tables 6 and 7 on page 20-9 were used for the calculations. FDA analyses incorporated results at the subject level. Below are the results, all of which are statistically significant.
   - Accuracy between days 1 and 2 for minute ventilation: average absolute difference of 4.12%, with a 95% confidence interval of [3.10%, 5.55%]
   - Precision between days 1 and 2 for minute ventilation: 2.9% for the average absolute difference of precision with 95% confidence interval of [1.99%, 3.76%]
   - Accuracy between days 1 and 2 for tidal volume: average absolute difference of 4.105%, with 95% confidence interval of [2.73%, 5.63%]
   - Precision between days 1 and 2 for tidal volume: average absolute difference of 2.91%, with 95% confidence interval of [2.05%, 3.87%]

   In light of these results, it is unclear that the device performs comparably on different days, especially with respect to minute ventilation and tidal volume. Please comment on these results.
2. On page 20-7, a three subject study is described which the ExSpiron is compared to the SpiroAir-LT in order to determine whether the graphical display can track respiratory curves accurately. Using only three subjects is a small sample size, rendering any generalizations to the entire intended use population questionable. Also, the SpiroAir-LT was used to calibrate the ExSpiron, which may introduce bias. It is also unclear that only the SpiroAir-LT will be used for calibration in routine clinical practice. In addition to addressing these concerns, please provide plots which superimpose the tracings from the SpiroAir-LT and ExSpiron on the same graph, with clear legends that clearly depict the device producing each tracing.
3. Please provide Bland-Altman plots comparing the ExSpiron against the Wright Respometer, separately for each subject and combined. Please see Bland and Altman The Lancet Volume 327, Issue 8476, 8 February 1986, Pages 307–310 for more information about Bland-Altman plots.
4. The calculation method used for quantifying the bias, precision, and accuracy (shown on page 20-5) is not a standard statistical method. Rather than using the logarithm scale, which could be difficult to interpret, please provide the bias, precision, and accuracy on the original raw measurement scale. If there are important medical or clinical decision points that are used in clinical practice, please incorporate these clinical decision points into the analysis of the ExSpiron against the predicate. These points can be incorporated by calculating sensitivity and false positive rate for the clinical study. To incorporate the correlated measurements (i.e. multiple measurements made on the same subject), please

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consider using bootstrap. For more information about bootstrap, please see Davison and Hinkley (1997) *Bootstrap Methods and Their Application.*

5. On page 20-3, it states that 20 subjects were used for the clinical study. Please provide justification for this sample size. From a statistical perspective, it is difficult to understand why this is sufficient.

If there are any questions, please contact me via phone: 301-796-6009 or e-mail: arkendra.de@fda.hhs.gov.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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K120087/S1

AH / DAGRIS

Respiratory Motion, Inc.
305 Second Avenue, Suite B
Waltham, Massachusetts 02451

FDA CDRH DMC
SEP 14 2012
Received

U.S. Food and Drug Administration
Center for Devices and Radiological Health
Document Mail Center – WO66-G609
10903 New Hampshire Avenue
Silver Spring, MD 20993-0002
September 13, 2012

Office of Device Evaluation:

Subject: Response to Request for Additional Information for 510(k) 120087

Respiratory Motion, Inc. (RMI) is submitting this response to FDA's request for additional information, dated March 30, 2012. The response in the enclosed pages includes concise answers and attachments for detailed information.

In May, a response was submitted, but FDA rejected it because it inappropriately requested to change from a Traditional 510(k) to an Abbreviated 510(k). This response replaces the May response in total. This response includes material from the May response that has not changed, additional material added based on conversations with FDA reviewers, and some material that has changed from the May response. There is no distinction made in this response. Other than references to the original 510(k) submittal, this response stands on its own

RMI is enclosing a CD with a pdf file containing this cover letter, the response, and its attachments. The paper copies are printed from this pdf file. The contents of the paper copy and the pdf file are identical.

Respectfully,

Chas Burr

Chas Burr
510(k) Correspondent for Respiratory Motion, Inc.

cc: Jenny Freeman, MD, President Respiratory Motion, Inc.
Encl.: CD with pdf file of Response to Request for Additional Information, with attachments

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Respiratory Motion, Inc.
305 Second Avenue, Suite B
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Respectfully,

Chas Burr
510(k) Correspondent for Respiratory Motion, Inc.

cc: Jenny Freeman, MD, President Respiratory Motion, Inc.
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Response to Request for Additional Information
510(k) K120087 ExSpiron Respiratory Monitor
Respiratory Motion, Inc. (RMI)

FDA's questions are shown in *italics*.

1. *You provided Indications For Use statement page in Section 4. However, you did not indicate whether your proposed device is prescription use or over-the-counter use. Please clarify and provide an updated Indications For Use statement page.*

   RMI unintentionally omitted indicating that the ExSpiron is intended for prescription use. A corrected Indications for Use Statement is in Appendix 1-1. The corrected Indications for Use Statement also includes a change limiting the intended patients to "adult (at least 21 years of age)". A modified 510(k) Summary is in Appendix 1-2.

2. *In Section 9 and 17, you stated that your proposed device will conform to standards and validation testing. Please be advised that we expect all testing to be completed prior to 510(k) clearance. Therefore, please provide completed test report and data on your proposed device in its final finished form.*

   Standards testing has been completed. In particular, testing to IEC 60601-1 and to IEC 60601-1-2 has been satisfactorily completed by The Compliance Management Group of Marlborough, Massachusetts. A revised Chapter 9, Reliance on Standards, is found in Appendix 2-1.

3. B4 [redacted]

   [redacted]

   [redacted]

b. *Please clarify whether you made any modifications to the electrodes identified above.*

   No modifications were made to the electrodes per se. Relative positioning is provided by an overlay. The patient contacting part of the overlay is medical grade polyethylene foam tape, coated on one side with non-sensitizing acrylic adhesive B4 [redacted] states that the tape has been tested for cytotoxicity, irritation, and sensitization.

c. *If you made any modifications to the electrodes in the predicate device, then please provide detailed description of all modifications. In addition, please provide biocompatibility testing.*

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There was no modification to the electrodes. B4 [redacted] "The device was subjected to biocompatibility testing as recommended in the May 1, 1995 FDA memorandum entitled: *Use of International Standard ISO-10993, "Biological Evaluation of Medical Devices Part 1: Evaluation and Testing.* The device was found to be non-irritating, non-cytotoxic, and non-sensitizing."

4. *In Section 18, you stated that "Bench performance testing has focused on usability." However, you did not provide human factors study data. Please provide human factor study on your final finished product according to FDA recognized standard "AAMI / ANSI HE75:2009, Human factors engineering - Design of medical devices". Please provide all labeling and training programs for your proposed device.*

At the time of the original 510(k), the usability testing had been used to determine usability requirements. Usability requirements were included in the System Requirements. User Error hazards were included in the Risk Management Plan (pages 16-7 and 16-8 of the original submission). The usability requirements and user error hazards were reviewed to develop the usability validation protocol and test record form in Appendix 4-1.

Technical usability content is found in the User Manual (Appendix 4-2). The Training Outline (Appendix 4-3) describes the training performed by RMI authorized personnel.

Final usability validation was performed at RMI's clinical test facility. Test users, who did not have previous experience with ExSpiron, included:

- 5 Anesthesiologists
- 1 Cardiothoracic surgeon
- 1 Critical care physician
- 2 ICU nurses
- 1 ER nurse

Test results showed no difficulties or failures with the final ExSpiron device and training. The ease of use results from use similarities with other common monitoring devices, a user interface designed to match typical user workflow, and documentation and training that address unique ExSpiron features. The ten test reports are provided in Appendix 4-4.

Promotional claims are listed in Appendix 4-5.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Clinical

5. *You have not provided sufficient information to evaluate potential limitations to the use or accuracy of the device with respect to clinical conditions or the presence of other equipment. Please address how issues of device function that may occur in the presence of very high or very low respiratory rates, morbid obesity, dehydration, anasarca, hypotension, and implanted or temporary neurostimulators or pacers. If there are other conditions or devices that may affect the performance of the device, please include them as well in your discussion. Please be aware that the adequacy of the clinical trial population cannot be assessed without such information.*

Very low and very high respiratory rates

The ExSpiron's bioimpedance-determined measurements provide accuracy for a broader range of respiratory rates than the measurements of the predicate device. Conventional spirometers respond to the mechanical properties of expired air, i.e., pressure, flow rate, mass, or volume, which vary with respiratory rate. ExSpiron's bioimpedance measurement is not subject to these changes. RMI in its work with the predicate device has found that the range of ExSpiron measurements is at least equivalent to that possible with the predicate device.

B4 [redacted]

Data from the study presented in the original 510(k) suggest that the ExSpiron measurement performance is insensitive to respiratory rate. Figure 5-1 shows accuracy and precision for each of the three measurements (TV, MV, and RR) plotted against RR. Accuracy and precision are within specifications and show no significant correlation in the range of RR from 7 to 23 breaths per minute. Each circle represents measurement performance data for each RR value. These data indicate that ExSpiron's measurement performance is not sensitive to RR. Measurement performance is within specification for the whole tested range, 7 to 23 breaths per minute. There is no correlation between RR and the accuracy or precision of three measurements ($p>0.2$ in all six cases.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

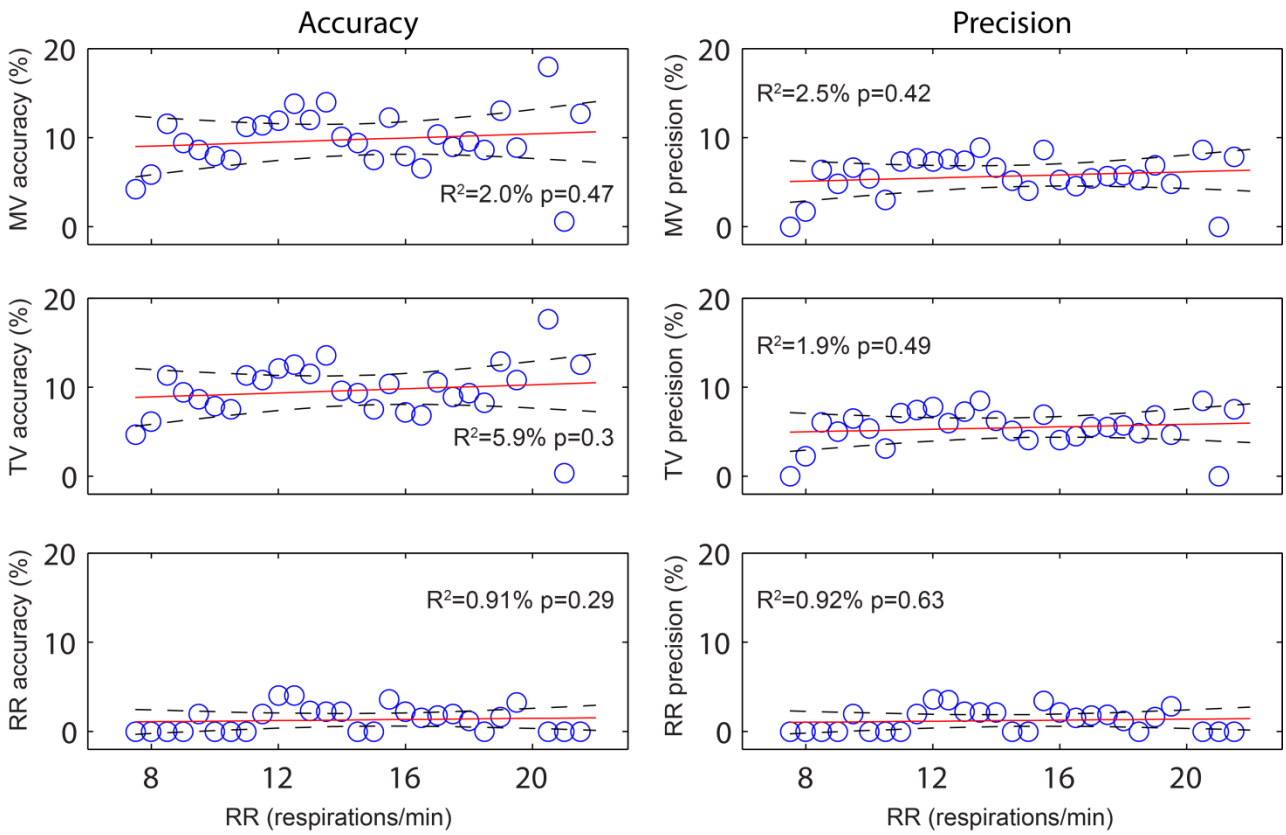
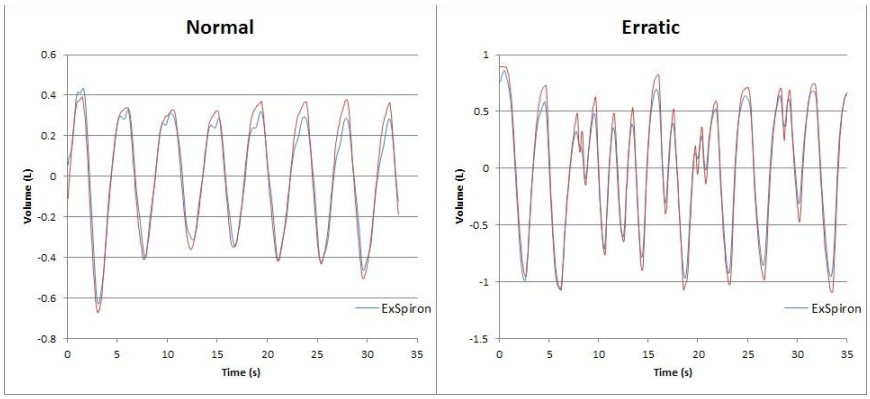


Figure 5-1 ExSpiron Measurement Performance plotted against Respiratory Rate

In the comparison of graphic displays of the ExSpiron and the Spiro Air-LT diagnostic spirometer, subjects were asked to breathe erratically. The results included samples of high frequency breathing and of large and small breaths. The original 510(k) described tests for three subjects. Figure 5-2 shows the three overlays of ExSpiron volume measurements over Spiro Air-LT measurements. The data suggest that ExSpiron responds equivalently to the diagnostic spirometer over a broad range of frequencies.



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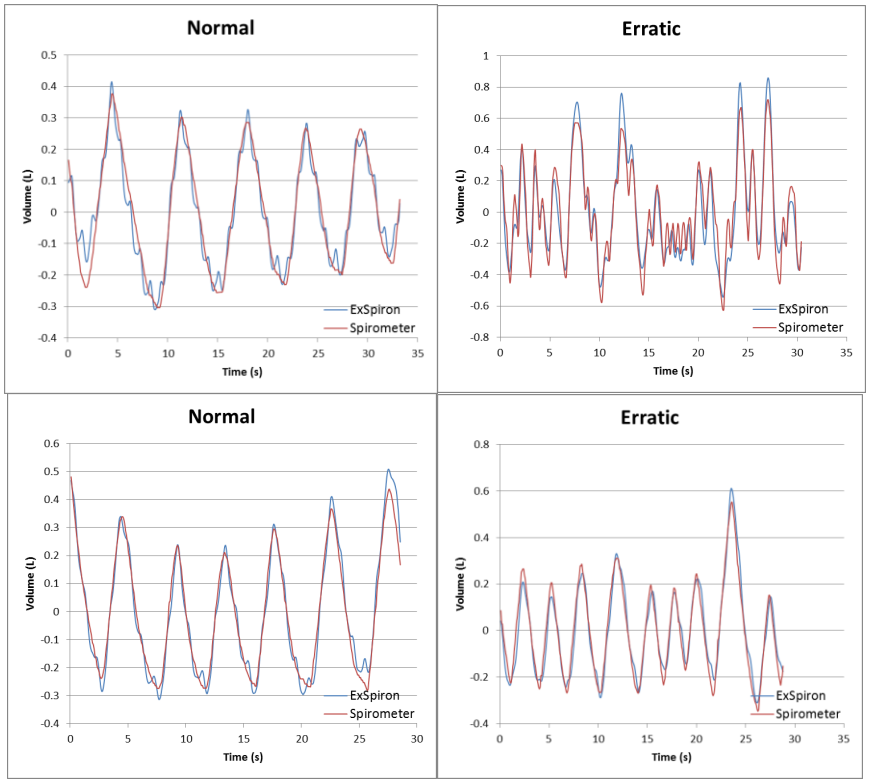

Figure 5-2 Overlays of Graphic Displays
ExSpiron and Spiro Air-LT
(Figure spans two pages)

B4 [redacted]

ExSpiron provides information to help assess respiratory distress. Because the existence of very low or very high respiratory rates is a sign of respiratory distress, RMI is adding this Caution to the User Manual:

> *The accuracy of ExSpiron volume measurements has not been confirmed at very high (> 30 breaths per minute) or very low (≤ 5 breaths per minute) respiratory rates. If a patient has a very high or very low respiratory rate, confirm respiratory status with other clinical information sources.*

Morbid obesity

Obesity and other body conditions affecting body composition are expected to shift baseline impedance. B4 [redacted]

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Results from the study presented in the original 510(k) demonstrate ExSpiron's measurement performance is not affected by obesity.

Data from the study presented in the original 510(k) indicate that the ExSpiron measurement performance is insensitive to BMI. Figure 5-3 shows accuracy and precision of ExSpiron measurement plotted against BMI. Each circle represents a single subject's average accuracy or precision. The red lines are the best linear regression fits to each data set with corresponding coefficients of determination and p-values listed within each panel. The charts show lack of correlation of ExSpiron measurement performance over the range of BMI's in the study (p>0.2) in all cases. Note that, reflecting the unfortunate trend in body type found in the US, five subjects in the study are obese (BMI>30) and two subjects are morbidly obese (BMI > 40).

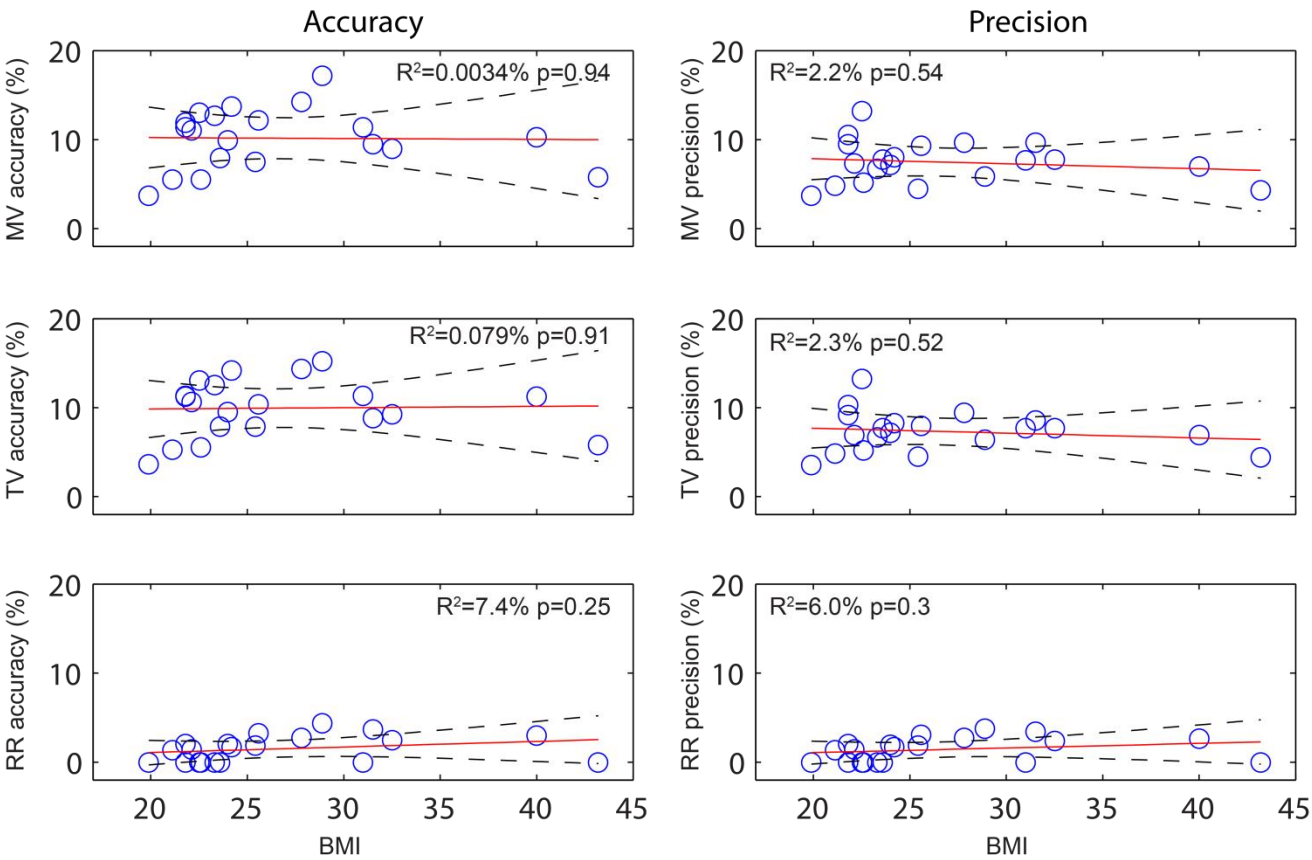

Figure 5-3 ExSpiron Measurement Performance data plotted against BMI

To ensure proper use, a Caution will be added to the User Manual:

> *The accuracy of ExSpiron measurements has not been confirmed for patient with a BMI over 43. If a patient has a BMI outside of this range, confirm respiratory status with other clinical information sources.*

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Dehydration and Anasarca

As with obesity, the state of hydration is expected to shift baseline impedance. This shift in baseline impedance does not affect ExSpiron lung volume measurements B4 [redacted]

The state of hydration was not measured or controlled during the study. As noted, the primary impact of the state of hydration is on the baseline impedance. B4 [redacted]. Figure 5-4 shows measurement performance versus baseline impedance. Each circle represents an individual subject's averaged data. The analysis demonstrates that measurement performance does not correlate with baseline impedance (p>0.2 in all cases). Accuracy and precision hold across the range of baseline impedance.

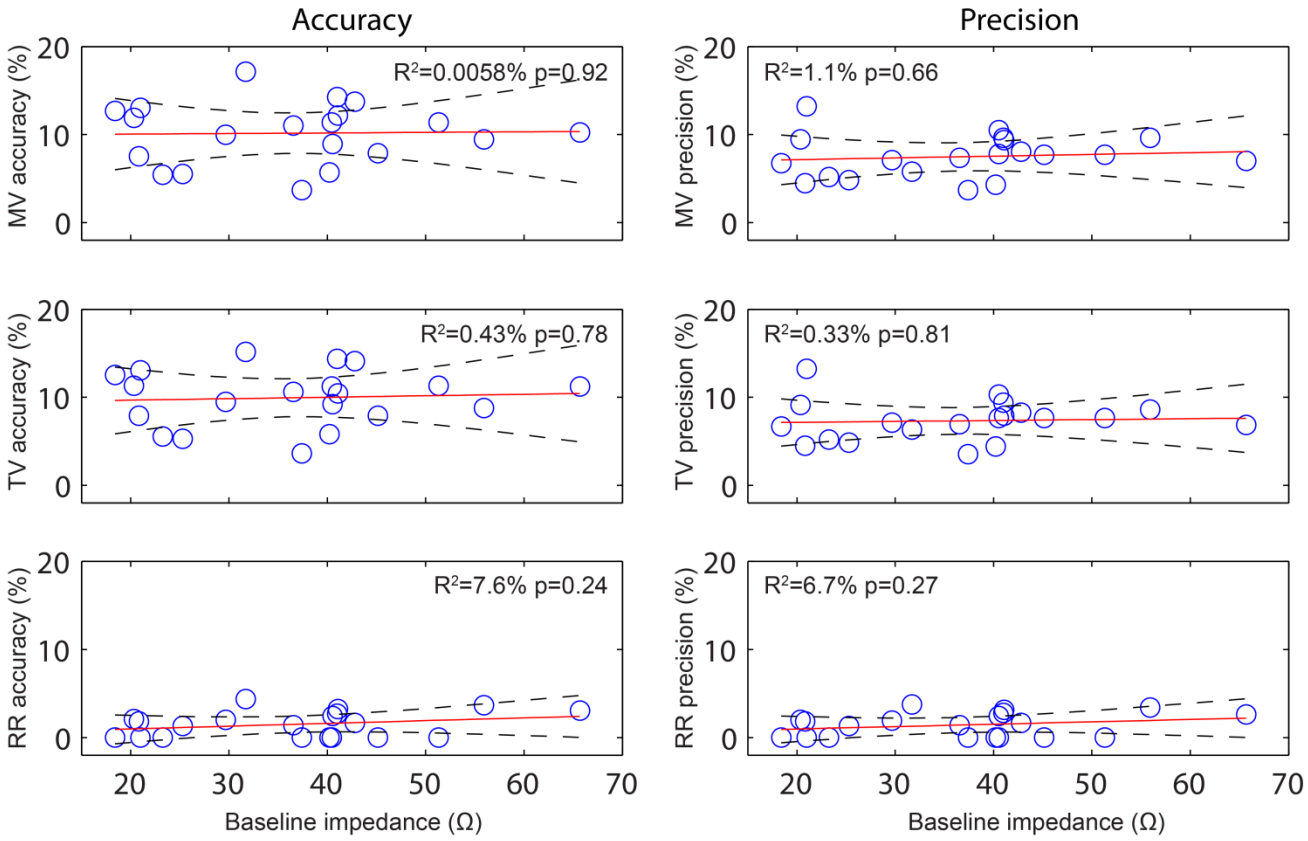

Figure 5-4 Measurement Performance plotted against Baseline Impedance

B4 [redacted]

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B4 [redacted]

ExSpiron does not rely on baseline impedance, and ExSpiron measurement performance is not significantly affected by hydration. RMI cannot rule out minor changes in measurement performance associated with a large change in hydration within the 24-hour period after a calibration, due to potential changes in impedance "gain". To ensure proper use, a Caution will be added to the User Manual:

> *A very large change in patient hydration may affect the calibration. If a patient experiences a large change in hydration, recalibrate the ExSpiron monitor.*

Hypotension

Hypotension should have a negligible effect on ExSpiron's measurement performance. Hypotension and low cardiac output may influence the small signals measured by cardiac impedance devices. However, because ExSpiron's measurements are based on the larger impedance differences between air and body tissue, they should be immune to cardiac output or hypotension.

Blood pressure was neither measured nor controlled in the ExSpiron studies.

Implanted or Temporary Neurostimulators or Pacers

ExSpiron measures bioimpedance using a 50 kHz stimulation current. A notch filter in the sensor restricts interference from other frequencies, ensuring that the significantly lower frequency pulses from a pacemaker or neurostimulator do not affect the 50 kHz bioimpedance measurement.

Another bioimpedance device with stimulating current in the 50 kHz frequency range may affect ExSpiron's measurement. The User Manual contains the Caution:

6. *Please provide clinical and statistical justification as to how your patient inclusion and exclusion criteria are representative of the entire intended patient population.*

The purpose of this study is based on the ExSpiron intended use:

> *ExSpiron is a non-invasive system that graphically displays lung volume against time and reports an approximate value of:*
> - *Tidal volume,*
> - *Respiratory rate, and*
> - *Minute ventilation.*

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ExSpiron measurements are used as an adjunct to other clinical information sources to determine respiratory status and appropriate therapy.

Because ExSpiron is intended to monitor, not to diagnose, the study's purpose is to demonstrate that ExSpiron's measurement performance is comparable to a clinically viable predicate device. The inclusion/exclusion criteria provide a broad sampling of subjects over which to demonstrate measurement performance.

The inclusion criterion for the study was:

- Males and females 18 to 90 years of age, of varying racial origins and body types, and with or without chronic respiratory diseases

The exclusion criteria were:

- Lactating or pregnant females
- Subjects that have been hospitalized for asthma or COPD in the past 30 days

The justification for the inclusion criterion is the demonstration of clinically useful accuracy across a broad spectrum of adult subjects. The justification for the exclusion criteria is the reduction of risk to vulnerable subject populations.

There is no reason to believe that the respiratory bioimpedance changes in lactating or pregnant females would be different from the general adult population. Exclusion of lactating or pregnant females is a common practice in clinical trials because it reduces risk to infants and fetuses.

Individuals who had been recently hospitalized with asthma or COPD (chronic obstructive pulmonary disease) subjects were excluded from the study to reduce the risk of respiratory distress caused by the effort of breathing through the predicate spirometer device. The clinical trial was performed at RMI's facility, so emergency medical facilities were not immediately available if there were a serious episode induced by breathing through the spirometer. Because the ExSpiron monitor does not add to the breathing workload, it is not considered a hazard to these subjects. Inclusion of asthma and COPD subjects who had not been hospitalized in the last 30 days provided confidence in the measurement performance in such subjects. Among the twenty subjects in the ExSpiron study, seven were smokers; two had a history of asthma, and one had a history of COPD.

7. *The clinical trial studied the device over a 24 hour period, but the device description does not provide information about the upper limits of duration of use of the electrode pads. Because testing should be done over the expected duration of use, please provide information about the upper limit of use of the electrode pads.*

RMI chose the 24-hour period as a conservatively short estimate of the duration for which the function of the ExSpiron system remains stable. The estimate is based primarily on the possibility of changes in electrode contact. Drift in ExSpiron calibration is not expected to be significant within twenty-four hours. Daily electrode replacement ensures optimal function. The clinical trial confirmed that measurement performance remains stable over 24 hours.

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Information on the 24-hour re-calibration appears in the User Manual in the first Caution in the Safety Measures section, the Clinical Procedure, and the Signal Quality section. See Appendix 4-2.

B4 [redacted]

8. *The Indications for Use statement does not specify an age range for intended use, but the clinical trial was conducted in subjects 20 years of age and older. Please modify the Indications for Use statement to indicate the age ranges for which the device may be used. If the age range is greater than that provided in the clinical testing, please be aware that additional testing may be needed to support the claim.*

The Indications for Use statement has been modified to indicate "adult (at least 21 years of age) patients". The subjects in the clinical trial ranged from 20 to 84 years of age. Please see the tabular data in appendices 9-1 and 9-2 for age distribution. See Appendix 1-1 for the modified Indications for Use.

9. *The 20 patients were selected to represent various ethnicity, disease states, and BMI values, but you have not provided specific information. Please provide line data in tabular form for each subject with respect to the selection variables.*

A table of selection variables data for each subject is in Appendix 9-1. Tables showing the distribution of these data across all subjects are in Appendix 9-2.

10. *You have not provided a sample size justification for the 20 patient trial. Please provide a sample size justification.*

B4 [redacted]

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B4

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From formula 3.19 in Chow et al. ('Sample Size Calculations in Clinical Research' by Shein-Chung Chow, Hansheng Wang,), Jun Shao, Chapman & Hall/CRC Biostatistics Series,2003, the paired-difference equivalence test power formula is:

$$ESS = \frac{\left(z_\alpha + z_\beta\right)^2 \sigma^2}{\left(B - \delta\right)^2}$$

B4

[redacted]

11. The analyses of percentage accuracy, precision, and bias of an unusually derived metric (natural log of the ratio of the device to the predicate measurements) are difficult to interpret clinically. Please provide an analysis of the results in terms of sensitivity, specificity, positive predictive values, and negative predictive value.

Questions 11 and 15 are closely related. Please see question 15 for the justification of the natural log calculation and an analysis of accuracy, precision, and bias based on the Bland-Altman formulas.

