On February 2, 2024, FDA published the final rule to amend the Quality System (QS) regulation in 21 CFR part 820 (89 FR 7496, effective February 2, 2026). The revised 21 CFR part 820 is now titled the Quality Management System Regulation (QMSR). The QMSR harmonizes quality management system requirements by incorporating by reference the international standard specific for medical device quality management systems set by the International Organization for Standardization (ISO), ISO 13485:2016. The FDA has determined that the requirements in ISO 13485 are, when taken in totality, substantially similar to the requirements of the QS regulation, providing a similar level of assurance in a firm's quality management system and ability to consistently manufacture devices that are safe and effective and otherwise in compliance with the Federal Food, Drug, and Cosmetic Act (FD&C Act).

This guidance document was issued prior to the effective date of the final rule. FDA encourages manufacturers to review the current QMSR to ensure compliance with the relevant regulatory requirements.

Contains Nonbinding Recommendations

Arthroscopy Pump Tubing Sets Intended for Multiple Patient Use - Premarket Notification (510(k)) Submissions

Guidance for Industry and Food and Drug Administration Staff

Document issued on December 23, 2021.

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For questions about this document, contact OHT6: Office of Orthopedic Devices/DHT6C: Division of Restorative, Repair, and Trauma Devices at (301) 796-5650.

U.S. Department of Health and Human Services
Food and Drug Administration
Center for Devices and Radiological Health

Preface

Public Comment

You may submit electronic comments and suggestions at any time for Agency consideration to https://www.regulations.gov. Submit written comments to the Dockets Management Staff, Food and Drug Administration, 5630 Fishers Lane, Room 1061, (HFA-305), Rockville, MD 20852. Identify all comments with the docket number FDA-2019-D-5606. Comments may not be acted upon by the Agency until the document is next revised or updated.

Additional Copies

Additional copies are available from the Internet. You may also send an email request to CDRH-Guidance@fda.hhs.gov to receive a copy of the guidance. Please include the document number 1500066 and complete title of the guidance in the request.

Table of Contents

Arthroscopy Pump Tubing Sets Intended for Multiple Patient Use - Premarket Notification (510(k)) Submissions

Guidance for Industry and Food and Drug Administration Staff

This guidance represents the current thinking of the Food and Drug Administration (FDA or Agency) on this topic. It does not establish any rights for any person and is not binding on FDA or the public. You can use an alternative approach if it satisfies the requirements of the applicable statutes and regulations. To discuss an alternative approach, contact the FDA staff or Office responsible for this guidance as listed on the title page.

I. Introduction and Scope

This guidance document provides recommendations for 510(k) submissions for arthroscopy pump tubing sets intended for multiple patient use. These devices are designed to deliver irrigation fluid to the surgical site, such as knee, shoulder, hip, elbow, ankle, and wrist joint cavities, during arthroscopic procedures.

In arthroscopic procedures, clinicians often use a single source of irrigation fluid for multiple patients without replacing the source of irrigation fluid or replacing or reprocessing the irrigation tubing system between patients. This practice may increase the risk of cross-contamination between patients and subsequent iatrogenic infection, because the irrigation system can become contaminated with patient fluids that travel back through the irrigation tubing (a phenomenon hereafter referred to as "backflow"). FDA has received reports of backflow of patient fluids which raises the question of potential for disease transmission when using irrigation and tubing systems in such a manner on multiple patients.

This guidance outlines the device design considerations, risk mitigation strategies, and testing recommendations for arthroscopy pump tubing sets intended for multiple patient use. This guidance document also clarifies the terminology used to describe arthroscopy pump tubing sets intended for multiple patient use.

The scope of this document is limited to Class II, arthroscopy pump tubing sets classified under the following regulation:

21 CFR 888.1100 Arthroscope.
An arthroscope is an electrically powered endoscope intended to make visible the interior of a joint. The arthroscope and accessories also is intended to perform surgery within a joint.

Devices that supply arthroscopic irrigation are found under product code HRX and require premarket notification (510(k)). These irrigation devices may be part of an arthroscopy pump system or marketed separately as accessories to arthroscopy pump systems.