Sensitivity, specificity, positive predictive value, and negative predictive value are meaningful in terms of diagnosis. The ExSpiron's intended use is monitoring of respiratory measurements to be used as an adjunct to other clinical information. An analysis of diagnostic power is not consistent with the intended use.

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Statistical

12. On page 20-13, you stated that the factor day had no effect on the intra-class correlation coefficient. One of the limitations with the intra-class correlation coefficient is that "estimates (as with all correlation coefficients) are dependent on the range of the measuring scale; the wider the range, the better the result." (from Müller and Büttner Stat. in Med., Vol. 13, 2465-2476 (1994)). FDA conducted its own analysis using bootstrap of the absolute difference for minute ventilation and tidal volume. Numerical results from tables 6 and 7 on page 20-9 were used for the calculations. FDA analyses incorporated results at the subject level. Below are the results, all of which are statistically significant.

    - Accuracy between days 1 and 2 for minute ventilation: average absolute difference of 4.12%, with a 95% confidence interval of [3.10%, 5.55%]
    - Precision between days 1 and 2 for minute ventilation: 2.9% for the average absolute difference of precision with 95% confidence interval of [1.99%, 3.76%]
    - Accuracy between days 1 and 2 for tidal volume: average absolute difference of 4.105%, with 95% confidence interval of [2.73%, 5.63%]
    - Precision between days 1 and 2 for tidal volume: average absolute difference of 2.91%, with 95% confidence interval of [2.05%, 3.87%]

    In light of these results, it is unclear that the device performs comparably on different days, especially with respect to minute ventilation and tidal volume. Please comment on these results.

Regarding the FDA analyses presented in this question: RMI respectfully disagrees with the conclusions and points out an issue in the analyses. Two analyses are presented below, one that illustrates that the more appropriate day measure is average difference and one that shows that the factor day is unrelated to accuracy.

B4 [redacted]

[redacted]

B4 [redacted]

[redacted]

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B4

[redacted]

These results show no effect of day on the accuracy or precision of the ExSpiron. See Appendix 12-1 for details of the bootstrap analysis. The last page of Appendix 12-1 contains bootstrap analysis results using the original equation (Eq. 1) and the corrected one (Eq. 2).

Testing the Factor DAY as a Predictor of Accuracy

RMI has directly modeled accuracy from the 400 pairs, each pair consisting of the two measurements, one for each device. The outcome y is then the paired difference divided by the predicate measurement. RMI repeated the analysis with the log(ratio) definition of y. Previously RMI had modeled the raw data, including device as a factor, and reported the intra-class correlation coefficient, ICC, as a summary measure of accuracy. RMI never claimed that day was not a factor in predicting raw values, but only that any such day-difference had no effect on accuracy. In particular, RMI showed that raw-data models including or excluding the factor DAY had negligible effect on the estimate of the ICC. RMI made no major assertions about whether or not the factor DAY was significant.

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The basic model has outcome variable RE and one predictor variable, day. The two measurements of interest were MV and TV because, as shown above, the standard deviation of RE for the variable, RR, was very small, 0.02, and accuracy is very B4 [redacted]

REFERENCE
(Kenward, M. G. and Roger, J. H. (1997), "Small Sample Inference for Fixed Effects from Restricted Maximum Likelihood," Biometrics 53: 983-997 and Littell, R. C., Milliken, G. A., Stroup, W. W., and Wolfinger, R. D.(1996), SAS System for Mixed Models. SAS Institute Inc.: New York).

B4 [redacted]

REFERENCE
(Linear Mixed Models for Longitudinal Data by Geert Verbeke and Geert Molenbergs Springer 2000 NY section 6.2.4).

Sample SAS code appears in Appendix 12-2 SAS Code for Mixed Model.

Relative error is unrelated to the factor 'day'. For the outcome RE(MV) the unadjusted analysis, B4 [redacted] assigned p-values to the factor 'day' from 0.71 to 0.79. For RE(TV) the analogous p-values were 0.96 to 0.98. For the outcome log(accuracy) for MV the p-values ranged from 0.75 to 0.82 and for TV from 0.90 to 0.92.

13. On page 20-7, a three subject study is described which the ExSpiron is compared to the SpiroAir-LT in order to determine whether the graphical display can track respiratory curves accurately. Using only three subjects is a small sample size, rendering any generalizations to the entire intended use population questionable. Also, the SpiroAir-LT was used to calibrate the ExSpiron, which may introduce bias. It is also unclear that only the SpiroAir-LT will be used for calibration in routine clinical practice. In addition to addressing these concerns, please provide plots which superimpose the tracings from the SpiroAir-LT and ExSpiron on the same graph, with clear legends that clearly depict the device producing each tracing.

The short study's purpose is only to provide a reasonable validation that ExSpiron's graphical display of time plots works appropriately.

The clinical study with the predicate device demonstrated ExSpiron's measurement performance across a broad subject population for single measurements. Time plots of a collection of single measurements typically do not need a confirmation of accuracy separate from the accuracy of individual measurements.

RMI performed the time plot confirmation with the SpiroAir-LT, a diagnostic spirometer, which is not a predicate for the ExSpiron, but which has a graphic display function. The three-subject

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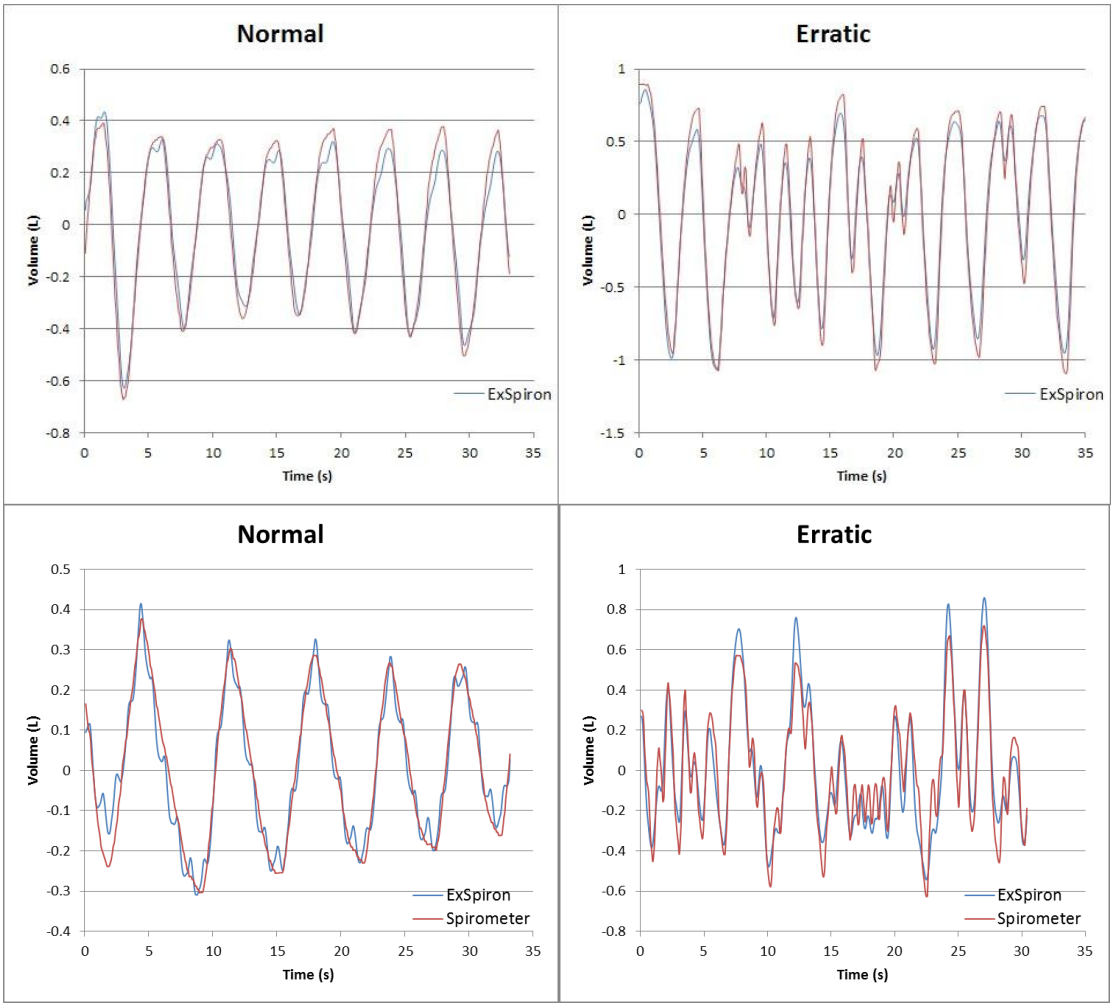
test provided a reasonable validation of a function for which proper performance can be argued based on engineering principles.

Individual patient calibration of the ExSpiron to the SpiroAir-LT is equivalent to the individual patient calibration performed with a spirometer per the User Manual. The validation relies on a visual comparison of the waveforms of produced by the SpiroAir-LT and by the ExSpiron. The comparison shows the expected result, the waveforms are virtually identical. See an example chart in Figure 13-1.



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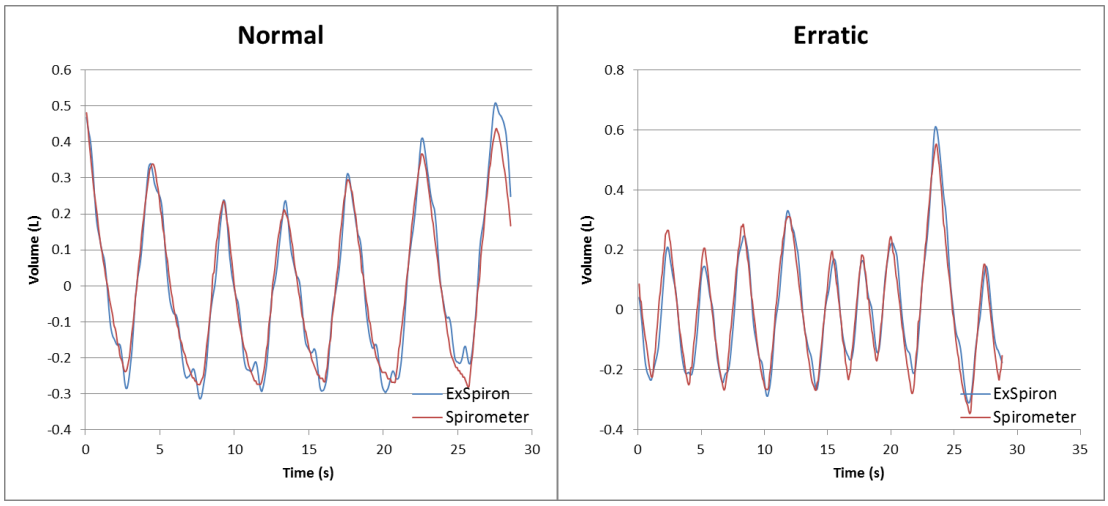

Figure 13-1
Overlays of an ExSpiron and a Spiro-Air LT waveform
(Note: Figure 13-1 spans two pages.)

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14. Please provide Bland-Altman plots comparing the ExSpiron against the Wright Respirometer, separately for each subject and combined. Please see Bland and Altman The Lancet Volume 327, Issue 8476, 8 February 1986, Pages 307–310 for more information about Bland-Altman plots.

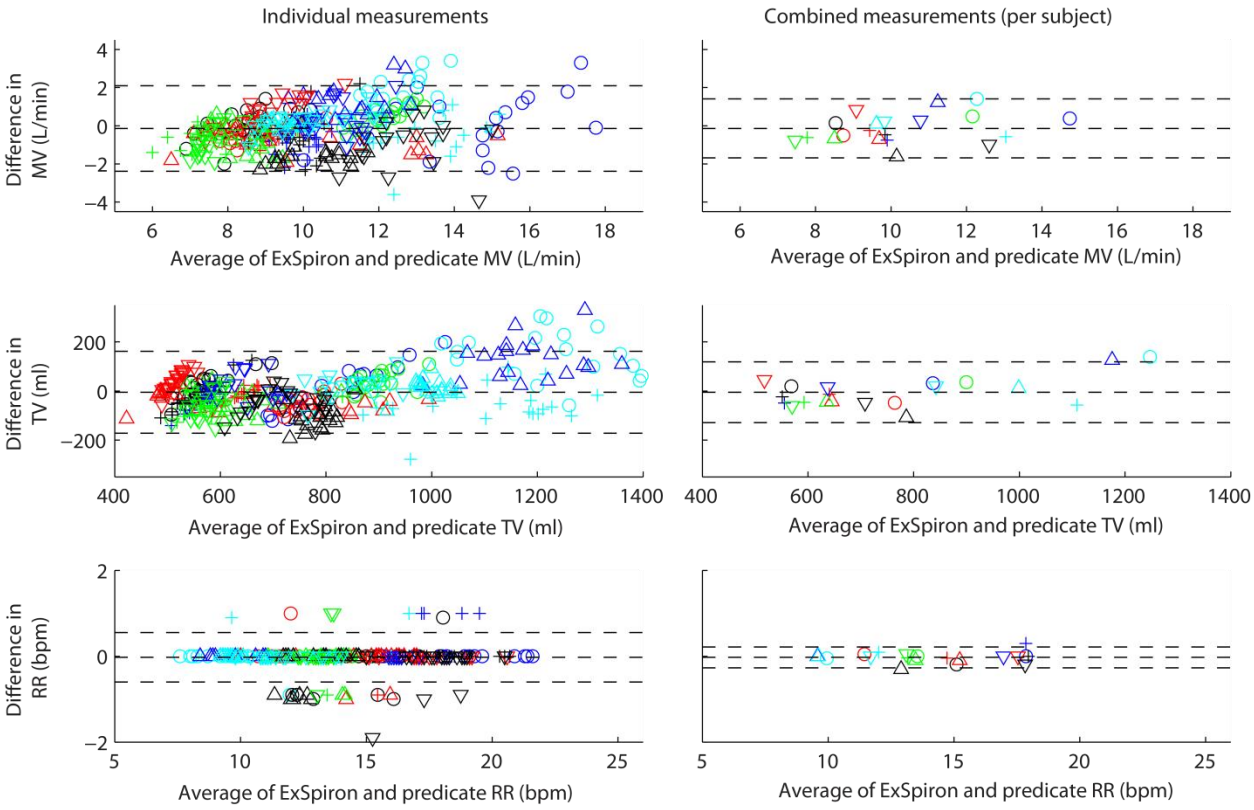

Figure 14-1 Bland-Altman Plots

RMI performed a Bland-Altman analysis of the clinical trial data in the standard fashion, following the guidelines in the Lancet 1986 article. The analyses confirmed that for all three measures the differences between the predicate and ExSpiron are small. The Bland-Altman analyses are consistent with the original analysis in section 20 of RMI's 510 (k). The average disparity between ExSpiron and the predicate device was confirmed to be small and clinically irrelevant (differences of -0.2 bmp, -5ml and -0.14 L/min for RR, TV, and MV, respectively).

RMI calculated the difference between ExSpiron and the predicate device for each measure (MV, TV, and RR) and the average of ExSpiron and the predicate for each measure. Figure 14-1 shows the resulting plots. Data from different subjects are depicted with a different color/symbol combination (i.e. blue plus sign is one subject, cyan plus sign in another subject, blue circle is a third subject, etc.). The left column shows individual data from all subjects and from all trials whereas the right column shows each subject's averaged data. The middle black dashed line on each plot depicts the average difference and the upper and lower black dashed lines indicate the 95% confidence intervals (±2 SD from the mean). Note that the mean differences between devices in all six plots are essentially zero.

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The bottom row shows the measurement difference in respiratory rate (RR). The left chart shows that the majority of the readings are perfectly accurate (difference of 0) and in only 1 trial out of 400 there is a difference between devices of 2 breaths/min. The right chart shows that the averaged measurements are even more similar between the two devices. 95% of the measurement differences are within the range of (-0.27 and 0.22) breaths/min.

The middle row shows the differences in tidal volume (TV) between ExSpiron and the predicate. On the left the individual differences are, on average, off by -5.0 ml (ExSpiron overestimates TV by 5 ml). Note that the 95% of the differences are in the range of (-172 and 162) ml and that this range is enlarged by the relatively larger disparities measured at large TV (greater than 1000ml). While the reported ExSpiron tidal volume measurements are within the clinically acceptable range, in fact, for the more clinically relevant portion of data, 550 ml to 1050 ml (see Lugo G, Casstaneda-Hernandez G. Critical care medicine 1997:25 (5) 806-811), the 95% range is even better (-151 and 114 ml). This range is further improved in the averaged data (right middle panel), showing that 95% of the differences measured are within (-129 and 119 ml). Once again, the largest differences occur at the largest TVs. It is likely that these unusually large tidal volumes were the result of the subject being asked to breathe into the predicate device spirometer for the test.

The top row shows the differences in minute ventilation (MV), which is the product of TV and RR. As such, it is not surprising that the MV disparity is somewhat larger than the RR and TV (the error in MV is affected by errors in both RR and TV). Nevertheless, on average ExSpiron underestimates MV by only 0.14 L/min (140 ml/min) Note that the largest errors are seen at large minute volumes (12-18 L/min) associated with the unusually large tidal volumes described above.

15. The calculation method used for quantifying the bias, precision, and accuracy (shown on page 20-5) is not a standard statistical method. Rather than using the logarithm scale, which could be difficult to interpret, please provide the bias, precision, and accuracy on the original raw measurement scale. If there are important medical or clinical decision points that are used in clinical practice, please incorporate these clinical decision points into the analysis of the ExSpiron against the predicate. These points can be incorporated by calculating sensitivity and false positive rate for the clinical study. To incorporate the correlated measurements (i.e. multiple measurements made on the same subject), please consider using bootstrap. For more information about bootstrap, please see Davison and Hinkley (1997) Bootstrap Methods and Their Application.

As requested, the statistical analysis has been repeated using a Bland-Altman difference error measure, not the logarithm scale. See Appendix 15-1 Statistical analysis of bias, precision, and accuracy.

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Figure 15-1 shows a summary comparison of measurement performance as determined by the Bland-Altman analysis and by the logarithm-based analysis in the original submittal. The results and conclusions of the studies, with the Bland-Altman error variable and with logarithm variable error are virtually identical.

	Log based analysis			Bland-Altman analysis		
	Absolute bias	Precision	Accuracy	Absolute bias	Precision	Accuracy
MV	6.4	7.5	10.2	6.4	7.5	10.1
TV	6.3	7.3	9.9	6.4	7.2	9.9
RR	0.5	1.4	1.5	0.5	1.4	1.5

Figure 15-1
Summary Comparison of Log-based analysis and Bland-Altman analysis

RMI used the logarithm-based analysis for ease of calculation. The log-based values are identical to the standard error values as a first order approximation. As shown below, for errors less than 25%, the values are virtual identical.

As Bland and Altman point out, given two measurements, X and Y, of the same quantity Z generated by two different devices, the best estimate of the true value of Z is the average of X and Y:

$$Z = \frac{1}{2}(X + Y)$$

The best estimate of the error between the two measurements is:

$$error = \frac{Y - X}{\frac{1}{2}(X + Y)}$$

B4

[redacted]

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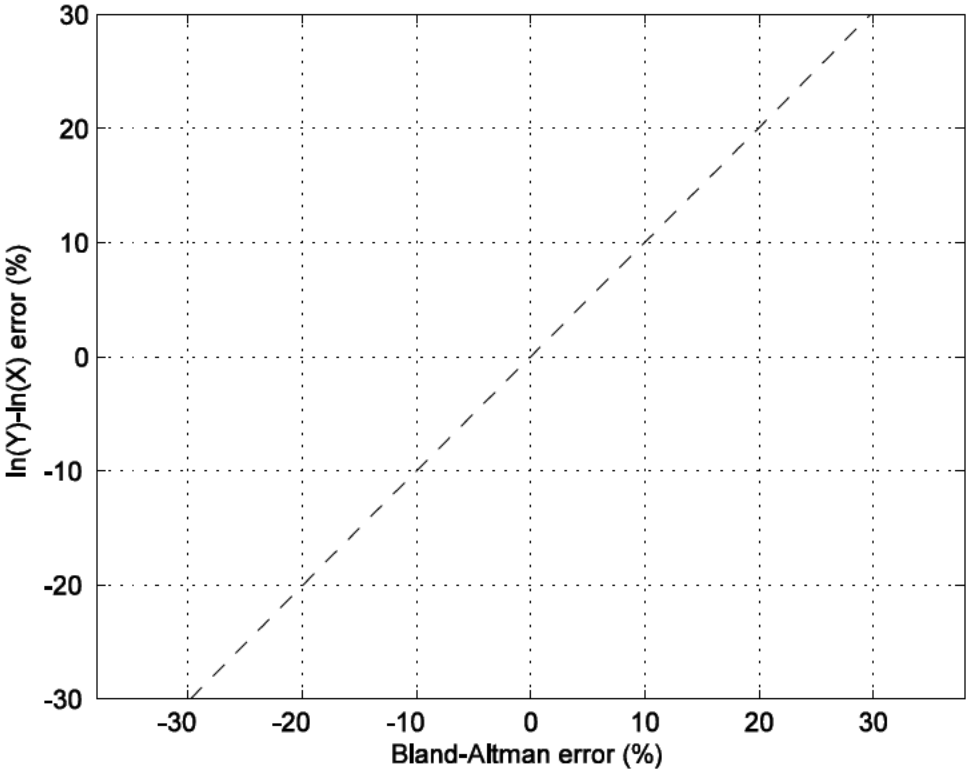
[redacted]

Thus, RMI's log-based error measure is the same as the Bland-Altman error measure to the first order. Plotting the two error measures within the range of 30% error, shows a nearly straight line of equality.



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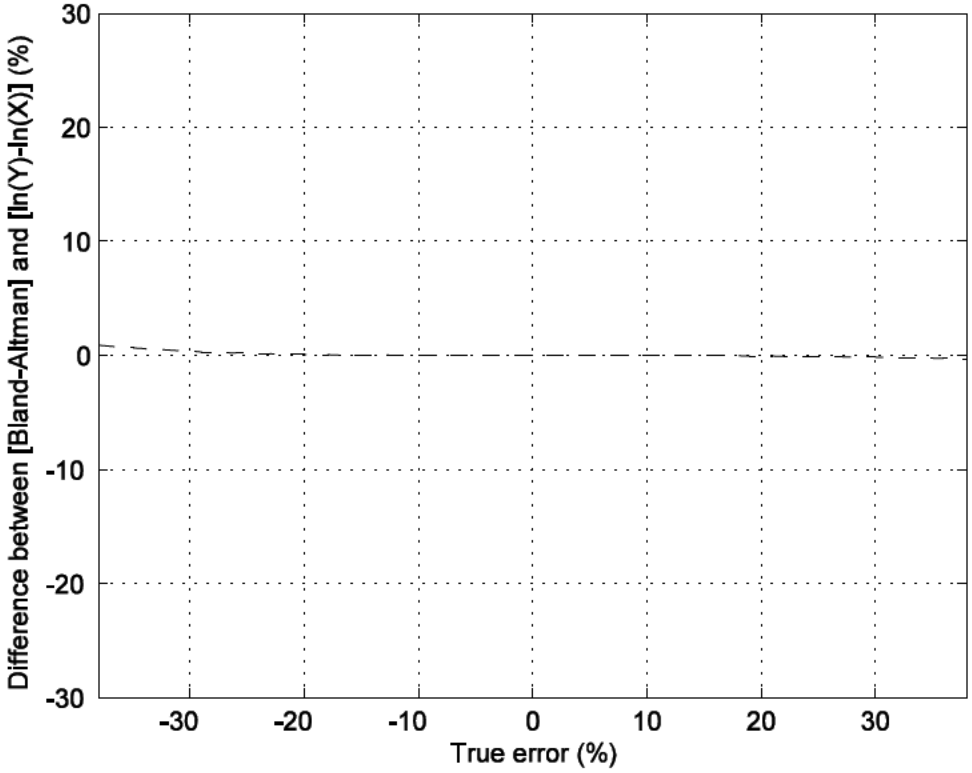
Another way to look at the relationship is a graph of the difference between the log-based error measure and the Bland-Altman error message. The difference is less than 1% for actual errors up to 30%.

Within the range of errors seen in the RMS clinical study, the log-based error measure is virtually identical to the Bland-Altman error measure.



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ExSpiron's intended use is described in the Indications for Use statement:

> *ExSpiron is a non-invasive system that graphically displays lung volume against time and reports an approximate value of:*
> - *Tidal volume,*
> - *Respiratory rate, and*
> - *Minute ventilation.*
>
> *ExSpiron measurements are used as an adjunct to other clinical information sources to determine respiratory status and appropriate therapy.*

There are no medical or clinical decision points implied by this intended use. ExSpiron provides measurement information to be used as an adjunct to other clinical information sources. As a measurement device, ExSpiron is evaluated based on measurement performance, accuracy and precision. Evaluation of diagnosis-specific performance, such as sensitivity and specificity, is inconsistent with the intended use.

16. On page 20-3, you stated that 20 subjects were used for the clinical study. Please provide justification for this sample size From a statistical perspective, it is difficult to understand why this is sufficient.

Questions 10 and 16 both ask for justification of the sample size. Please refer to the response to question 10 above for the justification.

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Since the Request for Additional Information, FDA reviewers in conference with RMI asked for a study that allowed comparison to a “gold standard” for respiratory volume measurement.

B4 [redacted]

[redacted]

[redacted]

	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

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Appendixes

1-1	Revised Indications for Use Statement
1-2	Revised 510(k) Summary
2-1	Revised Chapter 9, Reliance on Standards
4-1	Usability Test Record Format
4-2	Revised User Manual
4-3	Training Outline
4-4	Usability Test Results
4-5	Promotional Claims
7-1	B4 [redacted] Electrodes instruction sheet.
9-1	Subject selection data for each subject
9-2	Subject selection data across all subjects.
10-1	Derivation of the Variance Inflation Factor (VIF)
12-1	Details of bootstrap analysis
12-2	SAS Code for Mixed Model
15-1	Statistical analysis of bias, precision, and accuracy
17-1	Description of Wright-Morgan comparison study
17-2	Calculation of ExSpiron-Morgan measurement performance
17-3	Validation of serial configuration of the Wright and Morgan spirometers in the Wright-Morgan study

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Appendix 1-1
Revised Indications for Use Statement

The revised Indications for Use statement is on the next page.

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Indications For Use

510(k) Number (if known): K120087
Device Name: ExSpiron
Indications for Use:

ExSpiron is indicated for use by healthcare professionals in healthcare facilities, such as post-operative care and critical care units, to monitor breathing in adult (at least 21 years of age) patients with potential respiratory compromise.

ExSpiron is a non-invasive system that graphically displays lung volume against time and reports an approximate value of:

- Tidal volume,
- Respiratory rate, and
- Minute ventilation.

ExSpiron measurements are used as an adjunct to other clinical information sources to determine respiratory status and appropriate therapy.

Prescription Use ___X____ AND/OR Over-The-Counter Use_____
(Part 21 CFR 801 Subpart D) (Part 21 CFR 801 Subpart C)

(PLEASE DO NOT WRITE BELOW THIS LINE-CONTINUE ON ANOTHER PAGE IF NEEDED)

Concurrence of CDRH, Office of Device Evaluation (ODE)

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Appendix 1-2

510(k) Summary

The 510(k) Summary that begins on the next page replaces completely the 510(k) Summary in chapter 5 of the original K120087 510(k). The Indications for Use have been modified to restricted intended patients to adults, at least 21 years old. Sections describing bench testing and clinical testing have been added.

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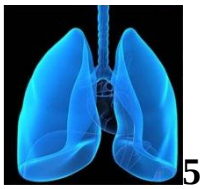

510(k) Summary

510(k) Owner:	Respiratory Motion, Inc.
Address:	305 Second Avenue, Suite B Waltham, Massachusetts 02451
Phone:	781-373-1636
Fax:	781-373-1653
Contact person:	Jenny Freeman, MD
Date 510(k) Summary prepared:	September 13, 2012
Trade name:	ExSpiron™
Common name:	Respiratory Monitor
Classifications:	Monitoring spirometer Product code: BZK Regulation: 21 CFR 868.1850 Breathing frequency monitor Product code BZQ Regulation: 21 CFR 868.2375
Predicate devices:	For product code BZK, nSpire Wright/Haloscale Respirometer, marketed by nSpire Health, Inc. of Longmont, CO 510(k) K091853 For product code BZQ, Philips MPn0 Intellivue Patient Monitors, marketed by Philips Healthcare 510(k) K060541
Device Description:	The ExSpiron™ consists of: • **Bioimpedance measurement system**: A stabilized high frequency current generator is connected to two outer electrodes. The inner four electrodes are connected to an adaptive circuit that conditions the resulting voltage signal and converts it to digital form. Firmware performs signal acquisition and relays data to the panel PC. • **Panel PC**: A Windows 7 PC performs signal processing and calibration, and runs the graphical user interface (GUI). The PC takes user input from a touch screen through a virtual keyboard and mouse. The GUI is used for recording patient data and displaying the respiratory trace as well as scalar values and trends for minute volume, tidal volume, and respiratory rate. • **Single Patient Use ExSpiron™ Electrode Lead Set:** An electrode lead set containing six electrodes to be placed on the torso. It delivers current and records impedance measurements. The electrode lead set is also used to perform subsystem checks prior to patient measurements.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Intended use:	ExSpiron™ is indicated for use by healthcare professionals in healthcare facilities, such as post-operative care and critical care units, to monitor breathing in adult (at least 21 years old) patients with potential respiratory compromise. ExSpiron™ is a non-invasive system that graphically displays lung volume against time and reports an approximate value of: • Tidal volume, • Respiratory rate, and • Minute ventilation ExSpiron™ measurements are used as an adjunct to other clinical information sources to determine respiratory status and appropriate therapy.
Comparison of technological characteristics:	

Characteristic	ExSpiron™	nSpire	Philips Intellivue Monitor	Comment
Intended Use	See above	See K091853	See K060541	The clinical application of the ExSpiron™ is equivalent to that of the nSpire The comparison to the intended use of the Philips monitor is restricted to monitoring of respiration rate ExSpiron™ has no alarm function All devices are used by healthcare professionals
Technology	Measurement is by thoracic bioimpedance	Measurement is by in-line turbine flow meter	Measurement is by bioimpedance	
Volume Measurements	Tidal volume Minute volume Volume vs time chart	Tidal volume Minute volume	None	The time function for the minute volume measurement of the nSpire is provided by a user's stopwatch
Rate Measurements	Respiratory rate (breaths/min)	None	Respiratory rate	
Safety	IEC 60601-1, including electrical and mechanical safety	Mechanical only Safety specifications are not given in the user manual or 510(k) summary	IEC 60601-1, etc	

Nonclinical performance testing:	Performance testing confirmed essential performance by IEC 60601-1 and IEC 60601-1-2 tests and confirmed usability by simulated use by physicians and nurses representative of intended users.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Clinical performance testing:

A clinical study compared simultaneous measurements from the ExSpiron and the predicate, Wright spirometer. (Respiratory rate was calculated using a stop watch.) Twenty subjects representing a broad range of intended patients participated in the study. (Age range: 20-84, BMI range: 19.9-43.2, 11 female, 9 male) The study involved two sessions for each subject, an initial session in which electrodes were applied, the ExSpiron was calibrated to the individual, and each subject performed ten 60-second breathing tests. Tidal volume, minute ventilation, and respiratory rate were measured simultaneously by the ExSpiron and the Wright spirometer. Each subject returned twenty-four hours after the first session with the original electrodes still attached. Using the same individual calibration values, a second set of ten 60-second breathing tests was performed.

The results of ExSpiron-Wright study were:

ExSpiron-Wright		**Minute Ventilation**	**Tidal Volume**	**Respiratory Rate**
Bias	**Overall**	**-2.1%**	**-1.9%**	**-0.2%**
	Day 1	-2.3%	-1.7%	-0.6%
	Day 2	-1.9%	-2.0%	0.2%
Precision	**Overall**	**10.5 %**	**10.3 %**	**2.0 %**
	Day 1	10.2%	9.7%	2.3%
	Day 2	10.8%	10.8%	1.6%
Accuracy	**Overall**	**10.7 %**	**10.4 %**	**2.0 %**
	Day 1	10.4%	9.8%	2.4%
	Day 2	10.9%	11.0%	1.6%

The results indicate that the individual calibration is stable over a 24-hour period.

Because of concern that the Wright spirometer might not provide a "gold standard" comparison, a similar study was performed comparing the Wright spirometer to the Morgan SpiroAir LT diagnostic spirometer. (The closed cell construction of the Morgan spirometer limits the breathing test time to 30 seconds. A direct comparison of the ExSpiron to the Morgan spirometer is suboptimal) A different set of twenty subjects participated. (Age range: 20-60, BMI range: 19.0-28.0, 9 female, 11 male) Each subject participated in one session performing twenty 30-second breathing tests with volume measurements made simultaneously with the Wright spirometer and the Morgan diagnostic spirometer.

The Morgan-Wright study results were:

Wright-Morgan	**Minute Ventilation**	**Tidal Volume**
Bias	**0.4%**	**0.4%**
Accuracy	**3.9%**	**3.9%**

Continued on next page.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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<table>
<tr><td>Clinical performance testing:
Continued from previous page</td><td>Combining the results of the ExSpiron-Wright study and the Wright-Morgan study provided calculated estimates of ExSpiron bias and accuracy with respect to the “gold standard” Morgan diagnostic spirometer:
<table>
<tr><th>ExSpiron-Morgan</th><th>Minute Ventilation</th><th>Tidal Volume</th></tr>
<tr><td>Bias</td><td>-1.7%</td><td>-1.5%</td></tr>
<tr><td>Accuracy</td><td>9.9%</td><td>9.6%</td></tr>
</table></td></tr>
<tr><td>Conclusions regarding safety and effectiveness:</td><td>Based on the comparisons of intended use, and results of nonclinical and clinical testing, the ExSpiron™ is substantially equivalent in intended use, safety, and effectiveness to the nSpire Respirometer and to the breathing frequency monitor function of the Philips Intellivue Patient Monitors.</td></tr>
</table>

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Records processed under FOIA Request 2014-156; Released 10/20/14

Appendix 2-1
Revised Chapter 9, Reliance on Standards

9. Statement Regarding Reliance on Standards

ExSpiron has completed certification testing for IEC 60601 (second edition) and IEC 60601-1-2. Cover pages of the preliminary test reports are included at the end of this section. The test house, B4 [redacted] is accredited to ISO/IEC 17025:2005 for these standards by the American Association for Laboratory Accreditation.

The IEC 60601 compliance includes class 1 (grounded) safety and type BF applied part. The component standards for IEC 60601-1-2 are listed in the test provided test report cover pages.

The patient cable and patient leads conform to FDA's Performance Standard for Electrode Lead Wires and Patient Cables, 21 CFR 898, and to ANSI/AAMI EC53: 1995/(R)2008 – ECG Cables and Wires and AAMI/ANSI EC 12:2000(R)2010. Testing was performed by the suppliers, Merit Cables, Inc. and Covidien.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

B4 Testing Data

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Appendix 4-2

Revised User Manual

The draft revised User Manual begins on the next page.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

B4 Draft Version

B4 Draft Version

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Contact Information

Respiratory Motion, Inc.
305 Second Avenue, Suite B
Waltham MA 02451

Tel: 781-373-1636
781-373-1635
Fax: 781-373-1653
www.respiratorymotion.com

Clinical Support:
clinicalsupport@respiratorymotion.com

Technical Support:
techsupport@respiratorymotion.com

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Table of Contents

To be added.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

B4 Draft Version

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Appendix 4-5

Promotional Claims

Promotional labeling for the ExSpiron monitor will include these claims:

- ExSpiron can monitor breathing in adult patients with respiratory compromise or potential respiratory compromise.
- ExSpiron assists in monitoring at-risk patients in near real-time.
- ExSpiron is non-invasive, point-of-care, and quantitative.
- ExSpiron provides quantitative measurement of:
  - Minute Ventilation (MV)
  - Tidal Volume (TV)
  - Respiratory Rate (RR)
- ExSpiron can measure MV, TV, and RR in non-ventilated patients.
- ExSpiron displays measurement values both numerically and graphically, displaying trend data.
- ExSpiron can quantify a patient's respiratory status and provide trending data in their respiratory parameters.
- MV, TV, and RR are important parameters for assessment of respiratory status. ExSpiron helps improve the standard of respiratory monitoring because it displays MV, TV, and RR over time. Changes in values over time can be compared.
- ExSpiron can help physicians identify patients with inadequate breathing.
- ExSpiron reports measurement in a user-friendly format.
- ExSpiron can assist physicians' decision-making by providing respiratory status data.
- ExSpiron is easy to use.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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- ExSpiron, as a bioimpedance monitor, does not require a breathing device, e.g., a spirometer, in the breathing path to obtain MV and TV.
- ExSpiron does not require participation of the patient to generate spirometry-like results.
- ExSpiron measures respiration without potential contamination that could result from having a monitor or probe (e.g. a capnometer or spirometer) in the patient's air-stream.
- ExSpiron measurements of MV, TV and RR do not rely on the measurement of sound.
- ExSpiron provides objective data about respiratory status that may facilitate better patient care.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Appendix 7-1 B4 [redacted]

[redacted]

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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B4

[redacted]

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Appendix 9-1

B4

B4

Subject ID

B4

[redacted]

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Appendix 9-2
Subject selection data across all subjects

Age Range	
20-29	3
30-39	3
40-49	4
50-59	4
60-69	2
70-79	2
80-89	2

Gender	
female	11
male	9

Race	
Asian	2
white	16
black	2
Hispanic	0

BMI Range		
18.5-24.9	11	normal
25-29.9	4	overweight
30-39.9	3	obese
40+	2	morbidly obese

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Appendix 10-1

Derivation of the Variance Inflation Factor (VIF)

The variance inflation factor (VIF) for compound symmetric variance-covariance matrices appears in many texts and is trivial to derive. The analogous VIF for autocorrelated data is seldom found but equally easy to derive:

The k = 20 repeated measurements per subject are autocorrelated, the AR1 option in the 'repeated' statement of SAS Mixed model procedure. The term, $M_{i,j}$, the(i,j) term in the 20-by-20 autocorrelation matrix, M, is r**|i-j|, where r is the correlation between adjacent measurements. VIF is the sum of the terms in the matrix divided by 20, the sum of the terms when r = 0. With dimension k = 20 the geometric series has sum:

$$c = \sum_{i=0}^{k} r^i = {(1 - r^{k+1})}/{(1 - r)}$$

Let T denote the sum of the terms in the upper triangular part of M, then T = $(k + 1 - c)/(1 - r)$. The sum of the terms in M = $2T - k$ and $VIF = {2T}/{k} - 1$. Finally, ESS = 20k/VIF.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Appendix 12-1 B4 [redacted]

B4 [redacted]

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

B4 Testing Data

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K120087/S2 V.1

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Food and Drug Administration
10903 New Hampshire Avenue
Document Control Room –WO66-G609
Silver Spring, MD 20993-0002

SEP 26 2012

Respiratory Motion, Incorporated
C/O Mr. Chas Burr
Chas Burr QR Services
11 Mystic Avenue
Winchester, Massachusetts 01890

Re: K120087
Trade/Device Name: ExSpiron™
Regulation Number: 21 CFR 868.2375
Regulation Name: Breathing Frequency Monitor
Regulatory Class: II
Product Code: BZQ, BZK
Dated: September 20, 2012
Received: September 21, 2012

Dear Mr. Burr:

We have reviewed your Section 510(k) premarket notification of intent to market the device referenced above and have determined the device is substantially equivalent (for the indications for use stated in the enclosure) to legally marketed predicate devices marketed in interstate commerce prior to May 28, 1976, the enactment date of the Medical Device Amendments, or to devices that have been reclassified in accordance with the provisions of the Federal Food, Drug, and Cosmetic Act (Act) that do not require approval of a premarket approval application (PMA). You may, therefore, market the device, subject to the general controls provisions of the Act. The general controls provisions of the Act include requirements for annual registration, listing of devices, good manufacturing practice, labeling, and prohibitions against misbranding and adulteration. Please note: CDRH does not evaluate information related to contract liability warranties. We remind you, however, that device labeling must be truthful and not misleading.

If your device is classified (see above) into either class II (Special Controls) or class III (PMA), it may be subject to additional controls. Existing major regulations affecting your device can be found in the Code of Federal Regulations, Title 21, Parts 800 to 898. In addition, FDA may publish further announcements concerning your device in the Federal Register.

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Please be advised that FDA's issuance of a substantial equivalence determination does not mean that FDA has made a determination that your device complies with other requirements of the Act or any Federal statutes and regulations administered by other Federal agencies. You must comply with all the Act's requirements, including, but not limited to: registration and listing (21 CFR Part 807); labeling (21 CFR Part 801); medical device reporting (reporting of medical device-related adverse events) (21 CFR 803); good manufacturing practice requirements as set forth in the quality systems (QS) regulation (21 CFR Part 820); and if applicable, the electronic product radiation control provisions (Sections 531-542 of the Act); 21 CFR 1000-1050.

If you desire specific advice for your device on our labeling regulation (21 CFR Part 801), please go to http://www.fda.gov/AboutFDA/CentersOffices/CDRH/CDRHOffices/ucm115809.htm for the Center for Devices and Radiological Health's (CDRH's) Office of Compliance. Also, please note the regulation entitled, "Misbranding by reference to premarket notification" (21CFR Part 807.97). For questions regarding the reporting of adverse events under the MDR regulation (21 CFR Part 803), please go to http://www.fda.gov/MedicalDevices/Safety/ReportaProblem/default.htm for the CDRH's Office of Surveillance and Biometrics/Division of Postmarket Surveillance.

You may obtain other general information on your responsibilities under the Act from the Division of Small Manufacturers, International and Consumer Assistance at its toll-free number (800) 638-2041 or (301) 796-7100 or at its Internet address http://www.fda.gov/MedicalDevices/ResourcesforYou/Industry/default.htm.

Sincerely yours,

Anthony D. Watson, B.S., M.S., M.B.A.
Director
Division of Anesthesiology, General Hospital,
Infection Control and Dental Devices
Office of Device Evaluation
Center for Devices and
Radiological Health

Enclosure

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Records processed under FOIA Request 2014-156; Released 10/20/14

Indications For Use

510(k) Number (if known): K120087
Device Name: ExSpiron
Indications for Use:

ExSpiron is indicated for use by healthcare professionals in healthcare facilities, such as post-operative care and critical care units, to monitor breathing in adult (at least 21 years of age) patients.

ExSpiron is a non-invasive system that graphically displays lung volume against time and reports an approximate value of:

- Tidal volume,
- Respiratory rate, and
- Minute ventilation.

ExSpiron measurements are used as an adjunct to other clinical information sources.

Prescription Use ___X____ AND/OR Over-The-Counter Use_____
(Part 21 CFR 801 Subpart D) (Part 21 CFR 801 Subpart C)

(PLEASE DO NOT WRITE BELOW THIS LINE-CONTINUE ON ANOTHER PAGE IF NEEDED)

Concurrence of CDRH, Office of Device Evaluation (ODE)

(Division Sign-Off)
Division of Anesthesiology, General Hospital
Infection Control, Dental Devices

510(k) Number: K120087

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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* * * COMMUNICATION RESULT REPORT (SEP. 27. 2012 8:26AM) * * *

FAX HEADER 1:
FAX HEADER 2:

TRANSMITTED/STORED : SEP. 27. 2012 8:25AM

FILE MODE	OPTION	ADDRESS	RESULT	PAGE
9569 MEMORY TX		17817232422	OK	3/3

REASON FOR ERROR
E-1) HANG UP OR LINE FAIL
E-2) BUSY
E-3) NO ANSWER
E-4) NO FACSIMILE CONNECTION

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Food and Drug Administration
10903 New Hampshire Avenue
Document Control Room –WO66-G609
Silver Spring, MD 20993-0002

SEP 26 2012

Respiratory Motion, Incorporated
C/O Mr. Chas Burr
Chas Burr QR Services
11 Mystic Avenue
Winchester, Massachusetts 01890

Re: K120087
Trade/Device Name: ExSpiron™
Regulation Number: 21 CFR 868.2375
Regulation Name: Breathing Frequency Monitor
Regulatory Class: II
Product Code: BZQ, BZK
Dated: September 20, 2012
Received: September 21, 2012

Dear Mr. Burr:

We have reviewed your Section 510(k) premarket notification of intent to market the device referenced above and have determined the device is substantially equivalent (for the indications for use stated in the enclosure) to legally marketed predicate devices marketed in interstate commerce prior to May 28, 1976, the enactment date of the Medical Device Amendments, or to devices that have been reclassified in accordance with the provisions of the Federal Food, Drug, and Cosmetic Act (Act) that do not require approval of a premarket approval application (PMA). You may, therefore, market the device, subject to the general controls provisions of the Act. The general controls provisions of the Act include requirements for annual registration, listing of devices, good manufacturing practice, labeling, and prohibitions against misbranding and adulteration. Please note: CDRH does not evaluate information related to contract liability warranties. We remind you, however, that device labeling must be truthful and not misleading.

If your device is classified (see above) into either class II (Special Controls) or class III (PMA), it may be subject to additional controls. Existing major regulations affecting your device can be found in the Code of Federal Regulations, Title 21, Parts 800 to 898. In addition, FDA may publish further announcements concerning your device in the Federal Register.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Records processed under FOIA Request 2014-156; Released 10/20/14

Food and Drug Administration
Office of Device Evaluation &
Office of In Vitro Diagnostics

COVER SHEET MEMORANDUM

From: Reviewer Name CHAN LEE

Subject: 510(k) Number K120087/S2

To: The Record

Please list CTS decision code SE

☐ Refused to accept (Note: this is considered the first review cycle, See Screening Checklist http://eroom.fda.gov/eRoomReg/Files/CDRH3/CDRHPremarketNotification510kProgram/0_5631/Screening%20Checklist%207%202%2007.doc)

☐ Hold (Additional Information or Telephone Hold).

☒ Final Decision (SE, SE with Limitations, NSE (select code below), Withdrawn, etc.).

Not Substantially Equivalent (NSE) Codes

☐	NO	NSE for lack of predicate
☐	NI	NSE for new intended use
☐	NQ	NSE for new technology that raises new questions of safety and effectiveness
☐	NU	NSE for new intended use AND new technology raising new questions of safety and effectiveness
☐	NP	NSE for lack of performance data
☐	NS	NSE no response
☐	NL	NSE for lack of performance data AND no response
☐	NM	NSE pre-amendment device call for PMAs (515i)
☐	NC	NSE post-amendment device requires PMAs
☐	NH	NSE for new molecular entity requires PMA
☐	TR	NSE for transitional device

Please complete the following for a final clearance decision (i.e., SE, SE with Limitations, etc.):		YES	NO
Indications for Use Page	*Attach IFU*	X	
510(k) Summary /510(k) Statement	*Attach Summary*	X	
Truthful and Accurate Statement.	*Must be present for a Final Decision*	X	
Is the device Class III?			X
If yes, does firm include Class III Summary?	*Must be present for a Final Decision*		X
Does firm reference standards? (If yes, please attach form from http://www.fda.gov/opacom/morechoices/fdaforms/FDA-3654.pdf)			X
Is this a combination product? (Please specify category N, see http://eroom.fda.gov/eRoomReg/Files/CDRH3/CDRHPremarketNotification510kProgram/0_413b/COMBINATION%20PRODUCT%20ALGORITHM%20(REVISED%203-12-03).DOC			X
Is this a reprocessed single use device? (Guidance for Industry and FDA Staff – MDUFMA - Validation Data in 510(k)s for Reprocessed Single-Use Medical Devices, http://www.fda.gov/cdrh/ode/guidance/1216.html)			X
Is this device intended for pediatric use only?			X
Is this a prescription device? (If both prescription & OTC, check both boxes.)		X	
Did the application include a completed FORM FDA 3674, Certification with Requirements of ClinicalTrials.gov Data Bank?			X
Is clinical data necessary to support the review of this 510(k)?		X	
For United States-based clinical studies **only**: Did the application include a completed FORM FDA 3674, *Certification with Requirements of ClinicalTrials.gov Data Bank*? (If study was			X

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conducted in the United States, and FORM FDA 3674 was not included or incomplete, then applicant must be contacted to obtain completed form.)	
Does this device include an Animal Tissue Source?	X
All Pediatric Patients age<=21	
Neonate/Newborn (Birth to 28 days)	
Infant (29 days -< 2 years old)	
Child (2 years -< 12 years old)	
Adolescent (12 years -< 18 years old)	
Transitional Adolescent A (18 - <21 years old) Special considerations are being given to this group, different from adults age ≥ 21 (different device design or testing, different protocol procedures, etc.)	
Transitional Adolescent B (18 -<= 21; No special considerations compared to adults => 21 years old)	
Nanotechnology	X
Is this device subject to the Tracking Regulation? (Medical Device Tracking Guidance, http://www.fda.gov/cdrh/comp/guidance/169.html) *Contact OC.*	X

Regulation Number	Class*	Product Code
21 CFR 868.2375	II	BZQ

(*If unclassified, see 510(k) Staff)

Additional Product Codes: BZK

Review: for L. Schultz (Branch Chief) ARDB (Branch Code) 9/20/12 (Date)

Final Review: (Division Director) 9/20/12 (Date)

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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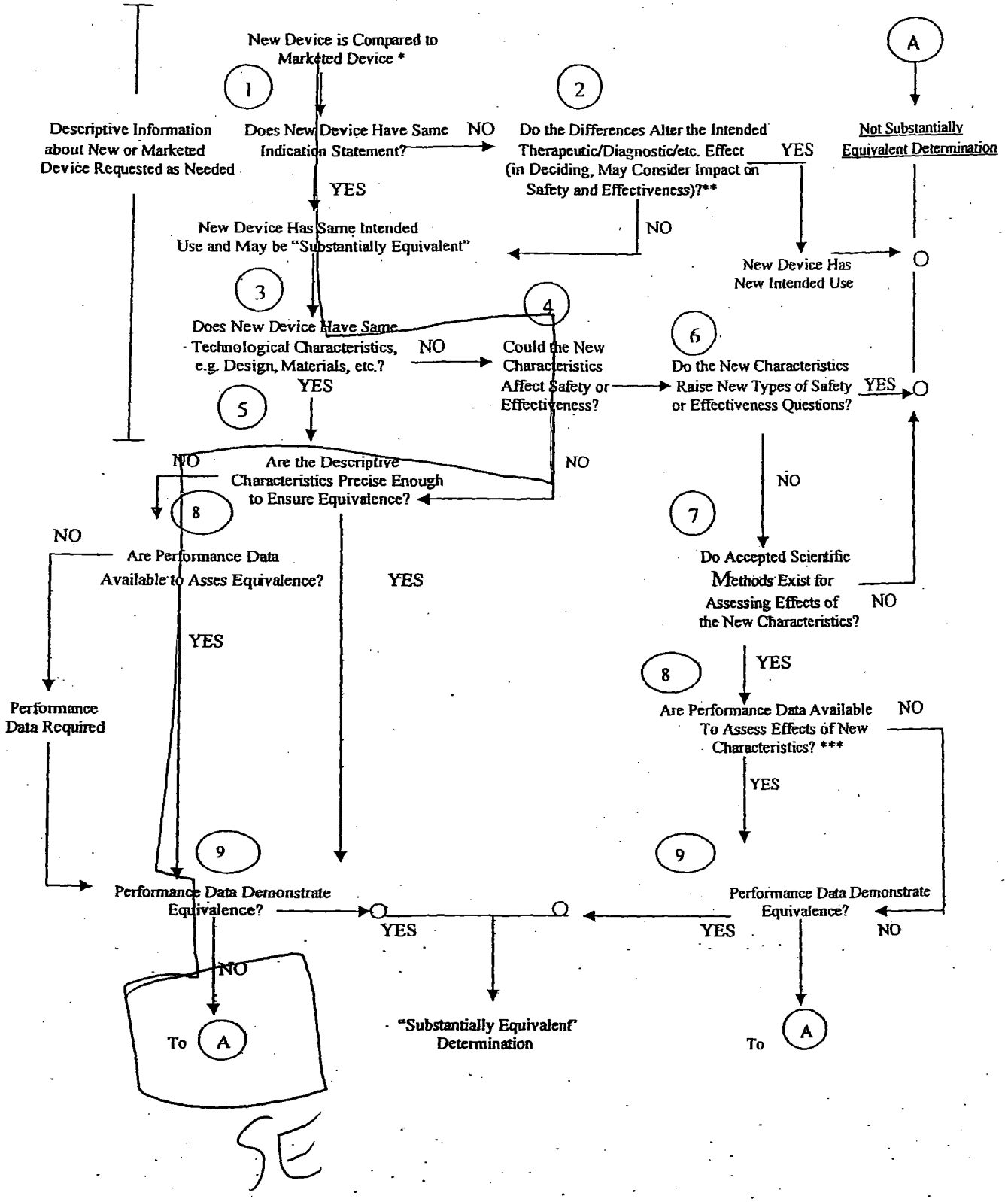
510(k) "SUBSTANTIAL EQUIVALENCE" DECISION-MAKING PROCESS



* 510(k) Submissions compare new devices to marketed devices. FDA requests additional information if the relationship between marketed and "predicate" (pre-Amendments or reclassified post-Amendments) devices is unclear.

** This decision is normally based on descriptive information alone, but limited testing information is sometimes required.

*** Data maybe in the 510(k), other 510(k)s, the Center's classification files, or the literature.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Records processed under FOIA Request 2014-156; Released 10/20/14

DEPARTMENT OF HEALTH AND HUMAN SERVICES **MEMORANDUM**

Food and Drug Administration
Office of Device Evaluation
9200 Corporate Boulevard
Rockville, MD 20850

Premarket Notification 510(k) Review
Traditional

K120087

Date: September 26, 2012
To: The Record
From: Chan Lee, Electrical Engineer

Office: ODE
Division: DAGID/ARDB

510(k) Holder: Respiratory Motion, Inc.
Device Name: ExSpiron
Contact: Mr. Chas Burr
Phone: (781) 789-1646
Fax: (781) 723-2422
Email: chas_burr@alum.mit.edu

I. Purpose and Submission Summary

The 510(k) holder would like to introduce ExSpiron into interstate commerce.

The proposed device is a respiratory monitor. It uses bioelectrical impedance measurement from electrodes to approximate the following: lung volume; tidal volume; minute ventilation; and respiratory rate.

Pre-IDE I110201

The sponsor submitted Pre-IDE I110201 in preparation for this current 510(k) application. In the Pre-IDE, the sponsor asked three questions. First was about split predicate devices. Second was about comparison of fundamental technology to predicate devices. Third was about test methodology to verify performance specifications. For the first two questions, the lead reviewer responded by stating that the proposed split predicate devices and comparison of fundamental technology were acceptable. For the third question, the sponsor asked whether a Wright Spirometer was adequate as a comparator in a clinical study. The lead reviewer responded that Wright Spirometer was acceptable.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

II. Administrative Requirements

		Yes	No	N/A
Indications for Use page (Indicate if: Prescription or OTC)	***Prescription Use Only***	X		
Truthful and Accuracy Statement	***Included in Section 6***	X		
510(k) Summary or 510(k) Statement	***Summary is included in Section 5***	X		
Standards Form	***Included in Section***	X		

III. Device Description

		Yes	No	N/A
Is the device life-supporting or life sustaining?			X	
Is the device an implant (implanted longer than 30 days)?			X	
Does the device design use software?		X		
Is the device sterile?			X	
Is the device reusable (not reprocessed single use)? Are "cleaning" instructions included for the end user?	***Computer is reusable*** ***Electrode is single use only***	X	X	

The proposed device is a respiratory monitor. A picture of the proposed device is shown in Figure 1. It uses bioelectrical impedance measurement from electrodes to monitor the following parameters: tidal volume; minute ventilation; and respiratory rate.

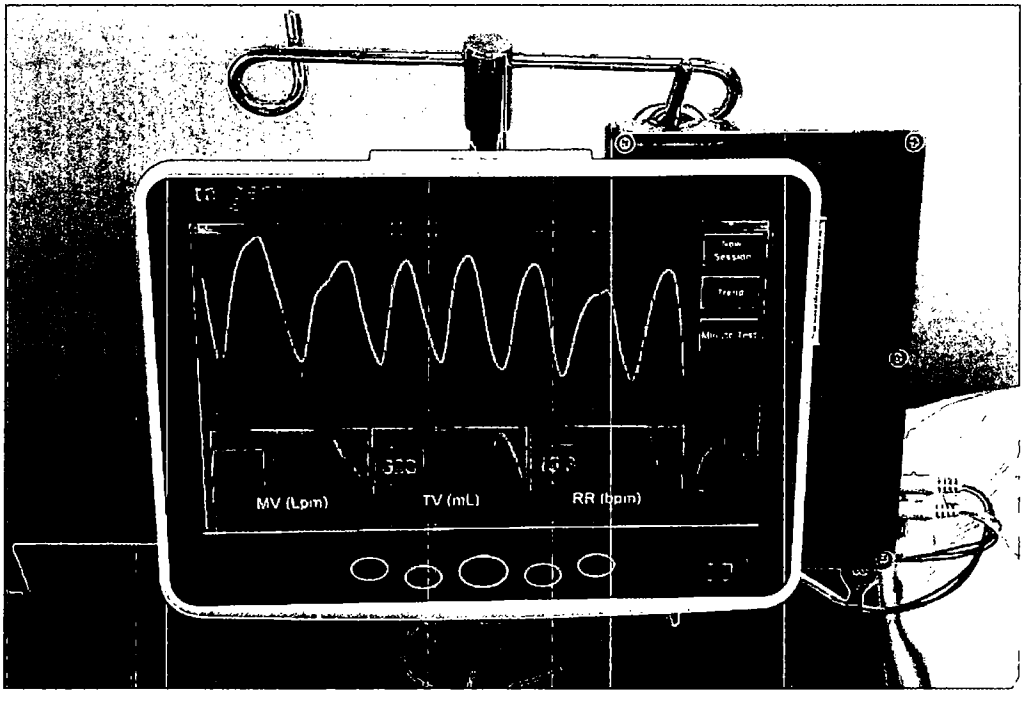


Figure 1 - Picture of Proposed Device

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

The proposed device is composed of three components:

- *Tangent Medix 11i Computer:* Base platform to run software and provide graphical display.
- *Impedance Meter:* Interface between the computer and electrodes.
- *Cable and Electrodes:* Connects to patient for bioimpedance measurement.

The proposed device uses electrodes on the patient to measure bioelectrical impedance as shown in Figure 2. Please note that the electrodes were already cleared under K960968.

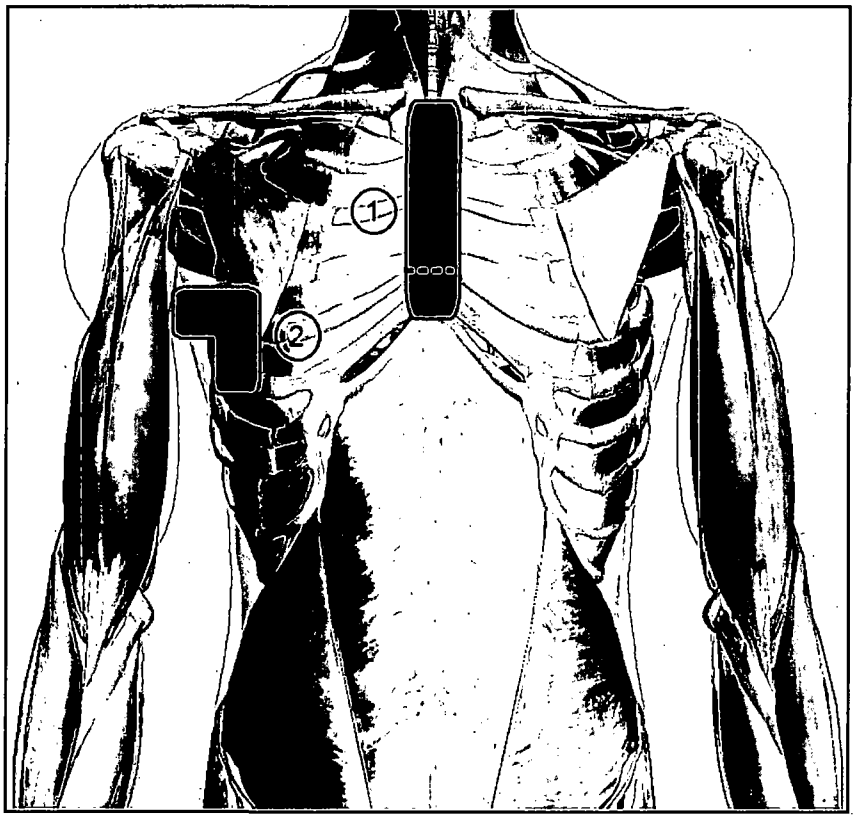


Figure 2 – Electrode Placement Diagram

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

IV. Indications for Use

Revision history of the proposed Indications For Use statement is shown in Table 1. Statements that have been modified or removed are underlined.

Table 1 – Proposed IFU Revision History

Revision	*IFU Statement*	*Notes*
Original	ExSpiron is indicated for use by healthcare professionals in healthcare facilities, such as post-operative care and critical care units, to monitor breathing in patients with potential respiratory compromise. ExSpiron is a non-invasive system that graphically displays lung volume against time and reports an approximate value of: • Tidal volume, • Respiratory rate, and • Minute ventilation. ExSpiron measurements are used as an adjunct to other clinical information sources to determine respiratory status and appropriate therapy.	From Section 4. Intended patient population is not well specified. Included clinical claims which were not validated.
S001	ExSpiron is indicated for use by healthcare professionals in healthcare facilities, such as post-operative care and critical care units, to monitor breathing in adult (at least 21 years of age) patients with potential respiratory compromise. ExSpiron is a non-invasive system that graphically displays lung volume against time and reports an approximate value of: • Tidal volume, • Respiratory rate, and • Minute ventilation. ExSpiron measurements are used as an adjunct to other clinical information sources to determine respiratory status and appropriate therapy.	From Appendix 1-1. Update IFU contains intended patient population and clinical claims which were not validated.
S002	ExSpiron is indicated for use by healthcare professionals in healthcare facilities, such as post-operative care and critical care units, to monitor breathing in adult (at least 21 years of age) patients. ExSpiron is a non-invasive system that graphically displays lung volume against time and reports an approximate value of: • Tidal volume, • Respiratory rate, and • Minute ventilation. ExSpiron measurements are used as an adjunct to other clinical information sources.	From Appendix 3. Sponsor removed clinical claims. IFU is adequate.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

510(k) Summary Review

The sponsor has provided a complete 510(k) Summary in Supplement 2 submission.