While FDA believes the recommendations listed below serve as rigorous risk mitigation strategies for reducing the risk of cross-contamination between patients, it should be noted that the only way to eliminate the risk of cross-contamination from multiple patient use is to utilize single patient use arthroscopy pump tubing sets.

For the current edition of the FDA-recognized consensus standard(s) referenced in this document, see the FDA Recognized Consensus Standards Database.[1] For more information regarding use of consensus standards in regulatory submissions, refer to the FDA guidance titled "Appropriate Use of Voluntary Consensus Standards in Premarket Submissions for Medical Devices."[2]

The contents of this document do not have the force and effect of law and are not meant to bind the public in any way, unless specifically incorporated into a contract. This document is intended only to provide clarity to the public regarding existing requirements under the law. FDA guidance documents, including this guidance, should be viewed only as recommendations, unless specific regulatory or statutory requirements are cited. The use of the word *should* in Agency guidance means that something is suggested or recommended, but not required.

II. Definitions

For the purposes of this guidance, FDA provides the following definitions for terms used to describe arthroscopy pump systems and tubing sets. We provide additional explanations for these terms in Figure 1. We recommend that arthroscopy pump tubing set manufacturers adopt similar definitions in both the labeling and in 510(k) submissions to ensure consistency in the use and premarket review of these devices.

FDA is defining both terms "single-use device" and "disposable" to refer to a device that is used on a single patient during a single procedure and then discarded. A single procedure performed on one patient, hereafter referred to as a "patient use," may include multiple insertions of an arthroscope that is connected to an arthroscopy pump system and associated tubing into the patient.

[1] Available at https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfStandards/search.cfm.
[2] Available at https://www.fda.gov/regulatory-information/search-fda-guidance-documents/appropriate-use-voluntary-consensus-standards-premarket-submissions-medical-devices.

- 24 Hour Use or Day Use: The use of a device for 24 hours with no reprocessing between patient uses. A device labeled "24 Hour Use" or "Day Use" implies multi-patient use.

- Backflow-Prevention Valve: The valve that is intended to prevent the proximal irrigation system from being contaminated by backflow of fluids from the patient (see Figure 1). When multiple valves are present in the irrigation system, the backflow-prevention valve is the one closest to the patient. The backflow-prevention valve may also be referred to as a "one-way valve."

- Consumable: A device that is intended to be discarded or replaced after use, with no reprocessing. Consumable devices include all single-use devices (see definition below) and the subset of multi-patient use devices that are discarded after a specified time period (e.g., 24 hours).

- Cross-contamination: The transfer of potentially harmful substances or disease-causing microorganisms from one patient to another patient.

- Irrigation Fluid: Fluid used to irrigate the surgical site during arthroscopic procedures by use of an arthroscopy pump system. Commonly, the irrigation fluid used is saline.

- Irrigation System: The irrigation fluid container (e.g., saline bag) and associated tubing, valves, and connectors used with the irrigation fluid for irrigation of the surgical site during arthroscopic procedures. The irrigation system may be subdivided into the following components:

    - Distal Irrigation System: All components of the irrigation system between the patient (e.g., distal tubing) and the distal (patient-side) connector, including the backflow-prevention valve. In arthroscopy tubing sets intended for multi-patient use, the distal irrigation system is typically discarded after use in each patient (i.e., single-use).

    - Proximal Irrigation System: All components of the irrigation system between the source of irrigation fluid (e.g., saline bag) and the proximal (pump-side) connector. In arthroscopy tubing sets intended for multi-patient use, the proximal irrigation system is typically used in multiple patients (i.e., multi-patient use) for a specified duration or number of uses and then discarded.

- Multiple Patient Use (Multi-Patient Use) Device: A device that is intended to be used on multiple patients, either with reprocessing (for reusable devices) or without reprocessing (for consumable devices) between patient uses.

- Reprocessing: Validated processes used to render a medical device fit for a subsequent single use on another patient after it has been previously used or contaminated. These processes are designed to remove soil and contaminants by cleaning and to inactivate microorganisms and viruses by disinfection or sterilization. For guidance regarding

reprocessing of reusable medical devices, please see "Reprocessing Medical Devices in Health Care Settings: Validation Methods and Labeling."[3]

- Reusable Medical Device: A device intended for repeated use, either on the same or different patients, with appropriate cleaning and disinfection or sterilization between uses.

- Single-Use Device (SUD) or Disposable Device: A single-use device, also referred to as a disposable device, is intended for use on one patient during a single procedure. It is not intended to be reprocessed (cleaned and disinfected or sterilized) and used on the same patient in a different procedure or on another patient.

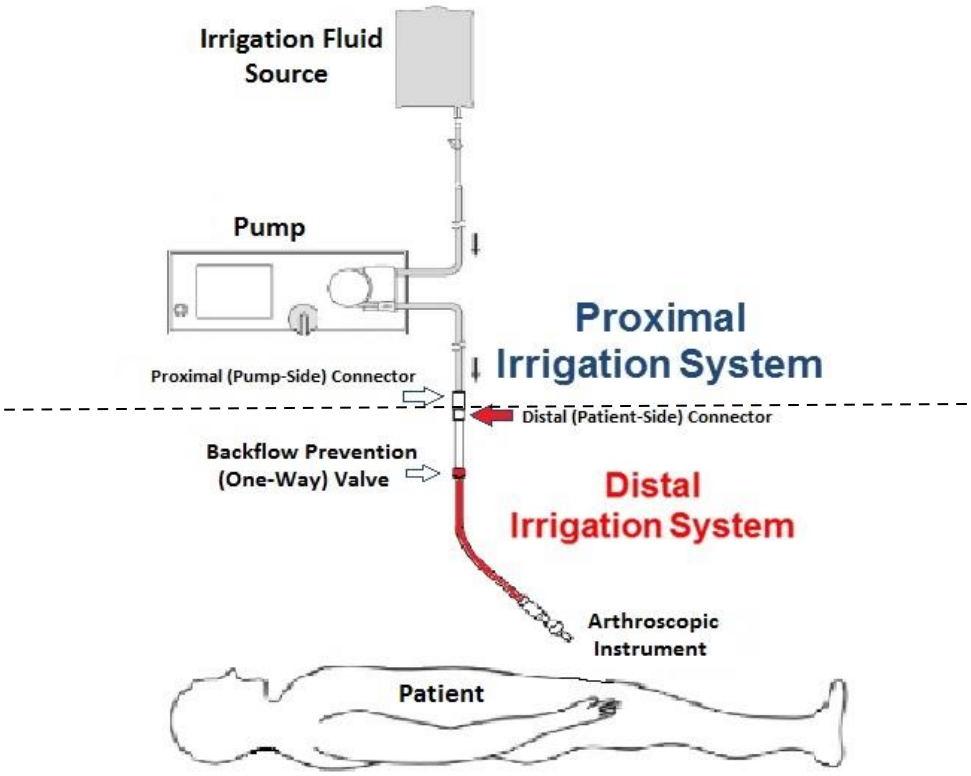

Figure 1. Example configuration of an Arthroscopy Pump Tubing Set for Multiple Patient Use. While not all arthroscopic pump tubing sets may exhibit this configuration, this example illustrates several of the critical terms used in this guidance document. A backflow-prevention (one-way) valve divides the irrigation system into a single-use distal irrigation system and a multi-patient use proximal irrigation system.

[3] https://www.fda.gov/regulatory-information/search-fda-guidance-documents/reprocessing-medical-devices-health-care-settings-validation-methods-and-labeling.

III. Premarket Submission Recommendations

A. Indications for Use

Arthroscopy pump tubing systems that have been designed and validated for multiple patient use should include this information in the indications for use statement, along with the maximum validated use time (e.g., "24 Hour Use") or use lives ("Up to 8 Procedures").

B. Device Description

We recommend you identify your device by the applicable regulation number and product code indicated in Section I above and include the information described below.

Submissions should include a description of all device components integral to the multiple patient use tubing sets, including those listed below and any other design features intended to reduce the risk of backflow for allowing multiple patient use. We recommend that you also provide illustrative schematics and/or engineering drawings of each device component, identify important design features, compare the similarities/differences of those features to legally marketed devices, and identify any applicable FDA-recognized consensus standards.