			YES	NO	N/A
Required Elements for 510(k) Summary (21 CFR 807.92)					
	Clearly labeled "510(k) Summary"		X		
	Submitter's name, address, phone #, a contact person		X		
	Date the summary was prepared		X		
	The name of the device/trade name/common name/classification name		X		
	An identification of the legally marketed Predicate		X		
	Description of the subject device		X		
	Statement of intended use (identical to indications for use)		X		
	Technological characteristics	If same, a summary of comparison of technological characters	X		
		If different, a summary of how do they compare to the Predicate	X		
	Performance Data	Brief discussion of non-clinical data submitted, referenced, or relied on	X		
		Brief discussion of clinical data submitted, referenced, or relied on, including: • Description upon whom the device was tested, • Data obtained from the tests and especially: • Adverse events and complications • Other information for SE determination	X		
		Conclusion that data demonstrate SE	X		
Required Elements for 510(k) Statement (21 CFR 807.93)					
	Signed verbatim statement				X

V. Predicate Device Comparison

The sponsor identified the two split predicate devices. One is for the intended use (Wright Haloscale Spirometer), and the other is for the technology (Intellivue). In the Pre-IDE I110201, the lead reviewer Ms. Amy LeVelle of ARDB stated that the split predicate devices were acceptable.

- For product code BZK, monitoring spirometer, the ExSpiron is compared to the nSpire Wright/Haloscale Respirometer, marketed by nSpire Health, Inc. of Longmont, CO. FDA cleared the nSpire respirometer in 510(k) K 091853.

- For product code BZQ, breathing frequency monitor, the ExSpiron is compared to the Philips MPn0 Intellivue Patient Monitors, marketed by Philips Healthcare. FDA cleared the Intellivue monitor in 510(k) K060541.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

VI. Labeling

Labeling Recommendations	*Yes*	*No*	*N/A*
Does the submission contain proposed labels, labeling, and advertisements sufficient to describe the device, its intended use, and the directions for use? (Labels include the information affixed directly to the device or its container or packaging. Labeling also includes professional or patient package inserts, and any other information that accompanies the device.)	X		
Does the labeling describe the intended uses?	X		
Does the labeling include adequate directions for use?	X		
Does the labeling include a prescription statement (21 CFR 801.109)?	X		
Labeling should include a list of device specifications including: reservoir volume, flow rates and profiles (if applicable), accuracy, residual volume, and the operational conditions (e.g., temperature, pressure, fluid viscosity) under which these are valid.	X		
Are route(s) of administration described as indicated in the statement of intended use?	X		
Does the labeling include comprehensive directions for preparation and use for all possible functions of the device?	X		
Has the sponsor provided a copy of patient instructions for use if the device is intended for home use, or would reasonably be expected to be used in a home setting?			X
Does the device include appropriate MR/CT/ultrasound labeling?			X

Labeling has been provided which includes instructions for use and an appropriate prescription statement as required by 21 CFR 801.109(b).

In Supplement 1, Dr. Anh Nguyen of ARDB reviewed the labeling and found clinical claims which the sponsor did not provide supporting evidence. In Supplement 2, the sponsor removed the clinical claims and provided updated labeling.

VII. Sterilization/Shelf Life/Reuse

In Section 14 of the original submission, the sponsor stated that the proposed device is not provided sterile. B4 [redacted] Since the electrodes are the only patient contacting material and were cleared in predicate submission, this reviewer does not have additional questions for the sponsor.

VIII. Biocompatibility

Only the electrodes in the proposed device contact the patient. In Section 15 of the submission, the sponsor stated the electrodes are B4 [redacted] Since the electrodes are the only patient contacting material and were cleared in predicate submission, this reviewer does not have additional questions for the sponsor.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

IX. Software

Version: **1.03.01**			
Level of Concern: **Moderate**			
		Yes	No
Software description:	***Refer to Section 16-2***	X	
Device Hazard Analysis:	***Refer to Section 16-3***	X	
Software Requirements Specifications:	***Refer to Section 16-18***	X	
Architecture Design Chart:	***Refer to Section 16-21***	X	
Design Specifications:	***Refer to Section 16-24***	X	
Traceability Analysis/Matrix:	***Refer to Section 16-35***	X	
Development:	***Refer to Section 16-44***	X	
Verification & Validation Testing:	***Refer to Section 16-46***	X	
Revision level history:	***Refer to Section 16-51***	X	
Unresolved anomalies:	***Refer to Section 16-50***	X	

In Section 16, the sponsor provided software documentation. The sponsor classified the proposed device as Moderate level of concern. This reviewer agrees with the sponsor because the clinician is likely to rely on other vital signs to determine clinical decisions. This reviewer reviewed the software documentation as shown in the table above. This reviewer found that the sponsor provided adequate documentation and did not have additional question for the sponsor.

X. Electromagnetic Compatibility and Electrical, Mechanical and Thermal Safety

In Section 17, the sponsor stated that they will conform to various standards. However, the sponsor should provide completed testing prior to seeking 510(k) clearance. This reviewer requested that the sponsor provide EMC and electrical safety testing.

In Supplement 1, the sponsor provided complete electromagnetic compatibility (EMC) and electrical safety testing according to IEC 60601-1 and IEC 60601-1-2 which are FDA recognized standards. This reviewer found that the proposed device passed testing. This reviewer does not have additional questions for the sponsor.

XI. Performance Testing – Bench

The proposed device uses electrode sensors to measure bioimpedance. Performance bench testing may be sufficient to verify and validate the operating performance specifications such as resistance, current, and voltage measurements. However, the clinical output is dependant on actual measurement of a human body which may not be adequately modeled. Therefore, this reviewer believes that clinical study is necessary to verify and validate the intended use and clinical claims of the proposed device. Please refer to Section XIII of this review memo for clinical review of the proposed device.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

XII. Performance Testing – Animal

The sponsor did not provide animal testing. This reviewer believes that animal testing is not necessary in order to determine substantial equivalence to the predicate devices.

XIII. Performance Testing – Clinical

Original Submission: Clinical

The sponsor provided clinical study in Section 20 of the original submission. This reviewer consulted Dr. Deborah Shure of ARDB for clinical review. Dr. Shure found the study to be inadequate. Dr. Shure identified the following deficiencies in her review memo.

- Intended duration of use for electrode pads.
- Detailed patient inclusion and exclusion criteria.
- No sample size justification.
- Demographic and anthropomorphic information was insufficient.
- The analysis of the clinical data is difficult to understand.

Original Submission: Statistical

This reviewer consulted Dr. Arkendra De of OSB for statistical review. Dr. De found the analysis to be inadequate and stated the following in his review memo:

> *"Using numerical values provided by the sponsor, FDA reached different conclusions about the clinical study than the sponsor. Additional information and explanation are requested from the sponsor. After talking with the clinician on February 22, 2012, a few remarks have been added to this review."*

Teleconference (7/26/2012)

The sponsor requested a teleconference with the review team for clarification to the deficiencies in our hold letter dated March 30, 2012. This reviewer and Dr. Anh Nguyen of ARDB attended the meeting.

During the discussions about clinical study, Dr. Nguyen raised concerns that the Wright spirometer may not be an adequate comparator because the Wright spirometer has up to 20% of error. However, Dr. Nguyen also acknowledged that the Agency agreed to the sponsor using Wright spirometer in our Pre-IDE response. The sponsor mentioned that they have considered the Morgan spirometer because of its higher accuracy but chose not to use it because it's not intended for continuous use for long period of time. The review team suggested that a comparison between the Wright spirometer and the Morgan spirometer may be helpful. The sponsor agreed to provide the comparison data to further validate using Wright spirometer as a comparator. In addition, the sponsor acknowledged that the original clinical study did not provide adequate evidence for pediatric patient population. Finally, the sponsor stated that they expected successful EMC and electrical safety testing by mid-August.

Supplement 1: Clinical

This reviewer consulted Dr. Anh Nguyen of ARDB for clinical review of the sponsor's response. The sponsor provided additional clinical data comparing the Wright spirometer to the Morgan spirometer which has better accuracy specification. The data showed that the Wright spirometer may be as accurate as Morgan spirometer. Dr. Nguyen recommended that the proposed device may be cleared under tool-based claim without clinical claims proposed in the promotional literature.

Supplement 1: Statistical

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

This reviewer consulted Dr. Arkendra De of OSB for statistical review of the sponsor's response. Dr. De found that the sponsor's responses were reasonable. However, Dr. De recommended that the user would better understand the accuracy specification if it was presented as bias and variance rather than bias, precision, and accuracy as the sponsor proposed. Dr. Dr also recommended adding 95% confidence interval for bias and variance.

Interactive Review (9/25/2012 and 9/26/2012)

On September 25, 2012, this reviewer contacted the sponsor via telephone and email requesting changes to the promotional literature and statistical reporting of accuracy. The sponsor provided updated labeling on September 26, 2012.

The sponsor calculated bias and variance. However, this reviewer believes that the variance values maybe misleading. One of the issues with root-mean-squared method is that the overall variance value can be low if sufficient number of data points is close to the bias line. For the proposed device, a good amount of data points are near the bias line. However, there are noticeable outliers at higher minute volume and tidal volume measurements which the user should be aware of. Please note that the variability in the clinical data is within expectation for similar respiratory rate monitors. The previous labeling with precision and accuracy values provided better understanding of this variability in the clinical data. This reviewer consulted the ARDB branch on September 26, 2012. The general consensus was that the labeling with precision and accuracy values provided better understanding of the proposed device. The risk of misunderstanding is further mitigated by providing graphical line data directly in the labeling. Therefore, this reviewer requested that the sponsor revert back to the previous labeling with precision and accuracy values. The sponsor agreed and provided updated labeling in an email dated September 26, 2012.

XIV. Substantial Equivalence Discussion

	Yes	No	
1. Same Indication Statement?	X		If **YES** = Go To 3
2. Do Differences Alter The Effect Or Raise New Issues of Safety Or Effectiveness?			If **YES** = Stop **NSE**
3. Same Technological Characteristics?		X	If **YES** = Go To 5
4. Could The New Characteristics Affect Safety Or Effectiveness?		X	If **YES** = Go To 6
5. Descriptive Characteristics Precise Enough?		X	If **NO** = Go To 8 If **YES** = Stop **SE**
6. New Types Of Safety Or Effectiveness Questions?			If **YES** = Stop **NSE**
7. Accepted Scientific Methods Exist?			If **NO** = Stop **NSE**
8. Performance Data Available?	X		If **NO** = Request Data
9. Data Demonstrate Equivalence?	X		Final Decision: **SE**

Note: See http://eroom.fda.gov/eRoomReq/Files/CDRH3/CDRHPremarketNotification510kProgram/0_4148/FLOWCHART%20DECISION%20TREE%20.DOC for Flowchart to assist in decision-making process. Please complete the following table and answer the corresponding questions. "Yes" responses to questions 2, 4, 6, and 9, and every "no" response requires an explanation.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

1. *Explain how the new indication differs from the predicate device's indication:*

2. *Explain why there is or is not a new effect or safety or effectiveness issue:*

3. *Describe the new technological characteristics:*

The proposed device uses bioimpedance measurement to monitor respiratory rate. The predicate device uses spirometry.

4. *Explain how new characteristics could or could not affect safety or effectiveness:*

The fundamental technologies of various components in the proposed device are not new and have been cleared for similar respiratory monitoring in predicate devices. This reviewer believes the new characteristic could not affect safety or effectiveness because the sponsor can demonstrate that the bioimpedance measurement can adequately monitor respiratory rate.

5. *Explain how descriptive characteristics are not precise enough:*

The sponsor should verify and validate their performance specifications on human test subjects because the proposed device uses bioimpedance measurement. This reviewer is unaware of an adequate bench model for the proposed device. The sponsor should compare the proposed device to predicate device in a clinical study.

6. *Explain new types of safety or effectiveness question(s) raised or why the question(s) are not new:*

7. *Explain why existing scientific methods can not be used:*

8. *Explain what performance data is needed:*

9. *Explain how the performance data demonstrates that the device is or is not substantially equivalent:*

The sponsor conducted clinical study and validated their performance specification claims. Clinical data showed that the proposed device can adequately monitor respiratory rate with acceptable accuracy.

XV. Deficiencies

First Deficiencies

The following deficiencies were sent to the sponsor in an email on March 30, 2012.

1. You provided Indications For Use statement page in Section 4. However, you did not indicate whether your proposed device is prescription use or over-the-counter use. Please clarify and provide an updated Indications For Use statement page.

Adequate Response: The sponsor stated that the proposed device is prescription use only. The sponsor provided updated IFU statement page.

2. In Section 9 and 17, you stated that your proposed device will conform to standards and validation testing. Please be advised that we expect all testing to be completed prior to 510(k) clearance. Therefore, please provide completed test report and data on your proposed device in its final finished form.

Adequate Response: The sponsor provided complete EMC and electrical safety testing according to IEC 60601-1 and IEC 60601-1-2. The proposed device met all test requirements.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

B4 [redacted]

4. In Section 18, you stated that "Bench performance testing has focused on usability." However, you did not provide human factors study data. Please provide human factor study on your final finished product according to FDA recognized standard "AAMI / ANSI HE75:2009, Human factors engineering - Design of medical devices". Please provide all labeling and training programs for your proposed device.

Adequate Response: The sponsor provided usability test reports in Appendix 4-1. The sponsor stated that the purpose of usability study was to validate that the users did not have difficulty using the proposed device. This reviewer found that the 10 test subjects were able to complete the training and assigned tasks without reporting difficulties. This reviewer believes that the risk of misuse of the proposed device is low and the usability study validated that there were no difficulties using the proposed device.

Clinical

5. You have not provided sufficient information to evaluate potential limitations to the use or accuracy of the device with respect to clinical conditions or the presence of other equipment. Please address how issues of device function that may occur in the presence of very high or very low respiratory rates, morbid obesity, dehydration, anasarca, hypotension, and implanted or temporary neurostimulators or pacers. If there are other conditions or devices that may affect the performance of the device, please include them as well in your discussion. Please be aware that the adequacy of the clinical trial population cannot be assessed without such information.

Adequate Response: The sponsor provided clinical justification. Dr. Anh Nguyen provided clinical consult and did not identify additional questions for the sponsor. Please refer to his consult memo dated September 19, 2012 for detailed review.

6. Please provide clinical and statistical justification as to how your patient inclusion and exclusion criteria are representative of the entire intended patient population.

Adequate Response: The sponsor provided justification for patient inclusion and exclusion. Dr. Anh Nguyen provided clinical consult and did not identify additional questions for the sponsor. Please refer to his consult memo dated September 19, 2012 for detailed review. Dr. Arkendra De provided statistical consult and did not identify additional questions for the sponsor. Please refer to his consult memo dated September 20, 2012 for detailed review.

7. The clinical trial studied the device over a 24 hour period, but the device description does not provide information about the upper limits of duration of use of the electrode pads. Because testing should be done over the expected duration of use, please provide information about the upper limit of use of the electrode pads.

Adequate Response: The sponsor stated that the electrodes were cleared under K960968 for 72 hours of use duration. This reviewer believes that the cleared electrodes should be adequate for 24 hours of use.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

8. The Indications for Use statement does not specify an age range for intended use, but the clinical trial was conducted in subjects 20 years of age and older. Please modify the Indications for Use statement to indicate the age ranges for which the device may be used. If the age range is greater than that provided in the clinical testing, please be aware that additional testing may be needed to support the claim.

Adequate Response: The sponsor updated the IFU statement to state adult patients only.

9. The 20 patients were selected to represent various ethnicity, disease states, and BMI values, but you have not provided specific information. Please provide line data in tabular form for each subject with respect to the selection variables.

Adequate Response: The sponsor provided line data in Appendix 9-1 and 9-2. Dr. Arkendra De provided statistical consult and did not identify additional questions for the sponsor. Please refer to his consult memo dated September 20, 2012 for detailed review.

10. You have not provided a sample size justification for the 20 patient trial. Please provide a sample size justification.

Adequate Response: The sponsor provided statistical justification for the sample size. Dr. Arkendra De provided statistical consult and did not identify additional questions for the sponsor. Please refer to his consult memo dated September 20, 2012 for detailed review.

11. The analyses of percentage accuracy, precision, and bias of an unusually derived metric (natural log of the ratio of the device to the predicate measurements) are difficult to interpret clinically. Please provide an analysis of the results in terms of sensitivity, specificity, positive predictive values, and negative predictive value.

Adequate Response: The sponsor provided the requested statistical analysis. Dr. Arkendra De provided statistical consult and did not identify additional questions for the sponsor. Please refer to his consult memo dated September 20, 2012 for detailed review.

Statistical

12. On page 20-13, you stated that the factor day had no effect on the intra-class correlation coefficient. One of the limitations with the intra-class correlation coefficient is that "estimates (as with all correlation coefficients) are dependent on the range of the measuring scale; the wider the range, the better the result." (from Müller and Büttner Stat. in Med., Vol. 13, 2465-2476 (1994)). FDA conducted its own analysis using bootstrap of the absolute difference for minute ventilation and tidal volume. Numerical results from tables 6 and 7 on page 20-9 were used for the calculations. FDA analyses incorporated results at the subject level. Below are the results, all of which are statistically significant.

    - Accuracy between days 1 and 2 for minute ventilation: average absolute difference of 4.12%, with a 95% confidence interval of [3.10%, 5.55%]
    - Precision between days 1 and 2 for minute ventilation: 2.9% for the average absolute difference of precision with 95% confidence interval of [1.99%, 3.76%]
    - Accuracy between days 1 and 2 for tidal volume: average absolute difference of 4.105%, with 95% confidence interval of [2.73%, 5.63%]
    - Precision between days 1 and 2 for tidal volume: average absolute difference of 2.91%, with 95% confidence interval of [2.05%, 3.87%]

    In light of these results, it is unclear that the device performs comparably on different days, especially with respect to minute ventilation and tidal volume. Please comment on these results.

Adequate Response: The sponsor provided the requested statistical analysis. Dr. Arkendra De provided statistical consult and did not identify additional questions for the sponsor. Please refer to his consult memo dated September 20, 2012 for detailed review.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

13. On page 20-7, a three subject study is described which the ExSpiron is compared to the SpiroAir-LT in order to determine whether the graphical display can track respiratory curves accurately. Using only three subjects is a small sample size, rendering any generalizations to the entire intended use population questionable. Also, the SpiroAir-LT was used to calibrate the ExSpiron, which may introduce bias. It is also unclear that only the SpiroAir-LT will be used for calibration in routine clinical practice. In addition to addressing these concerns, please provide plots which superimpose the tracings from the SpiroAir-LT and ExSpiron on the same graph, with clear legends that clearly depict the device producing each tracing.

Adequate Response: The sponsor provided the requested statistical analysis. Dr. Arkendra De provided statistical consult and did not identify additional questions for the sponsor. Please refer to his consult memo dated September 20, 2012 for detailed review.

14. Please provide Bland-Altman plots comparing the ExSpiron against the Wright Respometer, separately for each subject and combined. Please see Bland and Altman The Lancet Volume 327, Issue 8476, 8 February 1986, Pages 307–310 for more information about Bland-Altman plots.

Adequate Response: The sponsor provided the requested statistical analysis. Dr. Arkendra De provided statistical consult and did not identify additional questions for the sponsor. Please refer to his consult memo dated September 20, 2012 for detailed review.

15. The calculation method used for quantifying the bias, precision, and accuracy (shown on page 20-5) is not a standard statistical method. Rather than using the logarithm scale, which could be difficult to interpret, please provide the bias, precision, and accuracy on the original raw measurement scale. If there are important medical or clinical decision points that are used in clinical practice, please incorporate these clinical decision points into the analysis of the ExSpiron against the predicate. These points can be incorporated by calculating sensitivity and false positive rate for the clinical study. To incorporate the correlated measurements (i.e. multiple measurements made on the same subject), please consider using bootstrap. For more information about bootstrap, please see Davison and Hinkley (1997) Bootstrap Methods and Their Application.

Adequate Response: The sponsor provided the requested statistical analysis. Dr. Arkendra De provided statistical consult and did not identify additional questions for the sponsor. Please refer to his consult memo dated September 20, 2012 for detailed review.

16. On page 20-3, you stated that 20 subjects were used for the clinical study. Please provide justification for this sample size. From a statistical perspective, it is difficult to understand why this is sufficient.

Adequate Response: The sponsor provided the requested statistical analysis. Dr. Arkendra De provided statistical consult and did not identify additional questions for the sponsor. Please refer to his consult memo dated September 20, 2012 for detailed review.

Second Deficiencies

The following deficiencies were sent to the sponsor in an email on September 20, 2012.

1. In your 510(k) Summary page, you stated that the Morgan Spirometer is the "gold standard". However, the Morgan Spirometer is not the "gold standard" because it cannot be used as a continuous monitor. Your proposed device is intended to be used as a continuous monitor. Thus Morgan Spirometer is not an appropriate direct comparator to your proposed device. Please remove your claim that the Morgan Spirometer is the gold standard from your submission. Please provide updated copies of 510(k) Summary page and labeling.

Adequate Response: The sponsor removed the term gold standard from the submission and provided updated documentation.

2. In your Indications For Use (IFU) statement, you stated that your proposed device can "monitor breathing in patients with potential respiratory compromise". However, your clinical study did not identify or evaluate

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

specific respiratory compromises in patients. Therefore, please remove the statement "with potential respiratory compromise" from your submission. Please provide updated IFU statement page, 510(k) Summary page, and labeling.

Adequate Response: The sponsor removed the statement from the submission and provided updated documentation.

3. In your Indications For Use (IFU) statement, you stated that the measurements from your proposed device are used "to determine respiratory status and appropriate therapy." However, your proposed device is a monitor and not a diagnostic device. In addition, you did not provide clinical study that evaluates how the user used your proposed device to determine respiratory status and appropriate therapy. Therefore, please remove the statement "to determine respiratory status and appropriate therapy" from your submission. Please provide updated IFU statement page, 510(k) Summary page, and labeling.

Adequate Response: The sponsor removed the statement from the submission and provided updated documentation.

4. You provided promotional claims in Appendix 4-5. However, you made clinical claims about your proposed device without providing supporting evidence from your clinical study. Therefore, please remove the clinical claims identified below from your promotional claims. Please provide updated promotional claims for review.

   a. You stated that "ExSpiron can monitor breathing in adult patients with respiratory compromise or potential respiratory compromise." However, your clinical study did not identify or evaluate specific respiratory compromises in patients.

   b. You stated that "ExSpiron assists in monitoring at-risk patients in near real-time." However, your clinical study did not identify or evaluate specific at-risk patients.

   c. You stated that "ExSpiron helps improve the standard of respiratory monitoring because it displays MV, TV, and RR over time." However, your clinical study did not evaluate how your proposed device improved the standard of respiratory monitoring.

   d. You stated that "ExSpiron can help physicians identify patients with inadequate breathing." However, your clinical study did not evaluate how your proposed device helped care providers identify patients with inadequate breathing.

   e. You stated that "ExSpiron can assist physicians' decision-making by providing respiratory status data." However, your clinical study did not evaluate how your proposed assisted care providers in their decision making process.

Adequate Response: The sponsor removed the statements from the submission and provided updated documentation.

5. In your promotional claims in Appendix 4-5, you stated that "ExSpiron is easy to use." You conducted usability testing on 10 test subjects. However, the test reports provided limited granularity regarding user task performance and limited user commentary regarding ease of use. Therefore, please remove the claim "easy to use" from your submission. Please provide updated promotional claims.

Adequate Response: The sponsor removed the statement from the submission and provided updated documentation.

Interactive Review: Third Deficiencies

The following deficiencies were sent to the sponsor in an email on September 21, 2012.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

1. On page 36 of Supplement 2, you provided a table depicting bias and accuracy. Based on Appendix 17-2 of Supplement 1, accuracy is defined as mean squared error. Traditionally, in medical testing, accuracy refers to the closeness of the measurement to the truth (reference standard). Mean squared error incorporates both bias and variance, and variance is thought of as precision in medical testing. Precision is thought of a completely separate concept (separate from accuracy) in medical testing. To avoid confusion in interpretation by end users of the ExSpiron device, please convert the measures of "accuracy" depicted in this table to variance, using the following equation:

   Mean Squared Error = Variance + $(\text{Bias})^2$.

   The bias has already been calculated by the sponsor, and all that is needed to calculate the variance is to calculate the difference between Mean Squared Error and $(\text{Bias})^2$.

Adequate Response: The sponsor calculated the variance and updated the labeling. However, this reviewer believes that the variance values maybe misleading. One of the issues with root-mean-squared method is that the overall variance value can be low if sufficient number of data points is close to the bias line. For the proposed device, a good amount of data points are near the bias line. However, there are noticeable outliers at higher minute and tidal volume measurements which the user should be aware of. Please note that the variability in the clinical data is within expectation for similar respiratory rate monitors. The previous labeling with precision and accuracy values provided better understanding of this variability in clinical data. This reviewer consulted the ARDB branch on September 26, 2012. The general consensus was that the labeling with precision and accuracy values provided better understanding of the proposed device. The risk of misunderstanding is further mitigated by providing graphical line data directly in the labeling. Therefore, this reviewer requested that the sponsor revert back to the previous labeling with precision and accuracy values. The sponsor agreed and provided updated labeling in an email dated September 26, 2012.

2. On page 36 of Supplement 2, results for specific metrics have been depicted, but no 95% confidence intervals for these metrics have been presented. Please provide 95% confidence intervals for the bias and variance, so that the sampling variability of these metrics can be incorporated. Please update your labeling with this information. Bootstrap could be used to calculate the 95% confidence intervals for bias and variance. Please see Davison and Hinkley (1997) *Bootstrap Methods and Their Application* for more information.

Adequate Response: Please refer to comments for deficiency number 1. 95% confidence interval is not required for the precision and accuracy values.

3. On page 33 of Supplement 2, you provided a table comparing the ExSpiron to the Wright device. This table presents both precision and accuracy. Since accuracy is quantified through mean squared error, and mean squared error incorporates precision, it might be confusing to end users of the ExSpiron device who see the accuracy numbers in the table, since variance is the traditional measure of precision, and accuracy is traditionally thought of as a separate concept from precision. Thus, it suffices to just depict bias and variance. Please modify this table so that bias and variance are depicted instead of bias, precision, and accuracy.

Adequate Response: Please refer to comments for deficiency number 1.

4. For the ExSpiron-Wright clinical study, please provide 95% confidence intervals for the bias and variance, so that the sampling variability of these metrics can be incorporated. Bootstrap could be used to calculate the 95% confidence intervals for bias and variance. Please update your labeling with this information. Please see Davison and Hinkley (1997) *Bootstrap Methods and Their Application* for more information.

Adequate Response: Please refer to comments for deficiency number 1. 95% confidence interval is not required for the precision and accuracy values.

5. In your promotional claims in Appendix 4, you stated that "ExSpiron provides objective data about respiratory status that may facilitate better patient care." However, your clinical study did not quantify or evaluate how your proposed device may facilitate better patient care. The users will already be aware that they are

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monitoring patient's respiratory status with your propose device. Therefore, please remove the statement "that may facilitate better patient care." Please provide updated promotional claims.

Adequate Response: The sponsor removed the statements from the submission and provided updated documentation.

XVI. Contact History

Contact history with the sponsor is shown in Table 2.

Table 2 - Contact History

Contact Type	*Date*	*Sponsor's Response*	*Note*
Email	March 30, 2012	***September 14, 2012***	First Deficiency Letter
Email	September 20, 2012	***September 21, 2012***	Second Deficiency Letter
Email	September 25, 2012	***September 26, 2012***	Interactive Review about labeling
Email	September 26, 2012	***September 26, 2012***	Interactive Review about labeling

XVII. Recommendation

I recommend that the file be determined substantially equivalent to the predicate device.

The sponsor provided clinical data which demonstrated that the proposed device was safe and effective according to its proposed indications for use.

Regulation Number: 21 CFR 868.2375
Regulation Name: Breathing frequency monitor
Regulatory Class: Class II
Product Code: BZQ, BZK

Chan Lee — September 26, 2012 Date

for Dr. Lex Schultheis, ARDB Branch Chief — September 26, 2012 Date

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DEPARTMENT OF HEALTH & HUMAN SERVICES Public Health Service

Division of Anesthesia, General Hospital, Infection Control, and Dental Products (DAGID)
Anesthesia and Respiratory Devices Branch (ARDB)
Center for Devices and Radiation Health
Food and Drug Administration
Silver Spring, MD 20993 Tel: 301 796 5580 Fax: 301 796 8109

RESPONSE TO CONSULT REQUEST

Date: Wednesday, September 19, 2012

From: Anh Nguyen, M.D., MBA, ODE/DAGID/ARDB

To: Chan Lee, Lead Reviewer, ODE/DAGID/ARDB

Re: 510(k) Application: K120087 / S001 -ExSpiron
Respiratory Motion, Inc.

Device Name:
ExSpiron Respiratory Monitor

Proposed Indication For Use:
"ExSpiron™ is indicated for use by healthcare professionals in healthcare facilities, such as post-operative care and critical care units, to monitor breathing in adult (at least 21 years old) patients with potential respiratory compromise.

ExSpiron™ is a non-invasive system that graphically displays lung volume against time and reports an approximate value of:
• Tidal volume,
• Respiratory rate, and
• Minute ventilation

ExSpiron™ measurements are used as an adjunct to other clinical information sources to determine respiratory status and appropriate therapy."

Question:
Evaluate the Sponsor's responses to FDA questions received to DMC 9/14/2012.

Summary Recommendations:
Performance validation in terms of accuracy and precision to measure respiratory parameters such as 1) respiratory rate, 2) tidal volume, and 3) minute ventilation, has been the large concern throughout the entire review of this premarket application. In Pre-IDE discussion, the Wright spirometer was accepted as a clinical reference standard. The Wright spirometer is prone to have 20% error. Further testing was performed to

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demonstrate equivalence between the Wright spirometer and the Morgan spirometer. The testing demonstrated similar results. Compared to both the Wright and Morgan, the Exspiron device has tested with approximately 10% error. Combined, the Exspiron has a potential for 32% error (1.2 x 1.1) compared to actual. This degree of error can mask acute clinical concerns during active patient care.

This risk for error with the Exspiron is greater than measurement tools within mechanical ventilators. Electromagnetic valves within ventilators have a degree of precision in the order of 5% compared with measured values (data from Hamilton Medical). Flow measurements have a precision of < 10%. The volume values reported by the ventilators can thus vary from 50 to 100 ml for a set tidal volume of 1,000 ml.

The proposed device does not have alarms. However, it is unclear if such alarms would be useful in the proposed device, because the potentially high error rate can mask relevant clinical signs. A device with a potential 30% error rate would need further performance data to justify clinical claims. This 510(k) application has been reviewed in the context of only a tool-based claim (trend monitor).

Promotional labeling for clinical claims are to be excluded at this time.

Labeling for "ease-of-use" should be excluded at this time, because the usability test reports currently appear inadequate regarding their resolution to assess that factor.

Executive Summary:

B4

[redacted]

The review team recommended a file hold in March 2012, because of multiple clinical and statistical deficiencies.

In May, a response was submitted, but FDA rejected it because it inappropriately requested to change from a Traditional 510(k) to an Abbreviated 510(k). This September response replaces the May response in total. This response includes material from the May response that has not changed, additional material added based on conversations with FDA reviewers, and some material that has changed from the May response.