(1) Backflow-Prevention (One-way) Valve

We recommend that a description of the basic function and specifications of the backflow-prevention valve include the following:

- Maximum flow rate
- Reverse flow rate during closing of the valve and leakage under back pressure
- Pressure differentials for valve opening and closing
- Cracking pressure, i.e, the pressure required to open the valve
- Maximum back pressure, i.e., the maximum back pressure the valve can withstand before failure
- Valve design and mechanism for preventing backflow of fluids
- Materials of construction, including chemical formulation and identification of any color additives, lubricants, bonding agents, plasticizers, or other additives (e.g., ink, dyes, markings, radiopaque materials) and their amounts
- Non-pyrogenicity and sterility status

(2) Connectors

We recommend that a description of all connectors used in the device include the following:

- Connector types (e.g., Luer lock, slip fit, other screw types)

- Types of configurations
- Proximal and distal end configuration:
    - Shape
    - Location
    - Diameter of any outlets or ports
    - Duration of use for each end configuration (multi-patient use or single-use)
- Physical dimensions:
    - Inner diameter
    - Outer diameter
    - Length
    - Width
- Connection/reconnection mechanism of action
- Connector performance criteria/specifications (e.g., to prevent leakage or maintain sterility)
- Non-pyrogenicity and sterility status
- Materials of construction, including chemical formulation and identification of any color additives, lubricants, bonding agents, plasticizers, or other additives (e.g., ink, dyes, markings, radiopaque materials) and their amounts
- Any other unique physical features and specifications

(3) Tubing

We recommend that a description of the tubing include the following:

- Configuration of all tubing sets
- Identification of the functions of each tubing component (e.g., inflow line, suctioned waste line)
- Identification of parts mechanically stressed during normal operation by peristaltic rollers, tubing clamps, etc.
- Identification of proximal and distal tubing components, and the duration of use for each tubing component (multi-patient use or single-use)
- Physical dimensions:
    - Inner diameter
    - Outer diameter
    - Length
- Non-pyrogenicity and sterility status
- Materials of construction, including chemical formulation and identification of any color additives, lubricants, bonding agents, plasticizers, or other additives (e.g., ink, dyes, markings, radiopaque materials) and their amounts
- Any other relevant physical or performance specifications

(4) Pump

We recommend that you provide any relevant physical, performance, or safety specifications of the arthroscopy pump(s) intended to be used with the tubing sets that

would aid in the understanding of the tubing set functionality. For example, it is recommended that you describe the following aspects of the pump(s):

- The pump manufacturer and model number as well as the 510(k) number for previously cleared pumps
- Minimum and maximum flow rates
- Safety features designed to monitor pressure in the system and prevent over-pressurization or reverse flow, including their mechanism of action
- Mechanism for connection of the tubing sets to the pump
- Pump mechanism of action to create fluid flow
- Pump pressure head vs. flow curves to characterize the pump capability for given levels of back pressure
- Any other flow or pressure specifications
- Any other operating elements that may affect pressure or flow, such as gravity vs. suctioned outflow, elevated irrigation fluid bags, or pressure drops caused by attachment of arthroscopic instruments, and any control functions to react to those pressure or flow changes

C. Risk Management

We recommend that you apply accepted risk management principles, such as those described in the currently recognized version of ISO 14971: *Medical devices – Application of risk management to medical devices,* while conducting the risk analysis as part of your design controls required in 21 CFR 820 during the development of your device. We recommend that you submit risk management information that identifies hazardous situations, estimates the risks (e.g., risks of device malfunction, adverse tissue reaction, infection, use error, extravasation), describes risk control measures and overall residual risk specific to your device. Certain verification and validation testing performed as a result of these activities should be provided (as described in Sections D through J).

D. Biocompatibility

Significance: Arthroscopy pump tubing sets contain patient-contacting materials, which, when used for their intended purpose (i.e., contact type and duration), may induce a harmful biological response.