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Materials Reviewed:

1. Sponsor responses September 13, 2012

Review:

***Tool-based Claims:*
Page 10 Submission Materials:
"Because ExSpiron is intended to monitor, not to diagnose, the study's purpose is to demonstrate that ExSpiron's measurement performance is comparable to a clinically viable predicate device. The inclusion/exclusion criteria provide a broad sampling of subjects over which to demonstrate measurement performance."

Page 13 Submission materials:
"Sensitivity, specificity, positive predictive value, and negative predictive value are meaningful in terms of diagnosis. The ExSpiron's intended use is monitoring of respiratory measurements to be used as an adjunct to other clinical information. An analysis of diagnostic power is not consistent with the intended use."

From IFU:
"ExSpiron is indicated for use by healthcare professionals in healthcare facilities, such as post-operative care and critical care units, to monitor breathing in patients with potential respiratory compromise.

ExSpiron is a non-invasive system that graphically displays lung volume against time and reports an approximate value of:
• Tidal volume,
• Respiratory rate, and
• Minute ventilation.

ExSpiron measurements are used as an adjunct to other clinical information sources to determine respiratory status and appropriate therapy."

Reviewer Comment:
The Sponsor should explicitly label the device within its tool-based context.
This tool-based claim is seen, as per the Sponsor response as well as previous discussion in teleconference. The IFU will require revision to remove implied clinical claims.

- The phrase in IFU: "*monitor breathing in patients with potential respiratory compromise,*" should be removed.
- The phrase "*to determine respiratory status and appropriate therapy,*" should be removed.

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**Page 3 Submission Materials:

4. *In Section 18, you stated that "Bench performance testing has focused on usability." However, you did not provide human factors study data. Please provide human factor study on your final finished product according to FDA recognized standard "AAMI / ANSI HE75:2009, Human factors engineering - Design of medical devices". Please provide all labeling and training programs for your proposed device.*

At the time of the original 510(k), the usability testing had been used to determine usability requirements. Usability requirements were included in the System Requirements. User Error hazards were included in the Risk Management Plan (pages 16-7 and 16-8 of the original submission). The usability requirements and user error hazards were reviewed to develop the usability validation protocol and test record form in Appendix 4-1.

Technical usability content is found in the User Manual (Appendix 4-2). The Training Outline
(Appendix 4-3) describes the training performed by RMI authorized personnel.

Final usability validation was performed at RMI's clinical test facility. Test users, who did not have previous experience with ExSpiron, included:

- 5 Anesthesiologists
- 1 Cardiothoracic surgeon
- 1 Critical care physician
- 2 ICU nurses
- 1 ER nurse

Test results showed no difficulties or failures with the final ExSpiron device and training. The ease of use results from use similarities with other common monitoring devices, a user interface designed to match typical user workflow, and documentation and training that address unique ExSpiron features. The ten test reports are provided in Appendix 4-4.

Promotional claims are listed in Appendix 4-5.

Reviewer Comment:
The data exhibited within the test report only has 10 users, instead of 15 as recommended by the Human Factors Guidance. The 3 criteria used to assess ease of use or task performance (OK, Failure, Difficulty) is nonspecific. Also there was no participant comment. Though all the forms in test report appendix 4-4 stated "OK", it does not signal necessarily that the device is "easy to use."

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The promotional labeling regarding ease-of-use should be removed. It is unclear to me if the human factors testing is performed correctly.

**Promotional Labeling (Appendix 4-5):

- ExSpiron can monitor breathing in adult patients with respiratory compromise or potential respiratory compromise.
- ExSpiron assists in monitoring at-risk patients in near real-time.
- ExSpiron is non-invasive, point-of-care, and quantitative.
- ExSpiron provides quantitative measurement of:
  - Minute Ventilation (MV)
  - Tidal Volume (TV)
  - Respiratory Rate (RR)
- ExSpiron can measure MV, TV, and RR in non-ventilated patients.
- ExSpiron displays measurement values both numerically and graphically, displaying trend data.
- ExSpiron can quantify a patient's respiratory status and provide trending data in their respiratory parameters.
- MV, TV, and RR are important parameters for assessment of respiratory status. ExSpiron helps improve the standard of respiratory monitoring because it displays MV, TV, and RR over time. Changes in values over time can be compared.
- ExSpiron can help physicians identify patients with inadequate breathing.
- ExSpiron reports measurement in a user-friendly format.
- ExSpiron can assist physicians' decision-making by providing respiratory status data.
- ExSpiron is easy to use.

Reviewer Comment:
The proposed device is intended with a tool-based claim. Promotional labeling regarding improvement in clinical care, diagnostic potential, use with at-tick patients should be removed. The ease-of-use claim, without a valid human factors study, may not be justified.

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***Page 132 Submission Material (Wright spirometer and Morgan spirometer):*

The Wright spirometer was found to have accuracy with respect to the gold standard consistent with the
Wright spirometer's accuracy of 3-4%, claimed in its 510(k) Summary and labeling. Data for the Wright- Morgan comparison study, including Bland-Altman charts, are found in Appendix B. The table below shows the measurement performance results of the two studies and calculated measurement performance for the ExSpiron monitor compared to the gold standard Wright spirometer. The calculations for the calculated measurement performance results are described in Appendix C.

	Bias	Accuracy
ExSpiron – Wright (original 510(k) study)	2.1%	10.7%
Wright – Morgan (gold standard study)	0.4%	3.9%
ExSpiron – Morgan (calculated per Appendix C)	-1.7%	9.9%

Reviewer Comment:
The Sponsor has provided additional performance data describing similarity between the Morgan and the Wright spirometers. In previous Pre-IDE discussion, the Wright was allowed to be used a reference standard, though it is a "point-in-time" monitor, compared to the proposed device, which is a "continuous monitor."

The better reference standard would have been a predicate *which is also a continuous monitor, that has clinical utility.* A tidal volume monitor within a mechanical ventilator is used for clinical evaluation such as mechanical ventilator setting adjustment, wean, and extubation. As a reference standard, it would have allowed better resolution regarding the dynamic range of the device, and demonstrated clear clinical meaningfulness. The error rate on a mechanical ventilator is less than 10%, which is advantageous in the context of its ability to be a continuous monitor.

The Sponsor has provided additional demonstrating equivalence between ExSpiron and both the Wright at Morgan devices. This performance data would be sufficient only for tool-based claims.

Deficiencies noted:

1. Intended Use: As per discussion and within your responses, the Exspiron is intended to monitor, and not to diagnose. As a trend monitor, your proposed device has a tool-based claim. Please revise your labeling to remove clinical claims (direct or implied) within your Indication For Use. Specifically, please revise the IFU labeling:

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a. removing "*monitor breathing in patients with potential respiratory compromise,*" and
b. removing "*to determine respiratory status and appropriate therapy.*"

2. You have provided draft promotional labeling information for your device in Appendix 4-5 of the September 13 submission. Please remove the clinical claims (direct and implied) within this and all labeling. Please provide revised versions of your labeling for further review. Specifically, the following claims should be removed within the submitted promotional literature:

   a. ExSpiron can monitor breathing in adult patients with respiratory compromise or potential respiratory compromise.

   b. ExSpiron assists in monitoring at-risk patients in near real-time.

   c. MV, TV, and RR are important parameters for assessment of respiratory status. ExSpiron helps improve the standard of respiratory monitoring because it displays MV, TV, and RR over time. Changes in values over time can be compared.

   d. ExSpiron can help physicians identify patients with inadequate breathing.

   e. ExSpiron can assist physicians' decision-making by providing respiratory status data.

3. You have provided usability validation by providing data from 10 users. The test reports provided provide limited granularity regarding user task performance, as well as very limited user commentary regarding ease of use. However promotional labeling states, "ExSpiron is easy to use." Please provide further performance data regarding usability, justifying this claim.

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B4, B5

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Date: June 21, 2012
From: Arkendra De, Mathematical Statistician, OSB/DBS/DDB
To: Chan Lee, Electrical Engineer, ODE/DAGID/ARDB
Subject: Statistical Review of 510(k) K120087/S001, ExSpiron by Respiratory Motion, Inc.

The sponsor submitted a response to FDA's letter in May 2012. Please see the review from January 27, 2012 for more information. Below are the statistical deficiencies identified earlier and the sponsor's response. Below is the reviewer's response to the sponsor's responses.

10. You have not provided a sample size justification for the 20 patient trial. Please provide a sample size justification.
The intended use for the ExSpiron is monitoring of respiratory measurements: TV, MV, and RR. RMI's clinical study was to demonstrate that ExSpiron's measurement performance is comparable to a clinically viable predicate device.
Sample size can be justified indirectly by the use of descriptive statistics and figures such as Figure 5.1 or by setting up an appropriate hypothesis test and then calculating the statistical power for the test. RMI chose the size of the subject group to be 20 to demonstrate (with 90% power) that the accuracy and precision of ExSpiron is within 20% of the predicate device. In fact, with 20 subjects the study demonstrates (by the equivalence test described below) that the measurements from the two devices are within 15% of each other.
Overview of sample size justification
The sample size justification is based on a power calculation for an equivalence test. The calculation is done for both the familiar definition of relative error (RE) and the log(accuracy) that closely approximates RE for values of RE near zero. The twenty repeated measures per subject are autocorrelated and not independent. Thus, to calculate power, we need to compute the variance inflation factor (VIF) for autocorrelated data. For the 20 subjects studied, each with 20 autocorrelated repeated measures, the 400 = 20*20 observations are equivalent to 57 independent observations.
Definition of an equivalence test
Typically, a hypothesis test rejects the null hypothesis of *equal* means to establish the alternative hypothesis that the means differ. To show that the devices are alike, an equivalence test reverses matters with a null hypothesis that device means differ and an alternative hypothesis of 'no difference' between measurement devices. The null hypothesis asserts that the devices differ by an amount B or more where B is pre-specified by context experts. The test procedure is to construct an interval, (L,U), a 95% CI about the observed difference of means, d, and see whether or not the interval lies within a pre-specified interval [-B, B] as pictured below.

```
-----------|-------------------(----0----d---------)---------|-------
        -L B                                          U B
```

Let s be the estimated standard deviation of the observed difference, d. Then (L, U) = (d – 1.96*s, d + 1.96*s). The equivalence test rejects the null hypothesis and favors the alternative hypothesis of equivalence if the interval (L, U) falls entirely inside the interval from –B to B.

The effective sample size of 57 independent observations
The 20 repeated measures collected from each subject are autocorrelated with common adjacent-term correlation r = 0.8, the value of same in RMI's data. The variance inflation factor (derived in Appendix 10.1 Derivation of the Variance Inflation Factor (VIF)) is 7.02. This means that the twenty dependent observations per subject have the same variance as about 20/7 ~ 3 independent observations per subject. Thus, the effective sample size (ESS) is:
20 X 20 / 7.02, which is about 57.

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The 400 measurements obtained (20 subjects x 20 measurements) are equivalent to 57 uncorrelated observations on each device.

From formula 3.19 in Chow et al. ("Sample Size Calculations in Clinical Research" by Shein-Chung Chow, Hansheng Wang,), Jun Shao, Chapman & Hall/CRC Biostatistics Series,2003, the paired-difference equivalence test power formula is:

$$ESS = \frac{(z_\alpha + z_\beta)^2 \sigma^2}{(B-\delta)^2}$$

To obtain a two sided alternative with 90% power, RMI sets $z_\alpha = 1.96$, and $z_\beta = 1.65$. To ensure the two measurements are within 10% of each other, RMI sets $\delta = 0.1$. The limits for B are calculated as follows:

$$ESS = \frac{(z_\alpha + z_\beta)^2 \sigma^2}{(B-\delta)^2} \Leftrightarrow (B-\delta)^2 = \frac{(z_\alpha + z_\beta)^2 \sigma^2}{ESS}$$

$$\therefore |B-\delta| = \sqrt{\frac{(z_\alpha + z_\beta)^2 \sigma^2}{ESS}}$$

$$\therefore |B-0.1| \approx 0.05$$

$$\therefore B \approx [0.05, 0.15]$$

This result indicates that with 20 subjects and 20 measurements per subject RMI can demonstrate (with 90% power) if the difference in the measurements between ExSpiron and the predicate device is less than 5% or greater than 15%. Then analysis indicates that on average ExSpiron's measurements are likely to be less than 15% different from the predicate device's measurement.

Reviewer's Comment to ODE for item 10: The sponsor assumes in their samples size calculation that if their device is within 20% of the predicate, then this is acceptable. Whether this is acceptable clinically is for ODE to decide. The sample size calculation is appropriate if their assumption is clinically plausible.

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Statistical

12. On page 20-13, you stated that the factor day had no effect on the intra-class correlation coefficient. One of the limitations with the intra-class correlation coefficient is that "estimates (as with all correlation coefficients) are dependent on the range of the measuring scale; the wider the range, the better the result." (from Müller and Büttner Stat. in Med., Vol. 13, 2465-2476 (1994)). FDA conducted its own analysis using bootstrap of the absolute difference for minute ventilation and tidal volume. Numerical results from tables 6 and 7 on page 20-9 were used for the calculations. FDA analyses incorporated results at the subject level. Below are the results, all of which are statistically significant.

- Accuracy between days 1 and 2 for minute ventilation: average absolute difference of 4.12%, with a 95% confidence interval of [3.10%, 5.55%]
- Precision between days 1 and 2 for minute ventilation: 2.9% for the average absolute difference of precision with 95% confidence interval of [1.99%, 3.76%]
- Accuracy between days 1 and 2 for tidal volume: average absolute difference of 4.105%, with 95% confidence interval of [2.73%, 5.63%]
- Precision between days 1 and 2 for tidal volume: average absolute difference of 2.91%, with 95% confidence interval of [2.05%, 3.87%]

In light of these results, it is unclear that the device performs comparably on different days, especially with respect to minute ventilation and tidal volume. Please comment on these results.

Regarding the FDA analyses presented in this question: RMI respectfully disagrees with the conclusions and points out an issue in the analyses. Two analyses are presented below, one that illustrates that the more appropriate day measure is average difference and one that shows that the factor day is unrelated to accuracy.

Average Difference

When evaluating the difference in respiratory rate (RR) accuracy (this can be extended to TV and MV and to precision instead of accuracy) between Day 1 (RR_{Day1}) and Day 2 (RR_{Day2}) the reviewer computed the *average absolute difference*:

$$\frac{\sum_{N}(|RR_{Day1} - RR_{Day2}|)}{N} \text{ (Eq. 1)}$$

RMI believes the proper calculation is the *average difference*:

$$\frac{\sum_{N}(RR_{Day1} - RR_{Day2})}{N} \text{ (Eq. 2)}$$

The absolute difference is rarely, if ever, different. In fact, zero is an extreme value. The following example illustrates how absolute value may introduce positive bias, not otherwise present in the data.

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Assuming a population of two subjects (A and B) and two accuracy measurements for each subject on each day ($\{A_{Day1}, A_{Day2}\}$ and $\{B_{Day1}, B_{Day2}\}$), suppose that $A_{Day2} = A_{Day1} + \alpha$ and $B_{Day1} = B_{Day2} - \alpha$. In this contrived example, RMI postulates that the accuracy for subject 1 decreased from Day 1 to Day 2 by α, while the accuracy for subject 2 increased from Day 1 to Day 2 by the same amount. This example was chosen such that on average (across A and B only), there is zero change in accuracy from Day 1 to Day 2. However, Equation 1 is used to calculate the average absolute difference, there is a non-zero result, in fact, a change in accuracy equal to α):

$$\frac{\sum_N(|RB_{Day1} - RB_{Day2}|)}{N} = \frac{|A_{Day1} - A_{Day2}| + |B_{Day1} - B_{Day2}|}{2} = \frac{|A_{Day2} + \alpha - A_{Day2}| + |B_{Day2} - \alpha - B_{Day2}|}{2}$$

$$= \frac{|\alpha| + |-\alpha|}{2} = \alpha$$

Repeating the reviewer's bootstrap-based analysis (with 1000 iterations) using Equation 2 instead of Equation 1, RMI calculates:

- Accuracy between days 1 and 2 for minute ventilation: average difference of -0.77%, with a 95% confidence interval of [-3.04%, 1.51%]
- Precision between days 1 and 2 for minute ventilation: -0.04% for the average difference of precision with 95% confidence interval of [-1.65%, 1.56%]
- Accuracy between days 1 and 2 for tidal volume: average difference of -1.22%, with 95% confidence interval of [-3.50%, 1.05%]
- Precision between days 1 and 2 for tidal volume: average difference of -0.14%, with 95% confidence interval of [-1.78%, 1.51%]
- Accuracy between days 1 and 2 for respiratory rate: average difference of 0.47%, with 95% confidence interval of [-0.51%, 1.44%]
- Precision between days 1 and 2 for respiratory rate: average difference of 0.35%, with 95% confidence interval of [-0.44%, 1.14%]

These results show no effect of day on the accuracy or precision of the ExSpiron. See Appendix 12-1 for details of the bootstrap analysis. The last page of Appendix 12-1 contains bootstrap analysis results using the original equation (Eq. 1) and the corrected one (Eq. 2).

Testing the Factor DAY as a Predictor of Accuracy

RMI has directly modeled accuracy from the 400 pairs, each pair consisting of the two measurements, one for each device. The outcome y is then the paired difference divided by the predicate measurement. RMI repeated the analysis with the log(ratio) definition of y. Previously RMI had modeled the raw data, including device as a factor, and reported the intra-class correlation coefficient, ICC, as a summary measure of accuracy. RMI never claimed that day was not a factor in predicting raw values, but only that any such day-difference had no effect on accuracy. In particular, RMI showed that raw-data models including or excluding the factor DAY had negligible effect on the estimate of the ICC. RMI made no major assertions about whether or not the factor DAY was significant.

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The basic model has outcome variable RE and one predictor variable, day. The two measurements of interest were MV and TV because, as shown above, the standard deviation of RE for the variable, RR, was very small, 0.02, and accuracy is very high. RMI assumed autocorrelated measures within each subject-day and invoke the Kenward-Roger option recommended in the SAS documentation for small sample size.

REFERENCE

(Kenward, M. G. and Roger, J. H. (1997), "Small Sample Inference for Fixed Effects from Restricted Maximum Likelihood," *Biometrics* 53: 983-997 and Littell, R. C., Milliken, G. A., Stroup, W. W., and Wolfinger, R. D.(1996), *SAS System for Mixed Models*. SAS Institute Inc.: New York).

To check the results we reran the models using the 'empirical option' that invokes the sandwich estimator that to obtain more robust estimates.

REFERENCE

(Linear Mixed Models for Longitudinal Data by Geert Verbeke and Geert Molenbergs Springer 2000 NY section 6.2.4).

Sample SAS code appears in Appendix 12-2 SAS Code for Mixed Model.

Relative error is unrelated to the factor 'day'. For the outcome RE(MV) the unadjusted analysis, Kenward-Rogers analysis, and empirical-option analyses assigned p-values to the factor 'day' from 0.71 to 0.79. For RE(TV) the analogous p-values were 0.96 to 0.98. For the outcome log(accuracy) for MV the p-values ranged from 0.75 to 0.82 and for TV from 0.90 to 0.92.

13. On page 20-7, a three subject study is described which the ExSpiron is compared to the SpiroAir-LT in order to determine whether the graphical display can track respiratory curves accurately. Using only three subjects is a small sample size, rendering any generalizations to the entire intended use population questionable. Also, the SpiroAir-LT was used to calibrate the ExSpiron, which may introduce bias. It is also unclear that only the SpiroAir-LT will be used for calibration in routine clinical practice. In addition to addressing these concerns, please provide plots which superimpose the tracings from the SpiroAir-LT and ExSpiron on the same graph, with clear legends that clearly depict the device producing each tracing.

The short study's purpose is only to provide a reasonable validation that ExSpiron's graphical display of time plots works appropriately.

Reviewer's Comment to ODE for Item 12: Using the average of absolute differences assumes that the negativity or positivity of the difference does not matter. The usual average used by the sponsor assumes that negativity or positivity of the difference matters, where positive differences are reduced by negative differences. If the difference, regardless of sign, is clinically relevant, then the absolute difference is appropriate. On the other hand, if the sign and magnitude of the difference are clinically relevant, then the difference (usually computed difference) is appropriate. Which metric is clinically relevant is up to ODE to decide.

Reviewer's Comment to ODE for Item 13: The sponsor states a three subject study for the validation of the graphical display is "reasonable." There is no statistical basis for this assertion, so it is up to ODE to decide whether this is "reasonable."

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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14. Please provide Bland-Altman plots comparing the ExSpiron against the Wright Respirometer, separately for each subject and combined. Please see Bland and Altman The Lancet Volume 327, Issue 8476, 8 February 1986, Pages 307–310 for more information about Bland-Altman plots.

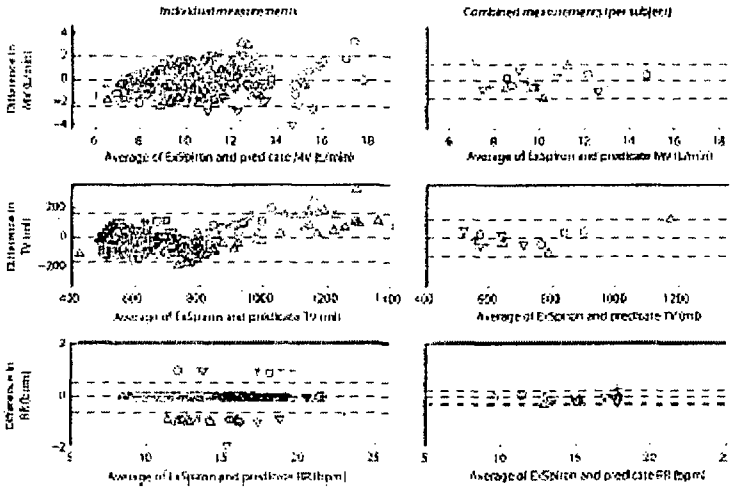

Figure 14-1 Bland-Altman Plots

RMI performed a Bland-Altman analysis of the clinical trial data in the standard fashion, following the guidelines in the Lancet 1986 article. The analyses confirmed that for all three measures the differences between the predicate and ExSpiron are small. The Bland-Altman analyses are consistent with the original analysis in section 20 of RMI's 510 (k). The average disparity between ExSpiron and the predicate device was confirmed to be small and clinically irrelevant (differences of -0.2 bmp, -5ml and -0.14 L/min for RR, TV, and MV, respectively).

RMI calculated the difference between ExSpiron and the predicate device for each measure (MV, TV, and RR) and the average of ExSpiron and the predicate for each measure. Figure 1- shows the resulting plots. Data from different subjects are depicted with a different color/sym combination (i.e. blue plus sign is one subject, cyan plus sign in another subject, blue circle is third subject, etc.). The left column shows individual data from all subjects and from all trials whereas the right column shows each subject's averaged data. The middle black dashed line c each plot depicts the average difference and the upper and lower black dashed lines indicate th 95% confidence intervals (±2 SD from the mean). Note that the mean differences between devices in all six plots are essentially zero.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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The bottom row shows the measurement difference in respiratory rate (RR). The left chart shows that the majority of the readings are perfectly accurate (difference of 0) and in only 1 trial out of 400 there is a difference between devices of 2 breaths/min. The right chart shows that the averaged measurements are even more similar between the two devices. 95% of the measurement differences are within the range of (-0.27 and 0.22) breaths/min.

The middle row shows the differences in tidal volume (TV) between ExSpiron and the predicate. On the left the individual differences are, on average, off by -5.0 ml (ExSpiron overestimates TV by 5 ml). Note that the 95% of the differences are in the range of (-172 and 162) ml and that this range is enlarged by the relatively larger disparities measured at large TV (greater than 1000ml). While the reported ExSpiron tidal volume measurements are within the clinically acceptable range, in fact, for the more clinically relevant portion of data, 550 ml to 1050 ml (see Lugo G, Castaneda-Hernandez G. Critical care medicine 1997;25 (5) 806-811), the 95% range is even better (-151 and 114 ml). This range is further improved in the averaged data (right middle panel), showing that 95% of the differences measured are within (-129 and 119 ml). Once again, the largest differences occur at the largest TVs. It is likely that these unusually large tidal volumes were the result of the subject being asked to breathe into the predicate device spirometer for the rest.

The top row shows the differences in minute ventilation (MV), which is the product of TV and RR. As such, it is not surprising that the MV disparity is somewhat larger than the RR and TV (the error in MV is affected by errors in both RR and TV). Nevertheless, on average ExSpiron underestimates MV by only 0.14 L/min (140 ml/min). Note that the largest errors are seen at large minute volumes (12-18 L/min) associated with the unusually large tidal volumes described above.

15. The calculation method used for quantifying the bias, precision, and accuracy (shown on page 20-5) is *not* a standard statistical method. Rather than using the logarithm scale, which could be difficult to interpret, please provide the bias, precision, and accuracy on the original raw measurement scale. If there are *important medical or clinical decision points that are used in clinical practice*, please incorporate these clinical decision points into the analysis of the ExSpiron against the predicate. These points can be incorporated by calculating sensitivity and false positive rate for the clinical study. To incorporate the correlated measurements (i.e. multiple measurements made on the same subject), please consider using bootstrap. For more information about bootstrap, please see Davison and Hinkley *(1997) Bootstrap Methods and Their Application.*

As requested, the statistical analysis has been repeated using a Bland-Altman difference error measure, not the logarithm scale. See Appendix 15-1 Statistical analysis of bias, precision, and accuracy.

Figure 15-1 shows a summary comparison of measurement performance as determined by the Bland-Altman analysis and by the logarithm-based analysis in the original submittal. The results and conclusions of the studies, with the Bland-Altman error variable and with logarithm variable error are virtually identical.

	Log based analysis			Bland-Altman analysis		
	Absolute bias	Precision	Accuracy	Absolute bias	Precision	Accuracy
MV	6.4	7.5	10.2	6.4	7.5	10.1
TV	6.3	7.3	9.9	6.4	7.2	9.9
RR	0.5	1.4	1.5	0.5	1.4	1.5

Figure 15-1
Summary Comparison of Log-based analysis and Bland-Altman analysis

Reviewer's Comment to ODE for items 14 and 15: The sponsor's response is acceptable.

Conclusion

Please see the above comments regarding the sponsor's response.
If there are any questions, please contact me via phone: 301-796-6009 or e-mail: arkendra.de@fda.hhs.gov.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Lee, Chan

From: Jenny E. Freeman [jenny.freeman@respiratorymotion.com]
Sent: Wednesday, September 26, 2012 3:17 PM
To: Lee, Chan; 'Chas Burr'
Cc: 'Jenny Freeman'; 'Jordan Brayanov'
Subject: RE: Response to email questions re RMI's K120087 510(k)

Chan,

We confirm that our final User Manual, promotional claims, and 510(k) Summary page will be as recommended in your e-mail below.

Jenny E. Freeman, M.D.
781-760-5569
jfreeman@respiratorymotion.com

From: Lee, Chan [mailto:Chan.Lee@fda.hhs.gov]
Sent: Wednesday, September 26, 2012 2:36 PM
To: Chas Burr
Cc: Jenny Freeman; Jordan Brayanov
Subject: RE: Response to email questions re RMI's K120087 510(k)

Chas,

Thank you for your response. The review team considered the updated labeling and found that the bias and variance values may not best represent the accuracy of your proposed device to the user. The review team recommends that the labeling and 510(k) Summary from your response letter dated September 20, 2012 should be your final documentation. Please note that the updated promotional claims in Appendix 3 should be your final documentation.

Since we already have your User Manual and 510(k) Summary page in your response letter dated September 20, 2012 and the updated promotional claims in Appendix 3 in your response email dated September 26, 2012, you do not have to submit additional documentation. Please respond to this email confirming that your final User Manual, promotional claims, and 510(k) Summary page will be as recommended above.

Thank you,

Chan O. Lee
Regulatory Reviewer
Food and Drug Administration
Center for Devices and Radiological Health
WO66-2543
10903 New Hampshire Avenue
Silver Spring, MD 20993
Phone: (301) 796-6267
Email: chan.lee@fda.hhs.gov

This communication is consistent with 21 CFR 10.85 (k) and constitutes an informal communication that represents my best judgment at this time. It does not constitute an advisory opinion, does not necessarily represent the formal position of FDA, and does not bind or otherwise obligate or commit the agency to the views expressed. No final decision of substantial equivalence should be inferred from this informal interaction.

THIS MESSAGE IS INTENDED ONLY FOR THE USE OF THE PARTY TO WHOM IT IS ADDRESSED AND MAY CONTAIN INFORMATION THAT IS PRIVILEGED, CONFIDENTIAL, AND PROTECTED FROM DISCLOSURE UNDER LAW. If you are not the addressee, or a person authorized to deliver the document to the addressee, you are hereby notified that any review, disclosure, dissemination, copying, or other action based on the content of this communication is not authorized. If you have received this document in error, please notify the sender immediately by e-mail or phone.

From: Chas Burr [mailto:charlesburr@comcast.net]
Sent: Wednesday, September 26, 2012 9:55 AM
To: Lee, Chan
Cc: Jenny Freeman; Jordan Brayanov
Subject: Response to email questions re RMI's K120087 510(k)
Importance: High

Chan,

Let me know if you need anything else.

Chas Burr, SM MBA FRAPS
Chas Burr Q/R Services
11 Mystic Avenue
Winchester, MA 01890-2920

Cell: 781-789-1646
eFax: 781-723-2422
chas_burr@alum.mit.edu

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Lee, Chan

From: Chas Burr [charlesburr@comcast.net]
Sent: Wednesday, September 26, 2012 9:55 AM
To: Lee, Chan
Cc: Jenny Freeman; Jordan Brayanov
Subject: Response to email questions re RMI's K120087 510(k)
Importance: High
Attachments: RMI Response to 9-25 questions CB 120926.pdf

Chan,

Let me know if you need anything else.

Chas Burr, SM MBA FRAPS
Chas Burr Q/R Services
11 Mystic Avenue
Winchester, MA 01890-2920

Cell: 781-789-1646
eFax: 781-723-2422
chas_burr@alum.mit.edu

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Response to September 25 eMail Request from Chan Lee
510(k) K120087 ExSpiron Respiratory Monitor
Respiratory Motion, Inc. (RMI)

FDA's questions are shown in *italics*.

1. *On page 36 of Supplement 2, you provided a table depicting bias and accuracy. Based on Appendix 17-2 of Supplement 1, accuracy is defined as mean squared error. Traditionally, in medical testing, accuracy refers to the closeness of the measurement to the truth (reference standard). Mean squared error incorporates both bias and variance, and variance is thought of as precision in medical testing. Precision is thought of a completely separate concept (separate from accuracy) in medical testing. To avoid confusion in interpretation by end users of the ExSpiron device, please convert the measures of "accuracy" depicted in this table to variance, using the following equation:*

   Mean Squared Error = Variance + (Bias)^2.

   The bias has already been calculated by the sponsor, and all that is needed to calculate the variance is to calculate the difference between Mean Squared Error and (Bias)^2.

2. *On page 36 of Supplement 2, results for specific metrics have been depicted, but no 95% confidence intervals for these metrics have been presented. Please provide 95% confidence intervals for the bias and variance, so that the sampling variability of these metrics can be incorporated. Please update your labeling with this information. Bootstrap could be used to calculate the 95% confidence intervals for bias and variance. Please see Davison and Hinkley (1997) Bootstrap Methods and Their Application for more information.*

3. *On page 33 of Supplement 2, you provided a table comparing the ExSpiron to the Wright device. This table presents both precision and accuracy. Since accuracy is quantified through mean squared error, and mean squared error incorporates precision, it might be confusing to end users of the ExSpiron device who see the accuracy numbers in the table, since variance is the traditional measure of precision, and accuracy is traditionally thought of as a separate concept from precision. Thus, it suffices to just depict bias and variance. Please modify this table so that bias and variance are depicted instead of bias, precision, and accuracy.*

4. *For the ExSpiron-Wright clinical study, please provide 95% confidence intervals for the bias and variance, so that the sampling variability of these metrics can be incorporated. Please update your labeling with this information. Bootstrap could be used to calculate the 95% confidence intervals for bias and variance. Please see*

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Davison and Hinkley (1997) Bootstrap Methods and Their Application for more information.

RMI has computed bias and variance using the bootstrap method. Appendix 1 contains the revised 510(k) Summary. Appendix 2 contains the revised User Manual Appendix C.

5. *In your promotional claims in Appendix 4, you stated that "ExSpiron provides objective data about respiratory status that may facilitate better patient care." However, your clinical study did not quantify or evaluate how your proposed device may facilitate better patient care. The users will already be aware that they are monitoring patient's respiratory status with your propose device. Therefore, please remove the statement "that may facilitate better patient care." Please provide updated promotional claims.*

RMI has removed the phrase "that may facilitate better patient care." Appendix 3 contains the revised promotional claims.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Appendix 1
Revised 510(k) Summary

The revised Indications for Use statement is on the next page.

The changes are:

- In the description of clinical testing, RMI replaced results tables with tables listing bias and variance and their 95% confidence limits.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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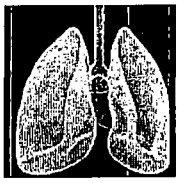

510(k) Summary

510(k) Owner:	Respiratory Motion, Inc.
Address:	305 Second Avenue, Suite B Waltham, Massachusetts 02451
Phone:	781-373-1636
Fax:	781-373-1653
Contact person:	Jenny Freeman, MD
Date 510(k) Summary prepared:	September 26, 2012
Trade name:	ExSpiron™
Common name:	Respiratory Monitor
Classifications:	Monitoring spirometer Product code: BZK Regulation: 21 CFR 868.1850 Breathing frequency monitor Product code BZQ Regulation: 21 CFR 868.2375
Predicate devices:	For product code BZK, nSpire Wright/Haloscale Respirometer, marketed by nSpire Health, Inc. of Longmont, CO 510(k) K091853 For product code BZQ, Philips MPn0 Intellivue Patient Monitors, marketed by Philips Healthcare 510(k) K060541
Device Description:	The ExSpiron™ consists of: • **Bioimpedance measurement system**: A stabilized high frequency current generator is connected to two outer electrodes. The inner four electrodes are connected to an adaptive circuit that conditions the resulting voltage signal and converts it to digital form. Firmware performs signal acquisition and relays data to the panel PC. • **Panel PC**: A Windows 7 PC performs signal processing and calibration, and runs the graphical user interface (GUI). The PC takes user input from a touch screen through a virtual keyboard and mouse. The GUI is used for recording patient data and displaying the respiratory trace as well as scalar values and trends for minute volume, tidal volume, and respiratory rate. • **Single Patient Use ExSpiron™ Electrode Lead Set:** An electrode lead set containing six electrodes to be placed on the torso. It delivers current and records impedance measurements. The electrode lead set is also used to perform subsystem checks prior to patient measurements.

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Intended use:	ExSpiron™ is indicated for use by healthcare professionals in healthcare facilities, such as post-operative care and critical care units, to monitor breathing in adult (at least 21 years old) patients. ExSpiron™ is a non-invasive system that graphically displays lung volume against time and reports an approximate value of: • Tidal volume, • Respiratory rate, and • Minute ventilation ExSpiron™ measurements are used as an adjunct to other clinical information sources.
Comparison of technological characteristics:	

Characteristic	ExSpiron™	nSpire	Philips Intellivue Monitor	Comment
Intended Use	See above.	See K091853	See K060541	The clinical application of the ExSpiron™ is equivalent to that of *the nSpire.* The comparison to the intended use of the Philips monitor is restricted to monitoring of respiration rate ExSpiron™ has no alarm function. All devices are used by healthcare professionals
Technology	Measurement is by thoracic bioimpedance.	Measurement is by in-line turbine flow meter.	Measurement is by bioimpedance.	
Volume Measurements	*Tidal volume* Minute volume Volume vs. time chart	*Tidal volume* Minute volume	None	*The time function for the* minute volume measurement of the nSpire is provided by a user's stopwatch.
Rate Measurements	Respiratory rate (breaths/min)	None	Respiratory rate	
Safety	IEC 60601-1, including electrical and mechanical safety	Mechanical only. Safety specifications are not given in the user manual or 510(k) summary.	IEC 60601-1, etc.	

Nonclinical performance testing:	Performance testing confirmed essential performance by IEC 60601-1 and IEC 60601-1-2 tests and confirmed usability by simulated use by physicians and nurses representative of intended users.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Clinical performance testing:

A clinical study compared simultaneous measurements from the ExSpiron and the predicate, Wright spirometer. (Respiratory rate was calculated using a stopwatch.) Twenty subjects representing a broad range of intended patients participated in the study. (Age range: 20-84, BMI range: 19.9-43.2, 11 female, 9 male) The study involved two sessions for each subject, an initial session in which electrodes were applied, the ExSpiron was calibrated to the individual, and each subject performed ten 60-second breathing tests. Tidal volume, minute ventilation, and respiratory rate were measured simultaneously by the ExSpiron and the Wright spirometer. Each subject returned twenty-four hours after the first session with the original electrodes still attached. Using the same individual calibration values, a second set of ten 60-second breathing tests was performed.

The results of ExSpiron-Wright study were:

ExSpiron-Wright		MV (95% CI)	TV (95% CI)	RR (95% CI)
Bias	**Overall**	**-2.1% (-3.1%, -1.1%)**	**-1.9% (-2.9%, -0.9%)**	**-0.2% (-0.4%, 0.0%)**
	Day 1	-2.3% (-3.7%, -0.9%)	-1.7% (-3.0%, -0.4%)	-0.6% (-0.9%, -0.3%)
	Day 2	-1.9% (-3.3%, 0.4%)	-2.0% (-3.5%, -0.6%)	0.2% (-0.04%, 0.4%)
Variance	**Overall**	**1.1% (0.9%, 1.3%)**	**1.1% (0.9%, 1.2%)**	**0.04% (0.02%, 0.06%)**
	Day 1	1.0% (0.8%, 1.2%)	0.9% (0.7%, 1.1%)	0.05% (0.03%, 0.08%)
	Day 2	1.2% (0.9%, 1.4%)	1.2% (0.9%, 1.4%)	0.03% (0.01%, 0.04%)

The results indicate that the individual calibration is stable over a 24-hour period.

A similar study was performed comparing the Wright spirometer to the Morgan SpiroAir LT diagnostic spirometer. (The closed cell construction of the Morgan spirometer limits the breathing test time to 30 seconds. A direct comparison of the ExSpiron to the Morgan spirometer is suboptimal.) A different set of twenty subjects participated. (Age range: 20-60, BMI range: 19.0-28.0, 9 female, 11 male) Each subject participated in one session performing twenty 30-second breathing tests with volume measurements made simultaneously with the Wright spirometer and the Morgan diagnostic spirometer.

The Morgan-Wright study results were:

Wright-Morgan	MV (95% CI)	TV (95% CI)
Bias	0.4% (0.03%, 0.8%)	0.4% (0.03%, 0.8%)
Variance	0.15% (0.12%, 0.18%)	0.15% (0.12%, 0.18%)

Continued on next page.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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<table>
<tr><td>Clinical performance testing:
Continued from previous page</td><td>Combining the results of the ExSpiron-Wright study and the Wright-Morgan study provided calculated estimates of ExSpiron bias and accuracy with respect to the Morgan diagnostic spirometer:

<table>
<tr><th>ExSpiron-Morgan</th><th>MV (95% CI)</th><th>TV (95% CI)</th></tr>
<tr><td>Bias</td><td>-1.7% (-2.8%, -0.6%)</td><td>-1.5% (-2.5%, -0.4%)</td></tr>
<tr><td>Variance</td><td>1.0% (0.9%, 1.2%)</td><td>0.9% (0.8% 1.1%)</td></tr>
</table></td></tr>
<tr><td>Conclusions regarding safety and effectiveness:</td><td>Based on the comparisons of intended use, and results of nonclinical and clinical testing, the ExSpiron™ is substantially equivalent in intended use, safety, and effectiveness to the nSpire Respirometer and to the breathing frequency monitor function of the Philips Intellivue Patient Monitors.</td></tr>
</table>

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Appendix 2

Revised User Manual Appendix C Clinical Studies to Determine Accuracy

The revised draft User Manual Appendix C begins on the next page.

Changes are:

- Replaced results tables with tables showing bias and variance with their 95% confidence limits.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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DRAFT

Appendix C Clinical Studies to Determine Accuracy

Two similar clinical studies provided ExSpiron accuracy information. The first study compared ExSpiron measurements to measurements made with Wright/Haloscale Respirometer. This study produced measurement performance statistics and confirmed that the ExSpiron calibration is stable for 24 hours. The second study compared the Wright/Haloscale Respirometer to the Morgan SpiroAir LT diagnostic spirometer. Results of the two studies were combined mathematically to produce measurement performance statistics relative to the Morgan spirometer.

ExSprion – Wright comparison

A clinical study compared simultaneous measurements from the ExSpiron and the Wright spirometer. Twenty subjects representing a broad range of intended patients participated in the study. (Age range: 20-84, BMI range: 19.9-43.2, 11 female, 9 male) Tidal volume, minute ventilation, and respiratory rate were measured simultaneously by the ExSpiron and the Wright spirometer. Each subject returned twenty-four hours after the first session with the original electrodes still attached. Using the same individual calibration values, a second set of ten 60-second breathing tests was performed.

The results of the ExSpiron comparison indicate that the individual calibration is stable over a 24-hour period.

ExSpiron-Wright		MV (95% CI)	TV (95% CI)	RR (95% CI)
Bias	**Overall**	**-2.1% (-3.1%, -1.1%)**	**-1.9% (-2.9%, -0.9%)**	**-0.2% (-0.4%, 0.0%)**
	Day 1	-2.3% (-3.7%, -0.9%)	-1.7% (-3.0%, -0.4%)	-0.6% (-0.9%, -0.3%)
	Day 2	-1.9% (-3.3%, 0.4%)	-2.0% (-3.5%, -0.6%)	0.2% (-0.04%, 0.4%)
Variance	**Overall**	**1.1% (0.9%, 1.3%)**	**1.1% (0.9%, 1.2%)**	**0.04% (0.02%, 0.06%)**
	Day 1	1.0% (0.8%, 1.2%)	0.9% (0.7%, 1.1%)	0.05% (0.03%, 0.08%)
	Day 2	1.2% (0.9%, 1.4%)	1.2% (0.9%, 1.4%)	0.03% (0.01%, 0.04%)

RMI performed a Bland-Altman analysis of the clinical trial data. (See Bland and Altman, The Lancet, vol. 327, issue 8476, pp. 307-310, February 1986.) The analyses confirmed that the average disparity between ExSpiron and the Wright spirometer was small and clinically irrelevant (differences of -0.2 bmp, -5ml and -0.14 L/min for RR, TV, and MV, respectively).

RMI calculated the difference between ExSpiron and the Wright spirometer for each measure (MV, TV, and RR) and calculated the average of ExSpiron and the predicate for each measure. The resulting plots are shown below. Data from different subjects are depicted with a different color/symbol combination (i.e. blue plus sign is one subject, cyan plus sign in another subject, blue circle is a third subject, etc.). The charts show each subject's averaged data. The middle black dashed line on each plot depicts the average difference and the upper and lower black dashed lines indicate the 95% confidence intervals (±2 SD from the mean). The mean differences between devices in all six plots are essentially zero.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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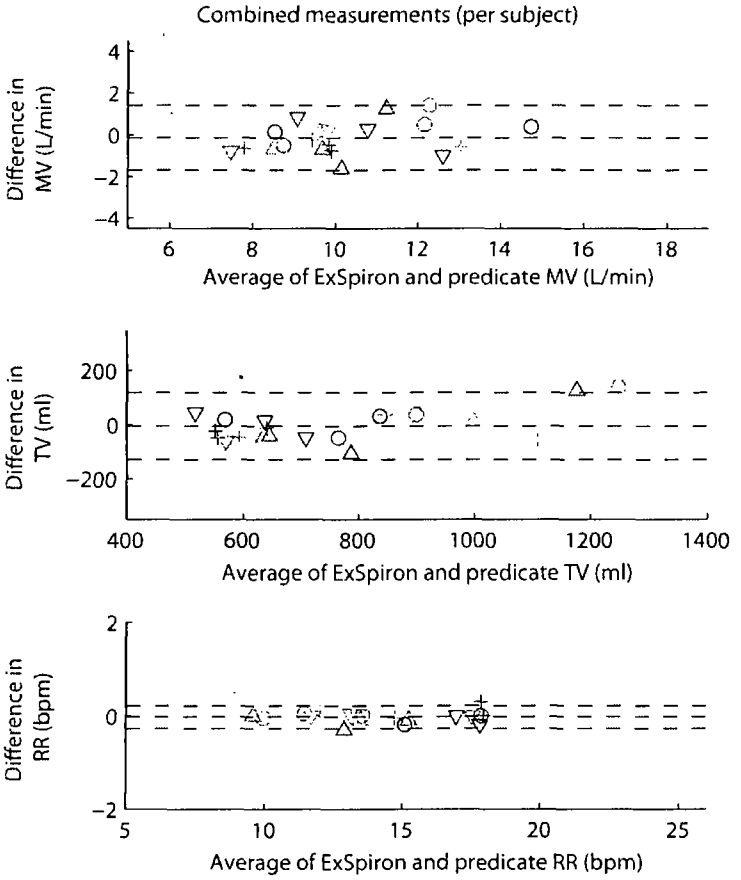

Figure 1 Bland-Altman plots of ExSpiron-Wright comparison

Subject demographics

The demographics of the twenty subjects are shown in these tables.

Age Range	
20-29	3
30-39	3
40-49	4
50-59	4
60-69	2
70-79	2
80-89	2

Gender	
female	11
male	9

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Race	
Asian	2
white	16
black	2
Hispanic	0

BMI Range		
18.5-24.9	11	normal
25-29.9	4	overweight
30-39.9	3	obese
40+	2	morbidly obese

The range of ages, 20-84, is consistent with ExSpiron's intended use with adults, at 21 years of age.

The maximum subject body mass index (BMI) was 43.2.

Subject hydration was not controlled in this study. Test data indicate that measurement performance is not sensitive to a subject's baseline impedance, an indicator of hydration.

Wright spirometer - Morgan SpiroAir LT diagnostic spirometer study

A second, similar study was performed comparing the Wright spirometer to the Morgan SpiroAir LT diagnostic spirometer. (The closed cell construction of the Morgan spirometer limits the individual breathing test time to 30 seconds. A direct comparison of the ExSpiron to the Morgan spirometer is not feasible.) A different set of twenty subjects participated. (Age range: 20-60, BMI range: 19.0-28.0, 9 female, 11 male) Each subject participated in one session performing twenty 30-second breathing tests with volume measurements made simultaneously with the Wright spirometer and the Morgan diagnostic spirometer.

The results of the Morgan-Wright comparison are consistent with the performance claims in their documentation, 2% accuracy for the Morgan and 2% accuracy in the tested flow range for the Wright. The Morgan-Wright study results were:

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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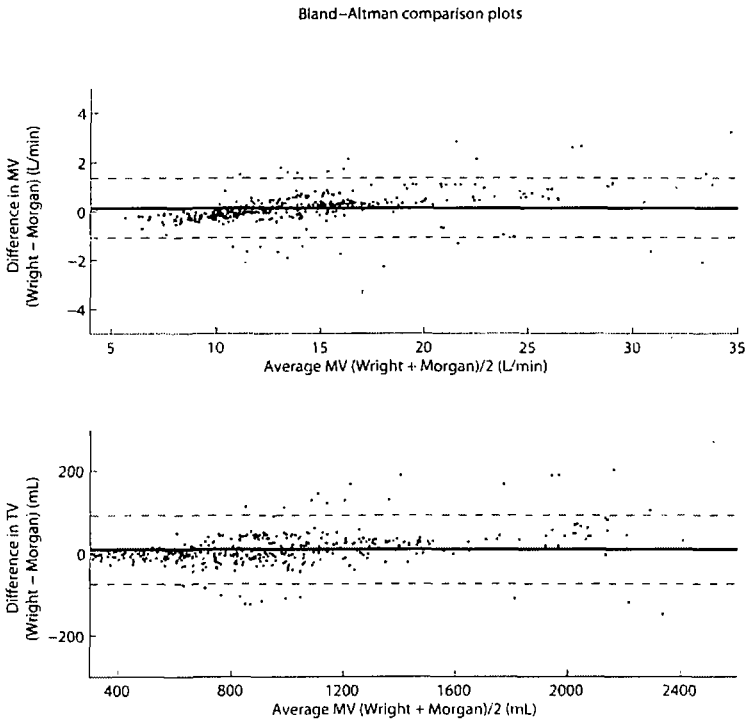

Figure 2: Bland-Altman plots. The average disparity between the two spirometers was confirmed to be small and clinically irrelevant (differences of 9 ml and 0.13 L/min for TV and MV, respectively). Both plots show individual data from all subjects and from all trials. The middle black solid line on each plot depicts the average difference and the upper and lower black dashed lines indicate the 95% confidence intervals (±2 SD from the mean). The mean differences between devices in both plots are essentially zero.

ExSpiron – Morgan Calculated Measurement Performance

Combining the results of the ExSpiron-Wright comparison and the Wright-Morgan comparison provided calculated estimates of ExSpiron bias and accuracy with respect to the Morgan diagnostic spirometer:

ExSpiron-Morgan	MV (95% CI)	TV (95% CI)
Bias	-1.7% (-2.8%, -0.6%)	-1.5% (-2.5%, -0.4%)
Variance	1.0% (0.9%, 1.2%)	0.9% (0.8% 1.1%)

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Appendix 3
Revised Promotional Claims

The change is removal of the phrase "that may facilitate better patient care" from the last claim in the list.

Promotional labeling for the ExSpiron monitor will include these claims:

- ExSpiron can monitor breathing in adult patients.
- ExSpiron assists in monitoring patients in near real-time.
- ExSpiron is non-invasive, point-of-care, and quantitative.
- ExSpiron provides quantitative measurement of:
  - Minute Ventilation (MV)
  - Tidal Volume (TV)
  - Respiratory Rate (RR)
- ExSpiron can measure MV, TV, and RR in non-ventilated patients.
- ExSpiron displays measurement values both numerically and graphically, displaying trend data.
- ExSpiron can quantify a patient's respiratory status and provide trending data in their respiratory parameters.
- MV, TV, and RR are important parameters for assessment of respiratory status. ExSpiron displays MV, TV, and RR over time. Changes in values over time can be compared.
- ExSpiron reports measurement in a user-friendly format.
- ExSpiron, as a bioimpedance monitor, does not require a breathing device, e.g., a spirometer, in the breathing path to obtain MV and TV.
- ExSpiron does not require participation of the patient to generate spirometry-like results.
- ExSpiron measures respiration without potential contamination that could result from having a monitor or probe (e.g. a capnometer or spirometer) in the patient's air-stream.
- ExSpiron measurements of MV, TV and RR do not rely on the measurement of sound.
- ExSpiron provides objective data about respiratory status.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

Lee, Chan

From: Chas Burr [charlesburr@comcast.net]
Sent: Tuesday, September 25, 2012 4:20 PM
To: Lee, Chan
Subject: RE: K120087 Response to 9-20 request for additional information

Will do.

The statisticians are on the case. It is highly likely, but still not absolutely certain that RMI will have what you need Wednesday morning.

Chas

From: Lee, Chan [mailto:Chan.Lee@fda.hhs.gov]
Sent: Tuesday, September 25, 2012 3:47 PM
To: Chas Burr
Cc: 'Jenny Freeman'
Subject: RE: K120087 Response to 9-20 request for additional information

Please email me the revised labeling and 510(k) Summary page. That should be adequate for me to complete my review. Thank you.

- Chan

From: Chas Burr [mailto:charlesburr@comcast.net]
Sent: Tuesday, September 25, 2012 3:42 PM
To: Lee, Chan
Cc: 'Jenny Freeman'
Subject: RE: K120087 Response to 9-20 request for additional information

Chan,

I have spoken with our statistician. He tells me he will send me the new numbers this afternoon. If so, I will have an email to you, probably this evening, indicating the sections of the 510(k) response that are being changed.

Will it suffice if I send just the pages that have revised information?

Chas Burr, SM MBA FRAPS
Chas Burr Q/R Services
11 Mystic Avenue
Winchester, MA 01890-2920

Cell: 781-789-1646
eFax: 781-723-2422
chas_burr@alum.mit.edu

From: Lee, Chan [mailto:Chan.Lee@fda.hhs.gov]
Sent: Tuesday, September 25, 2012 3:20 PM
To: Chas Burr
Cc: Jenny Freeman
Subject: RE: K120087 Response to 9-20 request for additional information

Hi Chas,

Per our telephone conversation, please let me know if you can provide updated labeling and 510(k) Summary page that addresses the following deficiencies. Please let me know if you can provide the response by tomorrow morning so that I may make my final recommendations to my Division management tomorrow. Thank you.

1. On page 36 of Supplement 2, you provided a table depicting bias and accuracy. Based on Appendix 17-2 of Supplement 1, accuracy is defined as mean squared error. Traditionally, in medical testing, accuracy refers to the closeness of the measurement to the truth (reference standard). Mean squared error incorporates both bias and variance, and variance is thought of as precision in medical testing. Precision is thought of a completely separate concept (separate from accuracy) in medical testing. To avoid confusion in interpretation by end users of the ExSpiron device, please convert the measures of "accuracy" depicted in this table to variance, using the following equation:

   Mean Squared Error = Variance + $(\text{Bias})^2$.

   The bias has already been calculated by the sponsor, and all that is needed to calculate the variance is to calculate the difference between Mean Squared Error and $(\text{Bias})^2$.

2. On page 36 of Supplement 2, results for specific metrics have been depicted, but no 95% confidence intervals for these metrics have been presented. Please provide 95% confidence intervals for the bias and variance, so that the sampling variability of these metrics can be incorporated. Please update your labeling with this information. Bootstrap could be used to calculate the 95% confidence intervals for bias and variance. Please see Davison and Hinkley (1997) *Bootstrap Methods and Their Application* for more information.

3. On page 33 of Supplement 2, you provided a table comparing the ExSpiron to the Wright device. This table presents both precision and accuracy. Since accuracy is quantified through mean squared error, and mean squared error incorporates precision, it might be confusing to end users of the ExSpiron device who see the accuracy numbers in the table, since variance is the traditional measure of precision, and accuracy is traditionally thought of as a separate concept from precision. Thus, it suffices to just depict bias and variance. Please modify this table so that bias and variance are depicted instead of bias, precision, and accuracy.

4. For the ExSpiron-Wright clinical study, please provide 95% confidence intervals for the bias and variance, so that the sampling variability of these metrics can be incorporated. Please update your labeling with this information. Bootstrap could be used to calculate the 95% confidence intervals for bias and variance. Please see Davison and Hinkley (1997) *Bootstrap Methods and Their Application* for more information.

5. In your promotional claims in Appendix 4, you stated that "ExSpiron provides objective data about respiratory status that may facilitate better patient care." However, your clinical study did not quantify or evaluate how your proposed device may facilitate better patient care. The users will already be aware that they are monitoring patient's respiratory status with your propose device. Therefore, please remove the statement "that may facilitate better patient care." Please provide updated promotional claims.

Chan O. Lee
Regulatory Reviewer
Food and Drug Administration
Center for Devices and Radiological Health

WO66-2543
10903 New Hampshire Avenue
Silver Spring, MD 20993
Phone: (301) 796-6267
Email: chan.lee@fda.hhs.gov

This communication is consistent with 21 CFR 10.85 (k) and constitutes an informal communication that represents my best judgment at this time. It does not constitute an advisory opinion, does not necessarily represent the formal position of FDA, and does not bind or otherwise obligate or commit the agency to the views expressed. No final decision of substantial equivalence should be inferred from this informal interaction.

THIS MESSAGE IS INTENDED ONLY FOR THE USE OF THE PARTY TO WHOM IT IS ADDRESSED AND MAY CONTAIN INFORMATION THAT IS PRIVILEGED, CONFIDENTIAL, AND PROTECTED FROM DISCLOSURE UNDER LAW. If you are not the addressee, or a person authorized to deliver the document to the addressee, you are hereby notified that any review, disclosure, dissemination, copying, or other action based on the content of this communication is not authorized. If you have received this document in error, please notify the sender immediately by e-mail or phone.

From: Chas Burr [mailto:charlesburr@comcast.net]
Sent: Thursday, September 20, 2012 4:03 PM
To: Lee, Chan
Cc: Jenny Freeman
Subject: K120087 Response to 9-20 request for additional information

Chan,

RMI has accepted all FDA suggestions in the recent request for additional information.

The attached pdf is the same file as in the response I just sent to the Document Center. The hard copy and pdf should arrive there tomorrow, Friday.

Chas Burr, SM MBA FRAPS
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Cell: 781-789-1646
eFax: 781-723-2422
chas_burr@alum.mit.edu

Lee, Chan

From: Chas Burr [charlesburr@comcast.net]
Sent: Friday, July 27, 2012 10:51 AM
To: Lee, Chan
Cc: 'Jenny Freeman'; Jordan12@seas.harvard.edu; 'Shelby Morss'; 'Elizabeth Messana'; Nguyen, Anh
Subject: RE: Thank you for yesterday's conference call

Chan

Thank you. I understand and agree with the message.

I will send a message late next week.

Chas Burr, SM MBA FRAPS
Chas Burr Q/R Services
11 Mystic Avenue
Winchester, MA 01890-2920

Cell: 781-789-1646
eFax: 781-723-2422
chas_burr@alum.mit.edu

From: Lee, Chan [mailto:Chan.Lee@fda.hhs.gov]
Sent: Friday, July 27, 2012 10:16 AM
To: Chas Burr; Nguyen, Anh
Cc: Jenny Freeman; Jordan12@seas.harvard.edu; Shelby Morss; Elizabeth Messana
Subject: RE: Thank you for yesterday's conference call

Chas,

Thank you and the team for a productive meeting. It helped us get assurance that your decisions were based on good science. That's a big part of what we do as reviewers. Thank you.

We concur with your summary. For the labeling, please provide comparison between your proposed device vs. Wright and then Wright vs. Morgan. As you have stated in the teleconference, please discuss the limitations of Wright and Morgan technology and justify the two step comparison. We would also recommend providing just a brief summary of this analysis in your 510(k) Summary page as well. We can get into this more when you send us your proposed labeling.

Thanks,

- Chan

From: Chas Burr [mailto:charlesburr@comcast.net]
Sent: Friday, July 27, 2012 9:14 AM
To: Lee, Chan; Anh.Nguyen@nih.hhs.gov

Cc: Jenny Freeman; Jordan12@seas.harvard.edu; Shelby Morss; Elizabeth Messana
Subject: Thank you for yesterday's conference call

Chan Lee and Dr. Nguyen,

Thank you for your conference call yesterday. There was useful clarification for everyone on the call. I believe we now have a clear understanding of how to proceed for the upcoming response to FDA's request for additional information. Let me summarize the key points I captured. Please let me know if I miss or misstate anything.

- FDA agreed to RMI's proposal for a study comparing the Wright spirometer to the Morgan spirometer.
- RMI is preparing the data analysis from that study. RMI hopes to send you a draft of the data and analysis, perhaps late next week.
- FDA has concerns about description of the studies in the ExSpiron labeling. A summary of the studies, the subject characteristics, and Bland-Altman plots were suggested. RMI will send a draft for comment late next week or early the following week.
- RMI agrees to amend the Indications for Use statement to limit the patient population to adults-only, 21 or older.
- RMI hopes to submit the official response about mid-August. RMI is waiting for the IEC 60601-1 and IEC 60601-1-2 test reports.

Some other information:

- I will submit the final extension letter for the response to arrive at the Document Center Monday. As usual, Chan Lee will be copied by e-mail.
- I will be on vacation Aug 8-18. During that time, if you need anything urgently from RMI, please email me and Dr. Freeman (jfreeman@respiratorymotion.com). I will check email occasionally.

Thank you again for the conference calls and ongoing communication.

Chas Burr, SM MBA FRAPS
Chas Burr Q/R Services
11 Mystic Avenue
Winchester, MA 01890-2920

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No virus found in this message.
Checked by AVG - www.avg.com
Version: 2012.0.2180 / Virus Database: 2437/5158 - Release Date: 07/27/12

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DEPARTMENT OF HEALTH & HUMAN SERVICES **Public Health Service**

U.S. Food and Drug Administration
Center for Devices and Radiological Health
Document Control Center WO66-G609
10903 New Hampshire Avenue
Silver Spring, MD 20993-0002

September 25, 2012

RESPIRATORY MOTION, INC.
C/O CHAS BURR QR SERVICES
11 MYSTIC AVENUE
WINCHESTER, MASSACHUSETTS 01890-2920
ATTN: CHAS BURR

510k Number: K120087

Product: EXSPIRON

The additional information you have submitted has been received.

We will notify you when the processing of this submission has been completed or if any additional information is required. Pleaseremember that all correspondence concerning your submission MUST be sent to the Document Mail Center at the above letterhead address. Correspondence sent to any address other than the one above will not be considered as part of your official premarket notification submission. Also, please note the new Blue Book Memorandum regarding Fax and E-mail Policy entitled, "Fax and E-Mail Communication with Industry about Premarket Files Under Review. Please refer to this guidance for information on current fax and e-mail practices at http://www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/GuidanceDocuments/ucm089402.htm. On August 12, 2005 CDRH issued the Guidance for Industry and FDA Staff: Format for Traditional and Abbreviated 510(k)s. This guidance can be found at http://www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/GuidanceDocuments/ucm084365.htm. Please refer to this guidance for assistance on how to format an original submission for a Traditional or Abbreviated 510(k).

The Safe Medical Devices Act of 1990, signed on November 28, states that you may not place this device into commercial distribution until you receive a letter from FDA allowing you to do so. As in the past, we intend to complete our review as quickly as possible. Generally we do so in 90 days. However, the complexity of a submission or a requirement for additional information may occasionally cause the review to extend beyond 90 days. Thus, if you have not received a written decision or been contacted within 90 days of our receipt date you may want to check with FDA to determine the status of your submission.

Please ensure that whether you submit a 510(k) Summary as per 21 CFR 807.92, or a 510(k) Statement as per 21 CFR 807.93, it meets the content and format regulatory requirements.

If you have procedural questions, please contact the Division of Small Manufacturers International and Consumer Assistance (DSMICA) at (301)796-7100 or at their toll-free number (800)638-2041, or contact the 510k staff at (301)796-5640.