Recommendation: You should determine the biocompatibility of all patient-contacting materials present in your device. If your device is identical in composition and processing methods to arthroscopy pump tubing sets with a history of successful use, you may reference previous testing experience or the literature, if appropriate. For some device materials, it may be appropriate to provide a reference to either a recognized consensus standard, or to a Letter of Authorization (LOA) for a device Master File (MAF). You should refer to the following FDA webpage for additional information on using device MAFs: https://www.fda.gov/medical-devices/premarket-approval-pma/master-files.

Differences in formulation, processing, sterilization, or device surface properties (e.g., submicron or nanoscale components) that could affect biocompatibility of the final product may warrant additional biocompatibility testing.

If you are unable to identify a legally marketed predicate device with similar location/duration of contact and intended use that uses the same materials as used in your device, we recommend you conduct and provide a biocompatibility risk assessment. The assessment should explain the relationship between the identified biocompatibility risks, the information available to mitigate the identified risks, and any knowledge gaps that remain. You should then identify any biocompatibility testing or other evaluations that were conducted to mitigate any remaining risks.

We recommend that you follow FDA's guidance "Use of International Standard ISO 10993-1, 'Biological evaluation of medical devices - Part 1: Evaluation and testing within a risk management process,'"[4] which identifies the types of biocompatibility assessments that should be considered and recommendations regarding how to conduct related tests.

Per ISO 10993-1: *Biological evaluation of medical devices – Part 1: Evaluation and testing within a risk management process* and Attachment A of FDA's guidance on ISO 10993-1, arthroscopy pump tubing sets are external-communicating devices in contact with tissue/bone/dentin for a limited contact duration. Therefore, the following endpoints should be addressed in your biocompatibility evaluation:

- cytotoxicity;
- sensitization;
- irritation or intracutaneous reactivity;
- acute systemic toxicity; and
- material mediated pyrogenicity.

E. Sterility

Significance: Arthroscopy pump tubing sets indirectly contact tissue and bone and should be adequately sterilized to minimize infections and related complications.

Recommendation: For arthroscopy pump tubing sets labeled as sterile, we recommend that you provide information for the final device in accordance with FDA's guidance "Submission and Review of Sterility Information in Premarket Notification (510(k)) Submissions for Devices Labeled as Sterile."[5]

[4] https://www.fda.gov/regulatory-information/search-fda-guidance-documents/use-international-standard-iso-10993-1-biological-evaluation-medical-devices-part-1-evaluation-and.
[5] https://www.fda.gov/regulatory-information/search-fda-guidance-documents/submission-and-review-sterility-information-premarket-notification-510k-submissions-devices-labeled.

F. Reprocessing

Significance: If any of the components or accessories (e.g., arthroscopic instruments, etc.) of the arthroscopic pump tubing system are reused, they should be adequately cleaned, disinfected and sterilized between uses to minimize infections and prevent device degradation.

Recommendation: Validated instructions on how to reprocess a reusable device or single-use device that is provided non-sterile to the user are critical to ensure that a device is appropriately prepared for its initial and subsequent uses. We also recommend that you apply principles of human factors and usability engineering, which include risk management focused on user interactions, to the development and validation of appropriate reprocessing instructions to support safe and effective use of the device.

As required under Section 3059 of the 21st Century Cures Act (Pub. L. 114-255), 82 FR 26807 was published on June 9, 2017,[6] which states that sponsors are required to provide reprocessing validation data and validated reprocessing instructions in 510(k) submissions for devices under product code HRX that possess design features which may pose a challenge to adequate reprocessing. For recommendations regarding the development and validation of reprocessing instructions in your proposed device labeling, refer to FDA's guidances "Reprocessing Medical Devices in Health Care Settings: Validation Methods and Labeling"[7] and "Applying Human Factors and Usability Engineering to Medical Devices."[8]

G. Pyrogenicity

Significance: Pyrogenicity testing is used to help protect patients from the risk of febrile reaction due to gram-negative bacterial endotoxins and/or chemicals that can leach from a medical device (e.g., material-mediated pyrogens).

Recommendation: To address the risks associated with the presence of bacterial endotoxins, arthroscopy pump tubing sets should meet pyrogen limit specifications by following the recommendations outlined in FDA's guidance "Submission and Review of Sterility Information in Premarket Notification (510(k)) Submissions for Devices Labeled as Sterile."[9] You should also follow the recommendations in "Guidance for Industry: Pyrogen and Endotoxins Testing: Questions and Answers."[10] To address the risks associated with material-mediated endotoxins, follow the recommendations in FDA's guidance "Use of International Standard ISO 10993-1,

[6] Available at https://www.federalregister.gov/documents/2017/06/09/2017-12007/medical-devices-validated-instructions-for-use-and-validation-data-requirements-for-certain-reusable.
[7] https://www.fda.gov/regulatory-information/search-fda-guidance-documents/reprocessing-medical-devices-health-care-settings-validation-methods-and-labeling.
[8] https://www.fda.gov/regulatory-information/search-fda-guidance-documents/applying-human-factors-and-usability-engineering-medical-devices.
[9] https://www.fda.gov/regulatory-information/search-fda-guidance-documents/submission-and-review-sterility-information-premarket-notification-510k-submissions-devices-labeled.
[10] https://www.fda.gov/regulatory-information/search-fda-guidance-documents/pyrogen-and-endotoxins-testing-questions-and-answers.

'Biological evaluation of medical devices - Part 1: Evaluation and testing within a risk management process.'"[11]

For devices intended to be labeled as "non-pyrogenic," we recommend that both bacterial endotoxins and material-mediated pyrogens be addressed.

H. Shelf Life and Packaging

Significance: Shelf life testing is conducted to support the proposed expiration date through evaluation of the package integrity for maintaining device sterility and/or evaluation of any changes to device performance or functionality.

Recommendation: With respect to package integrity for maintaining device sterility, you should provide a description of the packaging, including how it will maintain the device's sterility, and a description of the package integrity test methods, but not the package test data. We recommend that package integrity test methods include simulated distribution and associated package integrity, as well as simulated (and/or real-time) aging and associated seal strength testing, to validate package integrity and shelf life claims. We recommend you follow the methods described in the FDA-recognized series of consensus standards AAMI/ANSI/ISO 11607-1: *Packaging for terminally sterilized medical devices – Part 1: Requirements for materials, sterile barrier systems and packaging* and AAMI/ANSI/ISO 11607-2: *Packaging for terminally sterilized medical devices – Part 2: Validation requirements for forming, sealing and assembly processes.*

With respect to evaluating the effects of aging on device performance or functionality, shelf life studies should evaluate the critical device properties to ensure it will perform adequately and consistently during the entire proposed shelf life. To evaluate device functionality, we recommend that you assess each of the bench tests described in Section III.J (Non-Clinical Performance Testing) and repeat, using aged devices, all tests that evaluate design components or characteristics that are potentially affected by aging.

We recommend that you provide a summary of the test methods used for your shelf life testing, results and the conclusions drawn from your results. If you use devices subject to accelerated aging for shelf life testing, we recommend that you specify the way in which the devices were aged. We recommend that you age your devices as per the currently FDA-recognized version of ASTM F1980: *Standard Guide for Accelerated Aging of Sterile Barrier Systems for Medical Devices* and specify the environmental parameters established to attain the expiration date. For devices or components containing polymeric materials or coatings, you should conduct testing on real-time aged samples to confirm the results of the accelerated aging study. This testing should be conducted in parallel with 510(k) review and clearance with results documented to file in the design history file (i.e., complete test reports do not need to be submitted to FDA).

[11] https://www.fda.gov/regulatory-information/search-fda-guidance-documents/use-international-standard-iso-10993-1-biological-evaluation-medical-devices-part-1-evaluation-and.

I. Mitigation of Cross-Contamination Risk

Significance: Without proper mitigation strategies, backflow of patient fluids through the irrigation system of arthroscopic tubing sets can increase the risk of cross-contamination between patients and subsequent iatrogenic infection.

Recommendation: The risk of cross-contamination from multiple patient use of arthroscopy pump tubing sets can be mitigated by a combination of device design, labeling, proper device handling and performance testing, as described below. While FDA believes the recommendations listed below serve as rigorous risk mitigation strategies, it should be noted that the only way to eliminate the risk of cross-contamination from multi-patient use is to utilize single patient use arthroscopy pump tubing sets.