Sincerely,

510(k) Staff

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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K120087/S2

FDA CDRH DMC
SEP 21 2012
Received

Respiratory Motion, Inc.
305 Second Avenue, Suite B
Waltham, Massachusetts 02451

U.S. Food and Drug Administration
Center for Devices and Radiological Health
Document Mail Center – WO66-G609
10903 New Hampshire Avenue
Silver Spring, MD 20993-0002
September 20, 2012

FDA CDRH DMC
SEP 21 2012
Received

Office of Device Evaluation:

Subject: Response to September 20 Request for Additional Information for 510(k) 120087

Respiratory Motion, Inc. (RMI) is submitting this response to FDA's request for additional information, dated September 20, 2012. The response in the enclosed pages includes concise answers and attachments for detailed information.

RMI accepts all comments and believes that the attached response addresses all remaining FDA concerns.

RMI is enclosing a CD with a pdf file containing this cover letter, the response, and its attachments. The paper copies are printed from this pdf file. The contents of the paper copy and the pdf file are identical.

Respectfully,

Chas Burr

Chas Burr
510(k) Correspondent for Respiratory Motion, Inc.

cc: Jenny Freeman, MD, President Respiratory Motion, Inc.
Encl.: CD with pdf file of Response to Request for Additional Information, with attachments

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Response to September 20 Request for Additional Information 510(k) K120087 ExSpiron Respiratory Monitor Respiratory Motion, Inc. (RMI)

FDA's questions are shown in *italics*.

1. *In your 510(k) Summary page, you stated that the Morgan Spirometer is the "gold standard". However, the Morgan Spirometer is not the "gold standard" because it cannot be used as a continuous monitor. Your proposed device is intended to be used as a continuous monitor. Thus Morgan Spirometer is not an appropriate direct comparator to your proposed device. Please remove your claim that the Morgan Spirometer is the gold standard from your submission. Please provide updated copies of 510(k) Summary page and labeling.*

RMI will no longer claim that the Morgan Spirometer is a "gold standard." A revised 510(k) Summary is found in Appendix 1. It contains a revised description of clinical testing, as well as other changes described in this response. A revised User Manual is found in Appendix 2. It contains a revised description of clinical testing, as well as other changes described in this response.

2. *In your Indications For Use (IFU) statement, you stated that your proposed device can "monitor breathing in patients with potential respiratory compromise". However, your clinical study did not identify or evaluate specific respiratory compromises in patients. Therefore, please remove the statement "with potential respiratory compromise" from your submission. Please provide updated IFU statement page, 510(k) Summary page, and labeling.*

RMI is removing "with potential respiratory compromise" from its IFU. A revised Indications for Use form is found in Appendix 3. A revised 510(k) Summary is found in Appendix 1. A revised User Manual is found in Appendix 2.

3. *In your Indications For Use (IFU) statement, you stated that the measurements from your proposed device are used "to determine respiratory status and appropriate therapy." However, your proposed device is a monitor and not a diagnostic device. In addition, you did not provide clinical study that evaluates how the user used your proposed device to determine respiratory status and appropriate therapy. Therefore, please remove the statement "to determine respiratory status and appropriate therapy" from your submission. Please provide updated IFU statement page, 510(k) Summary page, and labeling.*

RMI is removing "to determine respiratory status and appropriate therapy" from the Indications for Use. A revised Indications for Use form is found in Appendix 3. A revised 510(k) Summary is found in Appendix 1. A revised User Manual is found in Appendix 2.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

4. *You provided promotional claims in Appendix 4-5. However, you made clinical claims about your proposed device without providing supporting evidence from your clinical study. Therefore, please remove the clinical claims identified below from your promotional claims. Please provide updated promotional claims for review.*

    a. *You stated that "ExSpiron can monitor breathing in adult patients with respiratory compromise or potential respiratory compromise." However, your clinical study did not identify or evaluate specific respiratory compromises in patients.*

    b. *You stated that "ExSpiron assists in monitoring at-risk patients in near real-time." However, your clinical study did not identify or evaluate specific at-risk patients.*

    c. *You stated that "ExSpiron helps improve the standard of respiratory monitoring because it displays MV, TV, and RR over time." However, your clinical study did not evaluate how your proposed device improved the standard of respiratory monitoring.*

    d. *You stated that "ExSpiron can help physicians identify patients with inadequate breathing." However, your clinical study did not evaluate how your proposed device helped care providers identify patients with inadequate breathing.*

    e. *You stated that "ExSpiron can assist physicians' decision-making by providing respiratory status data." However, your clinical study did not evaluate how your proposed assisted care providers in their decision making process.*

5. *In your promotional claims in Appendix 4-5, you stated that "ExSpiron is easy to use." You conducted usability testing on 10 test subjects. However, the test reports provided limited granularity regarding user task performance and limited user commentary regarding ease of use. Therefore, please remove the claim "easy to use" from your submission. Please provide updated promotional claims.*

RMI accepts FDA's changes to the promotional claims. A revised list of promotional claims is in Appendix 4.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Appendixes

1	Revised 510(k) Summary
2	Revised User Manual
3	Revised Indications for Use Statement
4	Revised Promotional Claims

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Appendix 1
Revised 510(k) Summary

The revised Indications for Use statement is on the next page.

The changes are:

- Removal of "with potential respiratory compromise" and "to determine respiratory status and appropriate therapy" from the Indications for Use
- Removal of references to the "gold standard" in the Clinical Performance Testing section

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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510(k) Summary

510(k) Owner:	Respiratory Motion, Inc.
Address:	305 Second Avenue, Suite B Waltham, Massachusetts 02451
Phone:	781-373-1636
Fax:	781-373-1653
Contact person:	Jenny Freeman, MD
Date 510(k) Summary prepared:	September 20, 2012
Trade name:	ExSpiron™
Common name:	Respiratory Monitor
Classifications:	Monitoring spirometer Product code: BZK Regulation: 21 CFR 868.1850 Breathing frequency monitor Product code BZQ Regulation: 21 CFR 868.2375
Predicate devices:	For product code BZK, nSpire Wright/Haloscale Respirometer, marketed by nSpire Health, Inc. of Longmont, CO 510(k) K091853 For product code BZQ, Philips MPn0 Intellivue Patient Monitors, marketed by Philips Healthcare 510(k) K060541
Device Description:	The ExSpiron™ consists of: • **Bioimpedance measurement system**: A stabilized high frequency current generator is connected to two outer electrodes. The inner four electrodes are connected to an adaptive circuit that conditions the resulting voltage signal and converts it to digital form. Firmware performs signal acquisition and relays data to the panel PC. • **Panel PC**: A Windows 7 PC performs signal processing and calibration, and runs the graphical user interface (GUI). The PC takes user input from a touch screen through a virtual keyboard and mouse. The GUI is used for recording patient data and displaying the respiratory trace as well as scalar values and trends for minute volume, tidal volume, and respiratory rate. • **Single Patient Use ExSpiron™ Electrode Lead Set:** An electrode lead set containing six electrodes to be placed on the torso. It delivers current and records impedance measurements. The electrode lead set is also used to perform subsystem checks prior to patient measurements.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Intended use:	ExSpiron™ is indicated for use by healthcare professionals in healthcare facilities, such as post-operative care and critical care units, to monitor breathing in adult (at least 21 years old) patients. ExSpiron™ is a non-invasive system that graphically displays lung volume against time and reports an approximate value of: • Tidal volume, • Respiratory rate, and • Minute ventilation ExSpiron™ measurements are used as an adjunct to other clinical information sources.
Comparison of technological characteristics:	

Characteristic	ExSpiron™	nSpire	Philips Intellivue Monitor	Comment
Intended Use	See above.	See K091853	See K060541	The clinical application of the ExSpiron™ is equivalent to that of the nSpire The comparison to the intended use of the Philips monitor is restricted to monitoring of respiration rate. ExSpiron™ has no alarm function. All devices are used by healthcare professionals
Technology	Measurement is by thoracic bioimpedance.	Measurement is by in-line turbine flow meter.	Measurement is by bioimpedance.	
Volume Measurements	Tidal volume Minute volume Volume vs. time chart	Tidal volume Minute volume	None	The time function for the minute volume measurement of the nSpire is provided by a user's stopwatch.
Rate Measurements	Respiratory rate (breaths/min)	None	Respiratory rate	
Safety	IEC 60601-1, including electrical and mechanical safety	Mechanical only. Safety specifications are not given in the user manual or 510(k) summary.	IEC 60601-1, etc.	

Nonclinical performance testing:	Performance testing confirmed essential performance by IEC 60601-1 and IEC 60601-1-2 tests and confirmed usability by simulated use by physicians and nurses representative of intended users.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Clinical performance testing:

A clinical study compared simultaneous measurements from the ExSpiron and the predicate, Wright spirometer. (Respiratory rate was calculated using a stop watch.) Twenty subjects representing a broad range of intended patients participated in the study. (Age range: 20-84, BMI range: 19.9-43.2, 11 female, 9 male) The study involved two sessions for each subject, an initial session in which electrodes were applied, the ExSpiron was calibrated to the individual, and each subject performed ten 60-second breathing tests. Tidal volume, minute ventilation, and respiratory rate were measured simultaneously by the ExSpiron and the Wright spirometer. Each subject returned twenty-four hours after the first session with the original electrodes still attached. Using the same individual calibration values, a second set of ten 60-second breathing tests was performed.

The results of ExSpiron-Wright study were:

ExSpiron-Wright		Minute Ventilation	Tidal Volume	Respiratory Rate
Bias	**Overall**	**-2.1%**	**-1.9%**	**-0.2%**
	Day 1	-2.3%	-1.7%	-0.6%
	Day 2	-1.9%	-2.0%	0.2%
Precision	**Overall**	**10.5 %**	**10.3 %**	**2.0 %**
	Day 1	10.2%	9.7%	2.3%
	Day 2	10.8%	10.8%	1.6%
Accuracy	**Overall**	**10.7 %**	**10.4 %**	**2.0 %**
	Day 1	10.4%	9.8%	2.4%
	Day 2	10.9%	11.0%	1.6%

The results indicate that the individual calibration is stable over a 24-hour period.

A similar study was performed comparing the Wright spirometer to the Morgan SpiroAir LT diagnostic spirometer. (The closed cell construction of the Morgan spirometer limits the breathing test time to 30 seconds. A direct comparison of the ExSpiron to the Morgan spirometer is suboptimal.) A different set of twenty subjects participated. (Age range: 20-60, BMI range: 19.0-28.0, 9 female, 11 male) Each subject participated in one session performing twenty 30-second breathing tests with volume measurements made simultaneously with the Wright spirometer and the Morgan diagnostic spirometer.

The Morgan-Wright study results were:

Wright-Morgan	Minute Ventilation	Tidal Volume
Bias	**0.4%**	**0.4%**
Accuracy	**3.9%**	**3.9%**

Continued on next page.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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<table>
<tr><td>Clinical performance testing:
Continued from previous page</td><td>Combining the results of the ExSpiron-Wright study and the Wright-Morgan study provided calculated estimates of ExSpiron bias and accuracy with respect to the Morgan diagnostic spirometer:
<table>
<tr><th>ExSpiron-Morgan</th><th>Minute Ventilation</th><th>Tidal Volume</th></tr>
<tr><td>Bias</td><td>-1.7%</td><td>-1.5%</td></tr>
<tr><td>Accuracy</td><td>9.9%</td><td>9.6%</td></tr>
</table></td></tr>
<tr><td>Conclusions regarding safety and effectiveness:</td><td>Based on the comparisons of intended use, and results of nonclinical and clinical testing, the ExSpiron™ is substantially equivalent in intended use, safety, and effectiveness to the nSpire Respirometer and to the breathing frequency monitor function of the Philips Intellivue Patient Monitors.</td></tr>
</table>

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Appendix 2

Revised User Manual

The revised draft User Manual begins on the next page.

Changes are:

- Removal of "with potential respiratory compromise" and "to determine respiratory status and appropriate therapy" from the Intended Use section, page 15
- Removal of references to the term "gold standard" in Appendix C Clinical Studies to Determine Accuracy, starting on page 33

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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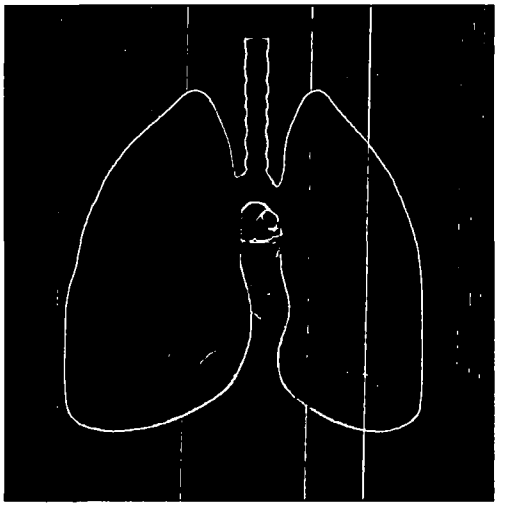

User Manual

ExSpiron™
Respiratory Variation Monitor™ (RVM)

© Respiratory Motion, Inc.

305 Second Avenue, Suite B
Waltham, MA 02451-1122

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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General Warning:

DO NOT use this monitor

- for any purpose other than specified in this manual
- if parts are broken or missing
- without reading this user manual

ONLY qualified personnel should use the ***ExSpiron™*** Monitor.

The ***ExSpiron™*** Monitor is NOT a diagnostic monitor. The ExSpiron should be used as an adjunct to other clinical information to determine respiratory status and appropriate therapy.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Contact Information

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To be added.

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Introduction

Intended Use

ExSpiron™ is indicated for use by healthcare professionals in healthcare facilities, such as post-operative care and critical care units, to monitor breathing in adult (at least 21 years old) patients.

ExSpiron™ is a non-invasive monitor that graphically displays lung volume against time and reports an approximate value of:

- Tidal volume,
- Respiratory rate, and
- Minute ventilation.

ExSpiron™ measurements are used as an adjunct to other clinical information sources.

NOTE: United States regulation restricts this device to sale by or on the order of licensed medical practitioners.

Intended Operators

ExSpiron™ is intended to be operated by trained technicians and clinical professionals.

Brief Description of Device

The system includes:

- **ExSpiron™** Data Acquisition System, including patient cable with leads
- Touch screen panel computer (Windows 7® Operating System)
- **ExSpiron™** Disposable Electrode Pads

The ***ExSpiron™*** Disposable Electrode Pads should always be used with the ExSpiron monitor.

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Safety Measures

Warnings

WARNING: Electric shock hazard. The ***ExSpiron***™ monitor is to be opened only by Respiratory Motion personnel, their designees, or qualified service engineers. There are no user-serviceable parts inside.

WARNING: Do not autoclave, gas-sterilize, or immerse any portion of the ***ExSpiron***™ monitor. This may create an electric shock hazard or damage internal components.

Cautions

CAUTION: ***ExSpiron***™ disposable electrode pad sets are designed for single use only and should not be re-used. Reuse may interfere with monitor function. An electrode pad set should not be used for more than 24 hours. Recalibrate the ***Exspiron***™ after changing electrode pad set. Dispose of electrode pads sets per requirements for biohazard waste.

CAUTION: Use only Respiratory Motion ***ExSpiron***™ electrode pad sets with the ***ExSpiron***™ monitor. Accuracy of the device cannot be assured unless Respiratory Motion ***ExSpiron***™ electrode pad sets are specifically used.

CAUTION: Other bioimpedance monitors may cause functional interference among the ExSpiron and the other monitors. When using ExSpiron with another bioimpedance monitor, confirm that both systems are operating properly.

CAUTION: Do not mount or store the ***ExSpiron***™ monitor under an IV bag or other liquids. Fluid leaking onto the monitor may interfere with monitor function and may create an electric shock hazard.

CAUTION: Before attaching the ***ExSpiron***™ monitor to a medical monitoring pole, ensure that the pole is specified to carry the weight of the ***ExSpiron***™ monitor.

CAUTION: The accuracy of ***ExSpiron*** volume measurements has not been confirmed at very high (> 30 breaths per minute) or very low ($\leq$5 breaths per minute) respiratory rates. If a patient has a very high or very low respiratory rate, confirm respiratory status with other clinical information sources.

CAUTION: The accuracy of ***ExSpiron***™ measurements has not been confirmed for patient with a BMI over 43. If a patient has a BMI outside of this range, confirm respiratory status with other clinical information sources.

CAUTION: A very large change in patient hydration may affect the calibration. If a patient experiences a large change in hydration, recalibrate the ***ExSpiron***™ monitor.

Precautions

The ***ExSpiron***™ monitor should not be used as the sole basis for diagnosis or therapy. Healthcare professionals should use ***ExSpiron***™ measurements as an adjunct to other clinical information sources to help determine regulatory status and appropriate therapy.

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The ***ExSpiron***™ monitor should not be used as an apnea monitoring system.

Cleaning and disinfection

Clean external surfaces of the ***ExSpiron***™ monitor with a cloth dampened with warm water. Cleaning with a mild disinfectant is recommended.

Disposal

Dispose of used electrode pad sets as biohazard waste.

Dispose of used batteries per local or national waste regulations.

At the end of its life, dispose of or recycle the ***ExSpiron***™ monitor per local or national regulations.

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Operation

Principles of Operation

Various types of bodily tissue have varying levels of electrical impedance. Impedance is the measure of an object's opposition to carrying an alternate current. Air has far more impedance than any bodily tissue. As an individual inhales and exhales, the movement of air in and out of the lungs sequentially increases and decreases the level of electrical impedance within the thorax. Similar to standard leads that measure respiratory rate, the ***ExSpiron***™ measures changes in impedance by passing a low level alternating constant current through the thorax. Respiratory Motion algorithms are able to correlate directly these changes in impedance with lung volumes. Analysis of the respiratory curve yields three important parameters: tidal volume of each breath, respiratory rate and minute ventilation.

Features of Design

Device Design

The ***ExSpiron***™ monitor is comprised of a set of electronics and standard computer functionality, which collects and analyzes pertinent patient information. ***ExSpiron***™ leads originating from the device connect to ***ExSpiron***™ electrode pads placed in predetermined configurations on the patient's skin. Electrode configuration and the monitor user interface are detailed in Sections 2 and 3.

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Electrode Configuration

Electrode configuration is detailed in Figure 1. There are two electrode pads, designated 1 and 2 (Fig. 1). Routine skin preparation following standard hospital procedures should be undertaken before electrode pad placement. The patient's skin should be thoroughly cleansed and failure to do so could interference with the integrity of the ***ExSpiron™*** readings.

Electrode pad 1 should be placed over the sternal notch and extend to the xiphoid process. If necessary, the bottom electrode pad can be torn along the perforated edge to allow for further extension.

Electrode pad 2 should be placed along the right mid-axillary line and horizontally in line with the xiphoid process and bottom electrode of Electrode pad 1.

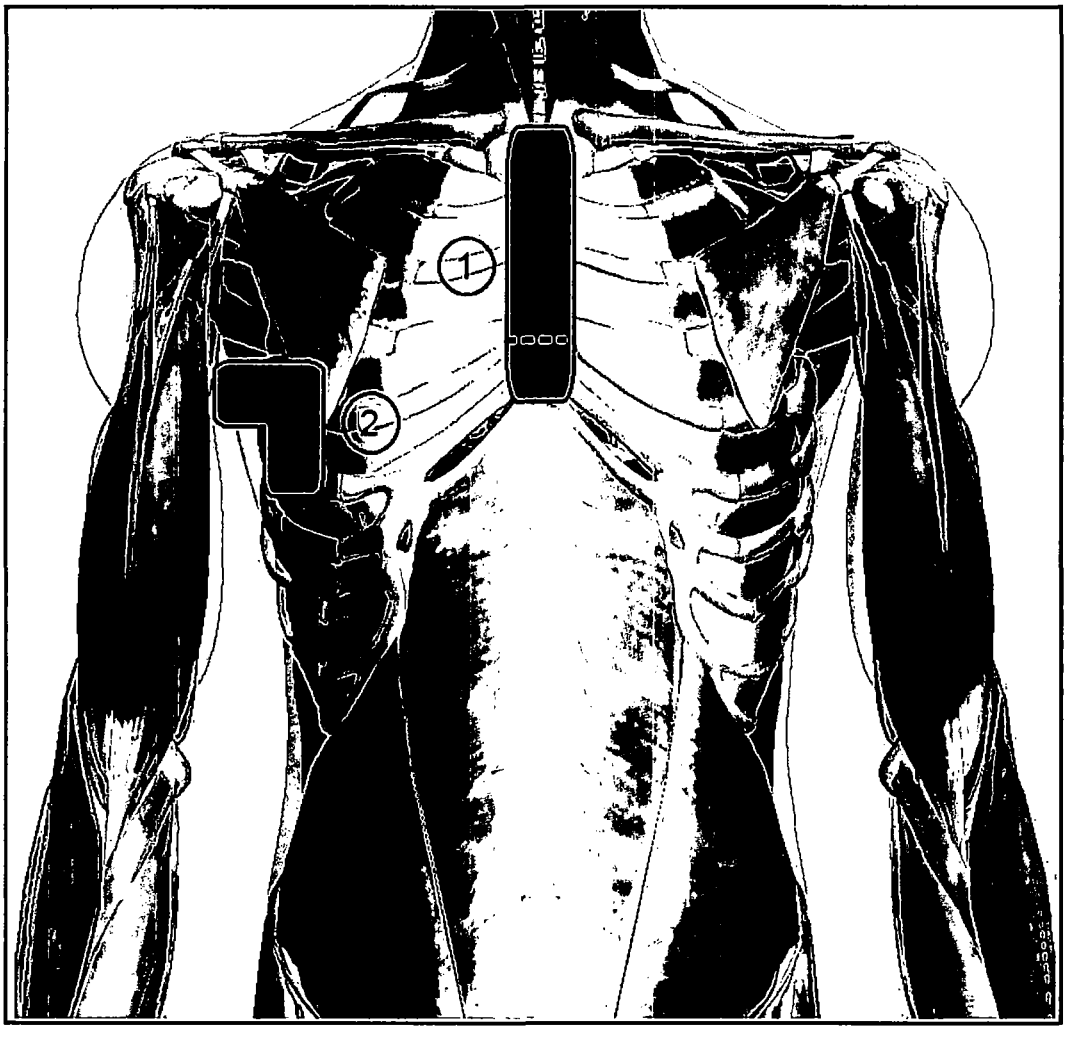

Figure 1 Standard electrode placement diagram.

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Monitor Start-up

1) Plug in the ***ExSpiron***™ monitor.
2) Turn on the monitor via the I/O button.
3) With the monitor turned on, an ***ExSpiron***™ icon will appear on the desktop.
4) Clicking on this icon will launch the graphical user interface and allow for subject data input and data collection.

User Interface

The ***ExSpiron***™ user interface (UI) contains a graphical representation of the respiratory curve, and outputs of three respiratory parameters: minute ventilation (MV), tidal volume (TV), and respiratory rate (RR). When the ***ExSpiron***™ software is launched or a new or different patient is being monitored, the initial starting screen will display only the respiratory curve (Fig 2). No values for MV, TV, or RR will be shown.

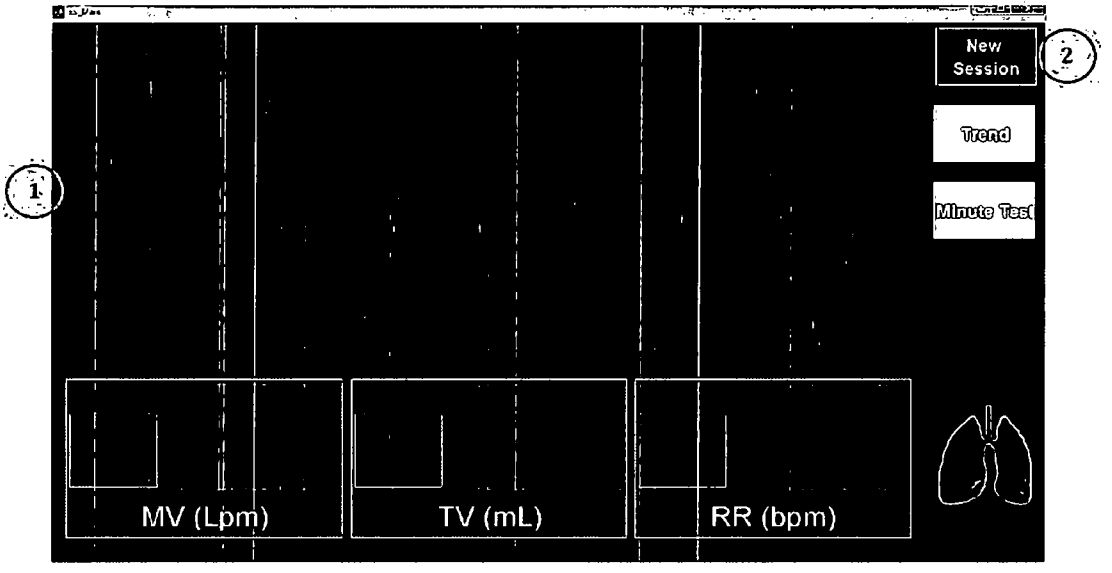

Figure 2 User Interface. The main screen will illustrate the respiratory curve. Navigate the touch screen using the buttons at the right. Beneath the respiratory curve are value boxes and trend curves for the 3 collected respiratory parameters. These will appear empty until a patient has been selected and the device calibrated.

Label	Button/ Field	Function
1	Respiratory Curve	Shows the patient's respiratory curve in real-time.
2	New Session	Brings user to patient ID screen in order to begin monitoring.

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Patient Selection

In order to select a patient for monitoring, the user will be prompted with a patient ID screen (Fig. 3). Enter the patient's ID and click Next to move to the next screen.

Figure 3 Patient ID Input Screen.

Label	Button/Field	Function
1	ID Field	Input the patient's ID.
2	Next	Once the patient's ID is entered, click Next to move to next screen.
3	Cancel	Click to leave the ID screen and return to initial monitoring screen.

Selecting a Calibration Setting for a New Patient

If the patient database does not recognize the patient ID, the new patient calibration screen will be shown (Fig. 4). Enter the fields listed; all are required. New Calibration is the only option for a new patient. Height, weight, and the calibration information used on the next screen will constitute that particular calibration, and it will be stored under the current date. Clicking Next will create a patient record and bring the user to the calibration screen.

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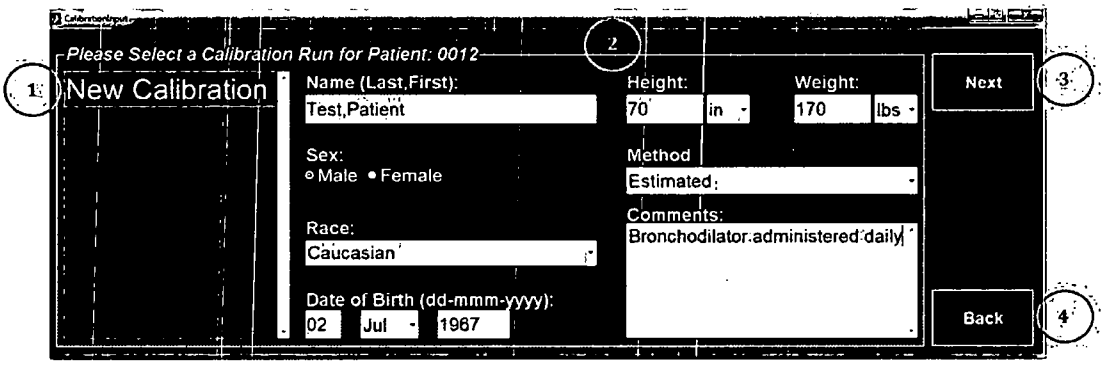

Figure 4 Patient Selection User Interface. Items on the user interface for patient selection.

Label	Button/ Field	Function
1	New Calibration	This will be the only option for a new patient.
2	Required Information	All fields are required. Those listed on the left (name, sex, race, date of birth) cannot be edited after initial entry. Those fields on the right (height, weight, method, comments) can be edited. Method is a dropbox containing options for "estimated" or "measured". Pick one in order to designate the method that was used for acquiring height and weight.
3	Next	Brings user to calibration screen.
4	Back	Brings user back to the initial monitoring screen.

The calibration screen will prompt the user to click Start and begin collecting data for minute ventilation or tidal volume and respiratory rate (Fig. 5). The fields on the right will remain disabled until the collection period is over and the progress bar shows that data acquisition is complete. At that time, the user can input the collected parameter(s) and click Next to go to the calibrated monitoring screen.

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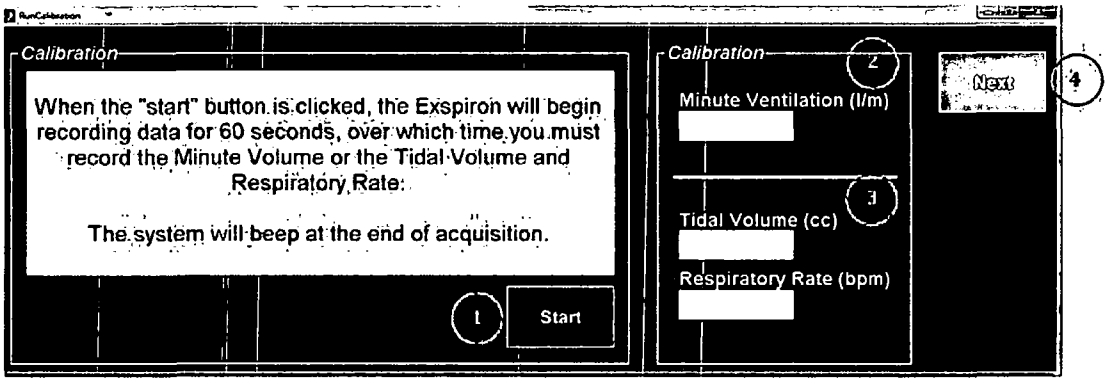

Figure 5 Calibration screen. After inputting the calibration parameters, the ExSpiron will start acquiring data.

Label	Button/Field	Function
1	Start	Begin collecting data for calibration (60 seconds).
2	Minute Ventilation	User can enter the calculated minute ventilation for calibration.
3	Tidal Volume & Respiratory Rate	User can enter tidal volume and respiratory rate for calibration.
4	Next	Brings user to monitoring screen; remains disabled until calibration has completed.

Selecting a Calibration Setting for an Existing Patient

The default screen is used for selecting existing patients (Fig. 6). The data entry fields become available when the operator selects a patient by clicking on an entry in the Patient List. Refer to the list below to navigate the Patient Selection UI.

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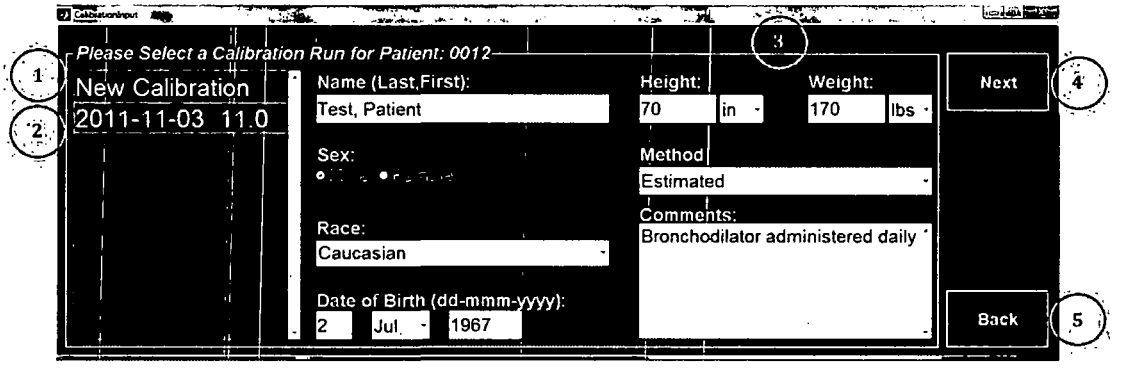

Figure 6 Calibration Selection for Existing Patient.