Manufacturers of arthroscopy pump tubing sets intended for multiple-patient use must establish and maintain procedures for validating the design of their device, which shall ensure that the device conforms to defined user needs and intended uses (21 CFR 820.30(g)). FDA interprets this to require manufacturers to validate the design, including instructions for use and associated claims, of such devices to ensure that the device can be safely and effectively used as intended. Therefore, we recommend you provide information in your 510(k) submission addressing the following items:

(1) Device Design

a. Prevention of Backflow to the Proximal Irrigation System

We recommend that the device design include at least one backflow-prevention valve or other feature that prevents the backflow of fluids into the irrigation system. Consideration should be given to redundant design/safety features for backflow prevention or reduction (e.g., a critical length of tubing that may reduce the potential for contaminated fluid to reach the backflow-prevention valve, pump mechanisms to prevent reverse flow). This valve or other feature should be tested with quantitative chemical and/or microbiological assays to demonstrate that it is capable of preventing the backward flow of fluids and contamination of the irrigation system by microorganisms, as described below in Section III.J.(2) (Backflow-Prevention Valve Testing).

In the absence of a backflow-prevention valve or other feature demonstrated to prevent backflow and contamination, the irrigation system is not appropriate for multi-patient use and should instead be discarded after every patient use to reduce the risk of patient infection.

b. Components of the Distal Irrigation System

Currently, some multiple patient use device designs include separation of the tubing sets into a distal single-use component (with respect to the irrigation fluid source) that

includes a backflow-prevention valve, and a proximal "Day Use" component that does not include the backflow-prevention valve.

It should be noted that the risk of cross-contamination cannot be completely eliminated with multi-patient use tubing, even when a backflow-prevention valve is used. FDA is not aware of any methods for assuring complete prevention of contamination of the backflow-prevention valve. Therefore, it is recommended that all device components in the distal irrigation system, including the backflow-prevention valve, be discarded after every patient use.

c. Components of the Proximal Irrigation System

Manufacturers may wish to indicate proximal irrigation system components for use in multiple patients over a certain time period (e.g., 24 hours), and then to be discarded. In order to confirm that such components are acceptable for this type of use, performance data to support use in multiple patients over the proposed time duration should be provided to demonstrate that the backflow-prevention valve or other feature in the distal irrigation system adequately prevents backflow into the proximal irrigation system, and provides adequate mitigation against the risk of cross-contamination between patients. See Section III.J below for additional information regarding recommended performance testing. Alternatively, the proximal irrigation system should be discarded after every patient use.

d. Reusable Devices used with the Irrigation System

While tubing components of the distal and proximal irrigation system are not typically reusable, the irrigation system may be used with devices and/or accessories (e.g., arthroscopic instruments, etc.) that are reusable. Any reusable devices should be designed to withstand multiple cleaning and sterilization cycles. Manufacturers should provide reprocessing validation data for reusable device components in their 510(k) submissions and provide clear, comprehensive instructions for reprocessing these components after every patient use. See Section III.F above for additional information regarding reprocessing.

J. Non-Clinical Performance Testing

Significance: Non-clinical performance testing is conducted to demonstrate that the device performs as intended and that all labeling statements, including identification of multi-patient use (e.g., "24 Hour Use", "Up to 8 Procedures"), are appropriately validated.

Recommendation: We recommend that non-clinical performance testing of arthroscopy pump tubing sets intended for multiple patient use include bench testing, backflow-prevention valve testing, and microbial ingress testing, as described below.

For all performance testing you perform, we recommend that you provide complete test reports. For information on recommended content and format of complete test reports for non-clinical bench performance testing in premarket submissions, refer to FDA's guidance, "Recommended Content and Format of Test Reports for Non-Clinical Bench Performance Testing in Premarket Submissions."[12]

(1) Bench Testing

We recommend that you conduct all testing under simulated use conditions, including use of a compliance model to simulate the joint, a wet environment simulating fluids being administered, and other conditions affecting operation, such as periodic changes in flow and pressure triggered by use of suction equipment. We recommend that you evaluate your device compared to a similar legally marketed device,[13] using clinically relevant worst case simulated static and dynamic forces to the failure point of the components. We also recommend that you describe how you determined the worst case conditions used in your testing.