Label	Button/Field	Function
1	New Calibration	Selecting this for an existing patient allows the user to create a new calibration setting.
2	Existing Calibration Setting	Existing calibration settings are listed by date and minute ventilation. Select one to set calibration to that setting.
3	Changeable fields	In creating a new calibration setting, the user can edit the height, weight, method, and comments fields.
4	Next	Brings user to calibrated monitoring screen.
5	Back	Returns user to initial monitoring screen.

Navigating the Monitoring Session

After the desired patient has been selected, the user will be brought to the monitoring screen (Fig. 7). The graphs will automatically populate with the calibrated respiratory curve and values and trends for TV, RR, and MV. The buttons at the right allow the user to navigate away from the monitoring screen, either to start a new monitoring session, view trends, or the run minute-long tests.

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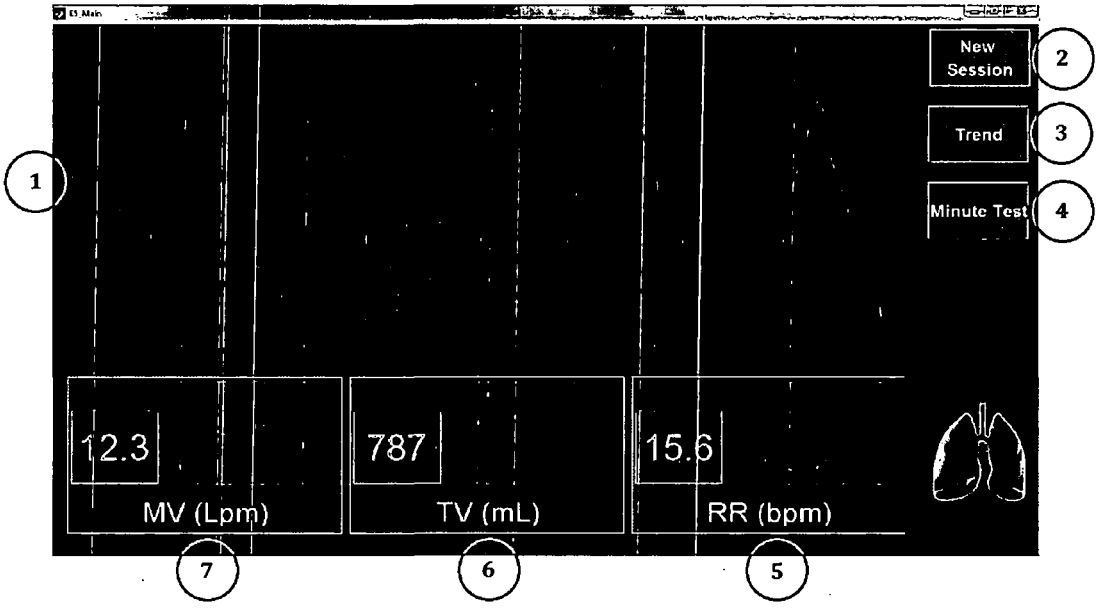

Figure 5 Monitoring Screen. Displays the calibrated respiratory curve and parameters.

Label	Button/Field	Function
1	Respiratory Curve	Tracks current respiratory curve in near real-time in 30-second blocks.
2	New Session	Allows the user to select a new or different patient for monitoring.
3	Trend	Brings user to trending screen.
4	Minute Test	Allows user to run discrete 60-second tests.
5	Respiratory Rate (RR)	Demonstrates graphical representation of RR over the past 60 minutes and provides current RR value.
6	Tidal Volume (TV)	Demonstrates graphical representation of TV over the past 60 minutes and provides current TV value.
7	Minute Ventilation (MV)	Demonstrates graphical representation of MV over the past 60 minutes and provides current MV value.

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Reviewing Patient Trends

The "Trends" tab graphically displays sequential measurements captured within the twenty-four hours of the current session (Fig. 7). Clicking this tab changes the display to show plots for respiratory rate, minute ventilation, and tidal volume. Above the plots is a dropdown menu which is used to select the time interval for the data in the table. Above the trending graphs is a horizontal scroll bar representing time. Move the scroll bar left or right to look at trends throughout the patient's monitoring period. Above the scroll bar is a schematic illustrating in blue when periods of ***ExSpiron***™ monitoring.

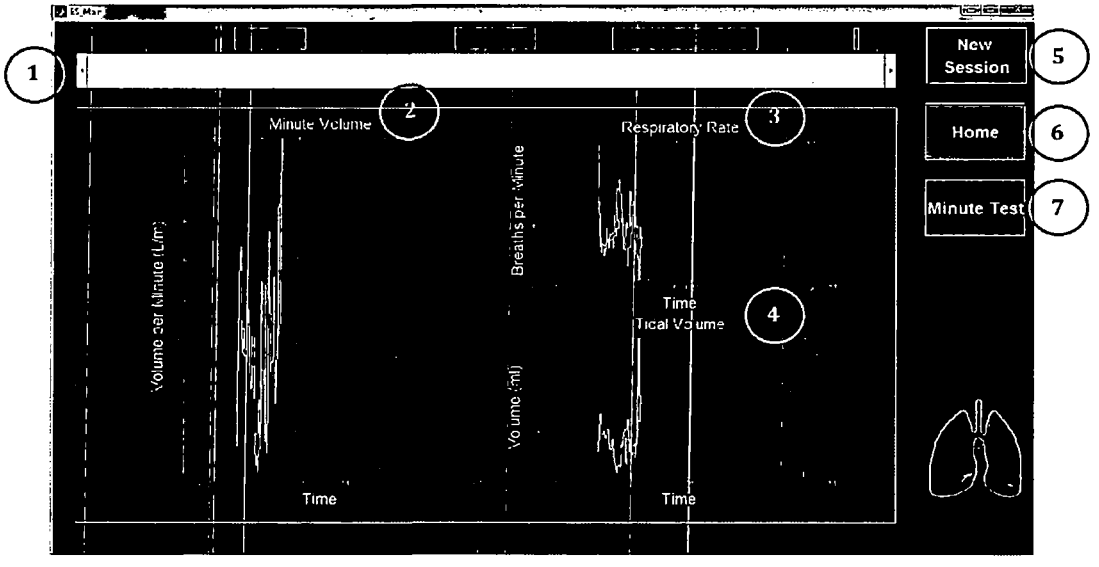

Figure 6 The Trends Tab. Respiratory rate (RR), minute volume (MV), and tidal volume (TV) trends graphs are plotted versus time.

Label	Field	Function
1	Scroll Bar	Moving the scroll (corresponds with time) will display trending graphs for those time periods.
2	MV Trending Graph	MV trends over 60 minutes.
3	RR Trending Graph	RR trends over 60 minutes.
4	TV Trending Graph	TV trends over 60 minutes.
5	New Session	Brings user back to patient ID screen.

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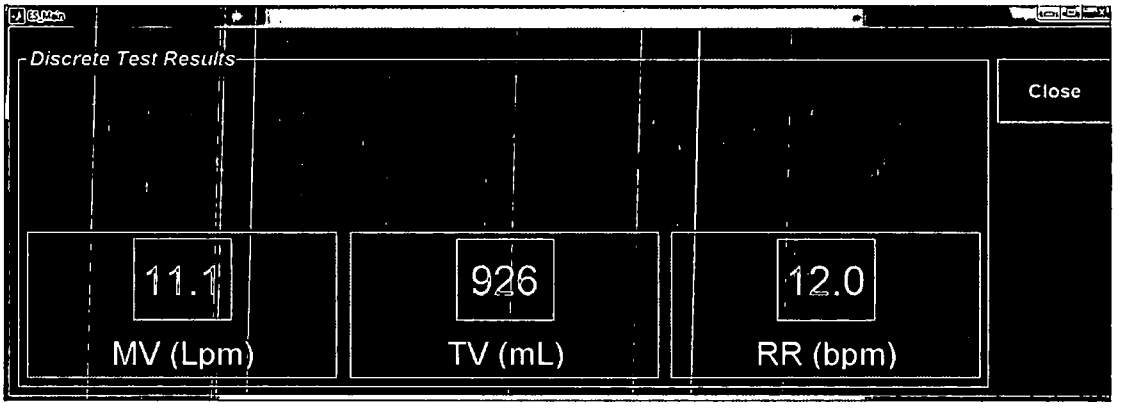
6	Home	Brings user back to the monitoring screen.
7	Minute Test	Allows user to run discrete 60-second tests.

Performing Minute Tests

Clicking on the Minute Test button will temporarily disable the monitoring screen. The progress bar demonstrates that the ***ExSpiron™*** is collecting data for 60 seconds. After the minute test has completed, the results are given as shown below. Click Close to exit the results screen and return to the regular monitoring screen.



Clinical Procedure

The following flow chart details the general procedure for clinical use of the ***ExSpiron™***.

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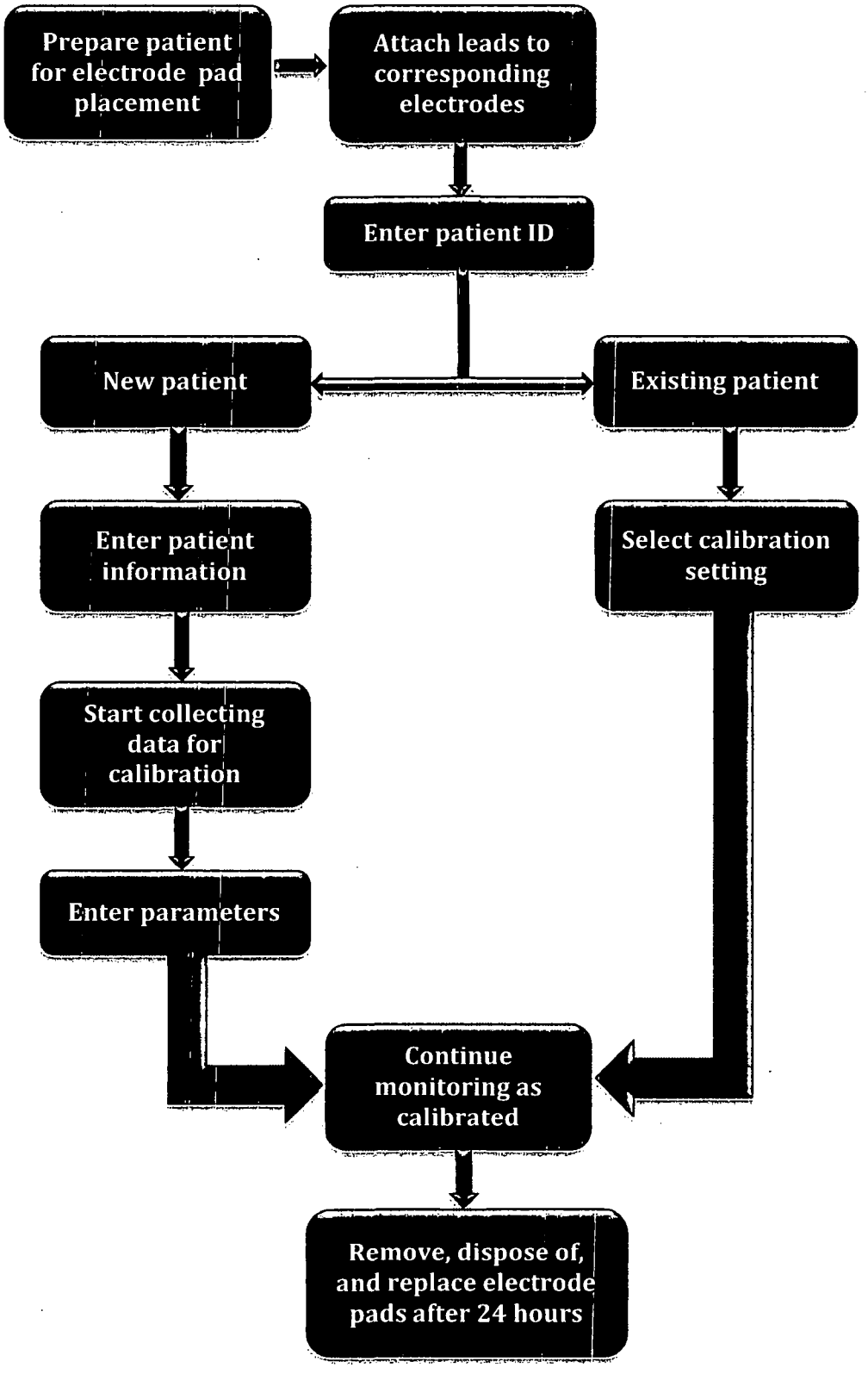

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Figure 7 Clinical Procedure Flow Chart. Start from patient selection to work through a complete monitoring session.

Signal Quality

Lack of adequate signal quality can result in a "flat line" displayed on the panel screen. Flat lining can be a result of the following:

- Electrode pads that are not in full contact with the patient's skin. Replace the electrode pads with new ones and record the event. Hair and sweat can affect the ability of the electrode pads to stick to the skin. Routine hospital preparation for electrode pad placement, such as abrasive cleansing or shaving of the area should be followed to avoid issues such as these. Electrodes are to be used no longer than 24 hours, but can be replaced sooner if necessary.
- Leads that are not properly attached to the electrode pads. Check lead-electrode pad attachment.
- Incorrect matching of electrode pad to lead. Check that the correct colored lead is attached to the correct electrode pad.
- Poor signal quality. Check that electrodes were attached in correct configuration. Anatomical differences can also cause poor signal quality.

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Understanding ExSpiron Readings

The following information should be used as informational purposes only and not for use of the ***ExSpiron***™ as a diagnostic tool.

Respiratory Rate

Respiratory Rate is defined as the number of breaths per minute. Respiratory Rate can be classified as normal, abnormally fast (tachypnea), abnormally slow (bradypnea), or nonexistent (apnea).

Tidal Volume

Tidal Volume is the total volume of air displaced between normal inspiration and expiration when extra effort is not applied.

Minute Ventilation

Minute Ventilation is the total volume of air displaced between normal inspiration and expiration over the duration of one minute. It can also be calculated as the product of tidal volume X respiratory rate.

Table 1 Normal Ranges of Respiratory Parameters.

Value	Normal Range	Description
Respiratory Rate	12-18 breaths/min	Breaths per minute
Tidal Volume	Dependent on gender and height. See graphs and tables below.	Milliliters per single breath
Minute Ventilation	RR x TV	Liters of aired breathed in one minute

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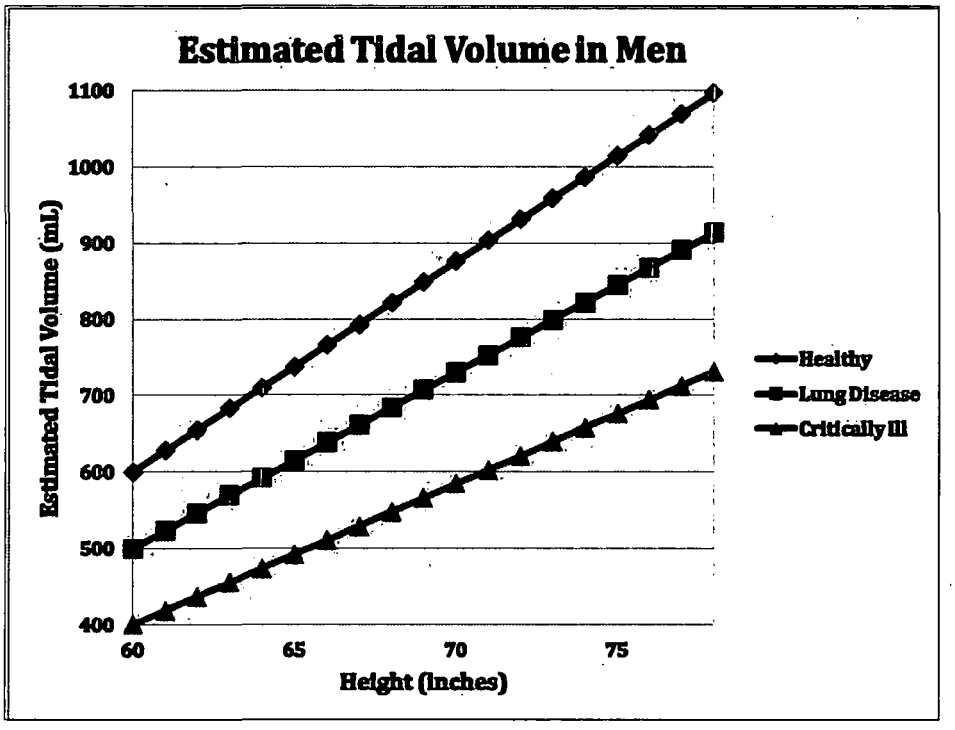
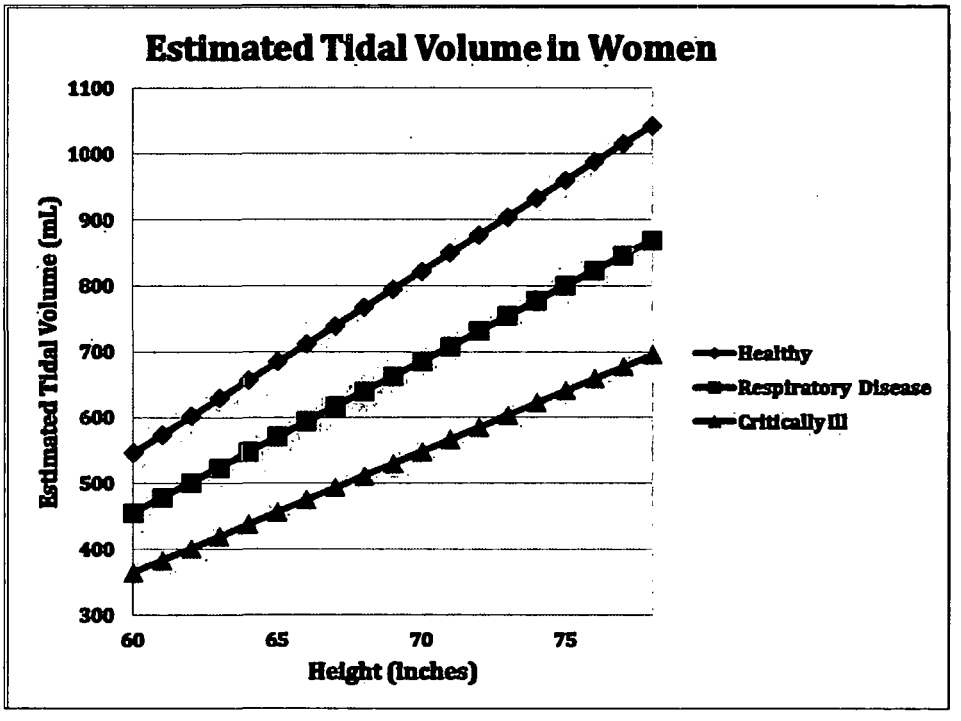


Graph 1 Estimated tidal volume in men based on height.



Graph 2 Estimated tidal volume in women based on height.

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Appendix A Accessories

Accessory	Model #
Exspiron™ Disposable Electrode Pads	200-010

Appendix B Specifications

Size	Computer Module	11.9" (H) x 8.7"(W) x 1.7" (D) 6.5" (H) x 4.5" (W) x 1.5" (D)
Weight		(Less than ten pounds)
Operating conditions		32° – 95° F 20% - 80% non-condensing humidity
Storage and transport conditions		-4° – 112° F 20% - 80% non-condensing humidity

The ***Exspiron™*** Power Supply is a switching power supply with input range:
100-240 V ~ 50/60 Hz 2 A

Standards compliance:

- IEC 60601-1 Second edition
  - Class 1 protection against electric shock.
  - Type BF applied part
  - Continuous duty cycle
  - Not suitable for use with flammable anesthetics

- IEC 60601-1-2: 2001
  - Class A Emissions

- FCC Certification

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Appendix C Clinical Studies to Determine Accuracy

Two similar clinical studies provided ExSpiron accuracy information. The first study compared ExSpiron measurements to measurements made with Wright/Haloscale Respirometer. This study produced measurement performance statistics and confirmed that the ExSpiron calibration is stable for 24 hours. The second study compared the Wright/Haloscale Respirometer to the Morgan SpiroAir LT diagnostic spirometer. Results of the two studies were combined mathematically to produce measurement performance statistics relative to the Morgan spirometer.

ExSprion – Wright comparison

A clinical study compared simultaneous measurements from the ExSpiron and the Wright spirometer. Twenty subjects representing a broad range of intended patients participated in the study. (Age range: 20-84, BMI range: 19.9-43.2, 11 female, 9 male) Tidal volume, minute ventilation, and respiratory rate were measured simultaneously by the ExSpiron and the Wright spirometer. Each subject returned twenty-four hours after the first session with the original electrodes still attached. Using the same individual calibration values, a second set of ten 60-second breathing tests was performed.

The results of the ExSpiron comparison indicate that the individual calibration is stable over a 24-hour period.

ExSpiron-Wright Comparison		Minute Ventilation	Tidal Volume	Respiratory Rate
Bias	**Overall**	**-2.1%**	**-1.9%**	**-0.2%**
	Day 1	-2.3%	-1.7%	-0.6%
	Day 2	-1.9%	-2.0%	0.2%
Precision	**Overall**	**10.5 %**	**10.3 %**	**2.0 %**
	Day 1	10.2%	9.7%	2.3%
	Day 2	10.8%	10.8%	1.6%
Accuracy	**Overall**	**10.7 %**	**10.4 %**	**2.0 %**
	Day 1	10.4%	9.8%	2.4%
	Day 2	10.9%	11.0%	1.6%

RMI performed a Bland-Altman analysis of the clinical trial data. (See Bland and Altman, The Lancet, vol. 327, issue 8476, pp. 307-310, February 1986.) The analyses confirmed that the average disparity between ExSpiron and the Wright spirometer was small and clinically irrelevant (differences of -0.2 bmp, -5ml and -0.14 L/min for RR, TV, and MV, respectively).

RMI calculated the difference between ExSpiron and the Wright spirometer for each measure (MV, TV, and RR) and calculated the average of ExSpiron and the predicate for each measure. The resulting plots are shown below. Data from different subjects are depicted with a different color/symbol combination (i.e. blue plus sign is one subject, cyan plus sign in another subject, blue circle is a third subject, etc.). The charts show each subject's averaged data. The middle black dashed line on each plot depicts the average difference and the upper and lower black

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dashed lines indicate the 95% confidence intervals (±2 SD from the mean). The mean differences between devices in all six plots are essentially zero.

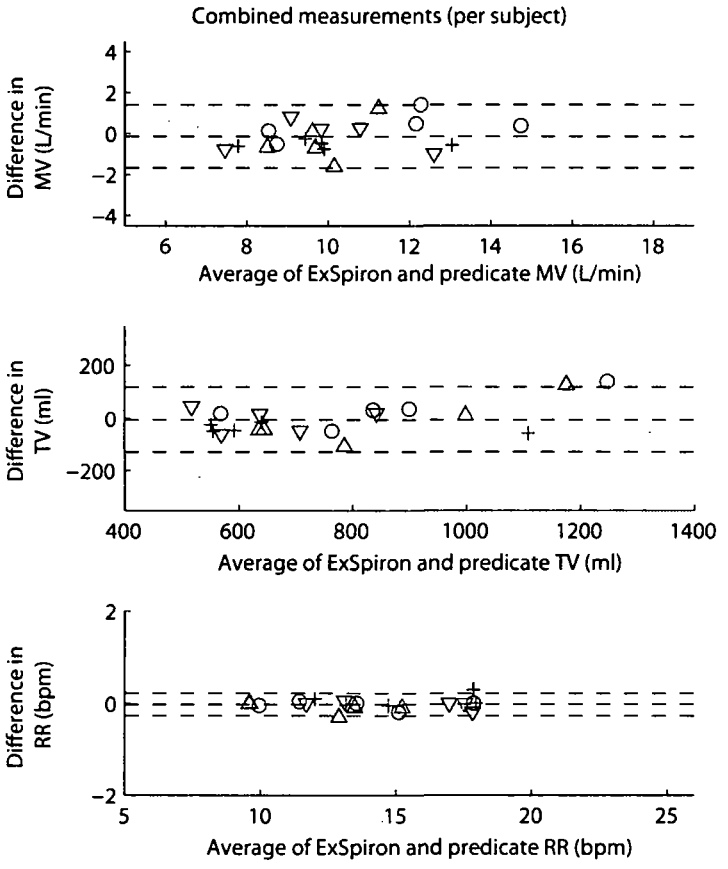

Figure 1 Bland-Altman plots of ExSpiron-Wright comparison

Subject demographics

The demographics of the twenty subjects are shown in these tables.

Age Range	
20-29	3
30-39	3
40-49	4
50-59	4
60-69	2
70-79	2
80-89	2

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Gender	
female	11
male	9

Race	
Asian	2
white	16
black	2
Hispanic	0

BMI Range		
18.5-24.9	11	normal
25-29.9	4	overweight
30-39.9	3	obese
40+	2	morbidly obese

The range of ages, 20-84, is consistent with ExSpiron's intended use with adults, at 21 years of age.

The maximum subject body mass index (BMI) was 43.2.

Subject hydration was not controlled in this study. Test data indicate that measurement performance is not sensitive to a subject's baseline impedance, an indicator of hydration.

Wright spirometer - Morgan SpiroAir LT diagnostic spirometer study

A second, similar study was performed comparing the Wright spirometer to the Morgan SpiroAir LT diagnostic spirometer. (The closed cell construction of the Morgan spirometer limits the individual breathing test time to 30 seconds. A direct comparison of the ExSpiron to the Morgan spirometer is not feasible.) A different set of twenty subjects participated. (Age range: 20-60, BMI range: 19.0-28.0, 9 female, 11 male) Each subject participated in one session performing twenty 30-second breathing tests with volume measurements made simultaneously with the Wright spirometer and the Morgan diagnostic spirometer.

The results of the Morgan-Wright comparison are consistent with the performance claims in their documentation, 2% accuracy for the Morgan and 2% accuracy in the tested flow range for the Wright. The Morgan-Wright study results were:

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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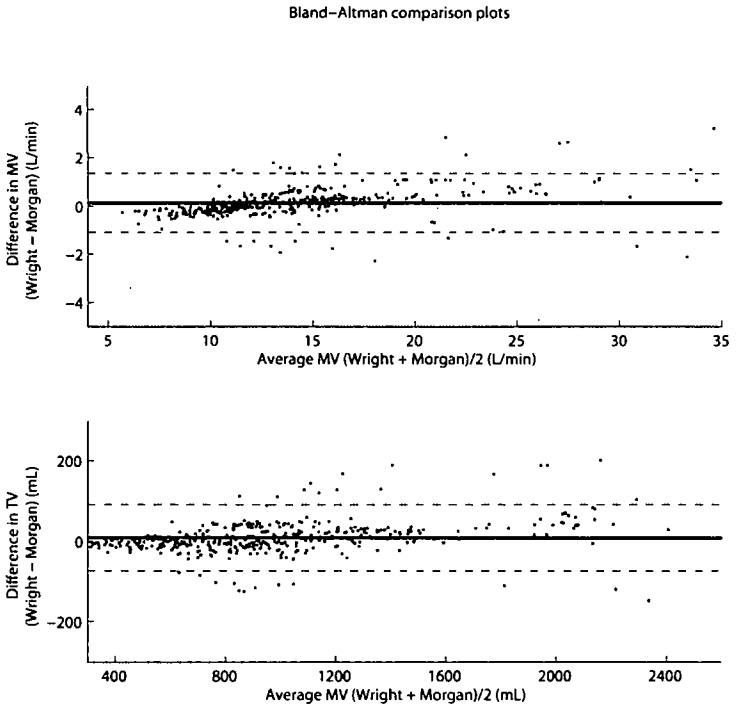

Figure 2: Bland-Altman plots. The average disparity between the two spirometers was confirmed to be small and clinically irrelevant (differences of 9 ml and 0.13 L/min for TV and MV, respectively). Both plots show individual data from all subjects and from all trials. The middle black solid line on each plot depicts the average difference and the upper and lower black dashed lines indicate the 95% confidence intervals (±2 SD from the mean). The mean differences between devices in both plots are essentially zero.

ExSpiron – Morgan Calculated Measurement Performance

Combining the results of the ExSpiron-Wright comparison and the Wright-Morgan comparison provided calculated estimates of ExSpiron bias and accuracy with respect to the Morgan diagnostic spirometer:

ExSpiron-Morgan	Minute Ventilation	Tidal Volume
Bias	-1.7%	-1.5%
Accuracy	9.9%	9.6%

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Appendix 3
Revised Indications for Use

The Indications for Use form begins on the next page.

The change is the removal of "with potential respiratory compromise" and "to determine respiratory status and appropriate therapy."

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Indications For Use

510(k) Number (if known): K120087
Device Name: ExSpiron
Indications for Use:

ExSpiron is indicated for use by healthcare professionals in healthcare facilities, such as post-operative care and critical care units, to monitor breathing in adult (at least 21 years of age) patients.

ExSpiron is a non-invasive system that graphically displays lung volume against time and reports an approximate value of:

- Tidal volume,
- Respiratory rate, and
- Minute ventilation.

ExSpiron measurements are used as an adjunct to other clinical information sources.

Prescription Use ___X____ AND/OR Over-The-Counter Use_____
(Part 21 CFR 801 Subpart D) (Part 21 CFR 801 Subpart C)

(PLEASE DO NOT WRITE BELOW THIS LINE-CONTINUE ON ANOTHER PAGE IF NEEDED)

Concurrence of CDRH, Office of Device Evaluation (ODE)

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118

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Appendix 4
Revised Promotional Claims

Changes are the removal of claims as requested by FDA.

Promotional labeling for the ExSpiron monitor will include these claims:

- ExSpiron can monitor breathing in adult patients.
- ExSpiron assists in monitoring patients in near real-time.
- ExSpiron is non-invasive, point-of-care, and quantitative.
- ExSpiron provides quantitative measurement of:
  - Minute Ventilation (MV)
  - Tidal Volume (TV)
  - Respiratory Rate (RR)
- ExSpiron can measure MV, TV, and RR in non-ventilated patients.
- ExSpiron displays measurement values both numerically and graphically, displaying trend data.
- ExSpiron can quantify a patient's respiratory status and provide trending data in their respiratory parameters.
- MV, TV, and RR are important parameters for assessment of respiratory status. ExSpiron displays MV, TV, and RR over time. Changes in values over time can be compared.
- ExSpiron reports measurement in a user-friendly format.
- ExSpiron, as a bioimpedance monitor, does not require a breathing device, e.g., a spirometer, in the breathing path to obtain MV and TV.
- ExSpiron does not require participation of the patient to generate spirometry-like results.
- ExSpiron measures respiration without potential contamination that could result from having a monitor or probe (e.g. a capnometer or spirometer) in the patient's air-stream.
- ExSpiron measurements of MV, TV and RR do not rely on the measurement of sound.
- ExSpiron provides objective data about respiratory status that may facilitate better patient care.

Questions? Contact FDA/CDRH/OCE/DID at CDRH-FOISTATUS@fda.hhs.gov or 301-796-8118