Your testing should address the following:

a) Cycle testing of connections, with inspection for mechanical damage and fluid leakage

b) Evaluation of tubing performance on new versus end-of-life devices to demonstrate the maintenance of tubing integrity after the intended use life of the device, including:

   i. Pressure and flow control performance

   ii. Correct operation of over-pressurization safety features that may be affected by loss of tubing integrity

(2) Backflow-Prevention Valve Testing

Testing should be conducted to verify that the backflow-prevention valve(s) used in the irrigation system are effective to prevent contaminated fluid from the surgical site from entering into the irrigation system during the clinical procedure (i.e., backflow). We recommend that the testing be performed with both a microbiological and chemical marker to investigate the potential for backflow in the system.

Your testing should address the following:

[12] https://www.fda.gov/regulatory-information/search-fda-guidance-documents/recommended-content-and-format-non-clinical-bench-performance-testing-information-premarket.
[13] https://www.fda.gov/regulatory-information/search-fda-guidance-documents/510k-program-evaluating-substantial-equivalence-premarket-notifications-510k.

a) Assessment of the volume of fluid that would backflow from the surgical site to the backflow-prevention valve and the time it would take for the backflow of fluid to reach the valve if backflow conditions were to occur

b) Investigation of the length of tubing that may reduce the risk of backflow of fluids at the surgical site from reaching the backflow-prevention valve

c) Investigation of the device pump properties that may reduce the risk of backflow of fluids at the surgical site from reaching the backflow-prevention valve. You should determine the maximum back pressure experienced by the backflow-prevention valve.

d) Investigation of the potential for regurgitation on valve closing and the volume of fluid that may backflow upon regurgitation. You should determine the closing volume and leakage volume.

We recommend that you provide detailed test methods for your study, which includes each of the following items:

a) Discussion of all conditions (i.e., pressure, volumes, fluid flow conditions, user handling, pressure changes occurring with the use of arthroscopic instruments, tubing lengths, overall time of test) that increase the potential for backflow of fluid into the system and a justification that the conditions of your testing maximize the potential for backflow of fluids through the system

b) Rationale for worst case parameters and clinical relevance of testing and parameters (e.g., if simulation of a certain joint is chosen, an explanation should be provided as to why the set-up and parameters are considered "worst case" for potential backflow)

c) Appropriate controls, including a positive control of forced/confirmed backflow and a negative control

d) Pressures/conditions that are relevant to the critical valve parameters described in Section III.B, above, and worst case clinical use of the device, including:

    i. Worst case parameters for pressure in terms of both critical valve failure and backflow/leakage should be considered, which may not be the same pressure parameters

    ii. Pressure cycling, with a justification of the clinical relevance for the number of cycles and length of time per cycle chosen

iii. Common errors, such as possible incorrect installation of the tubing set or blockage of the outflow should be considered as potential worst case situations for testing

e) Description of the fluid volume, flow rate, pressure settings, and valve opening and closing characteristics used at each stage in the testing and their clinical relevance

f) Description of the irrigation fluid used in the testing and its clinical relevance

i. All irrigation fluids intended to be used with the device, as identified in the labeling, should be included in your testing, or a justification provided for why the irrigation fluid tested represents all other fluids that may be used with the device

ii. Fluid chemical properties (e.g., wetting agents and other fluid properties that may affect flow)

g) Relevant simulation of multi-patient use (e.g., 24 Hour Use) tubing vs. single-use tubing, including an explanation of the number of each tubing set configurations tested and their associated time of testing; simulation of multi-patient use (e.g., 24 Hour Use) tubing should also include testing of stagnant flow conditions under minimum backpressure

h) For microbiological testing of the backflow-prevention valve, your protocol should include:

i. Amount and identity of the challenge organism(s)

ii. Rationale for the chosen challenge microorganisms

- We recommend that you include both bacteriophages and bacteria in your microbiological testing to represent viral and bacterial challenges, respectively.

- For bacterial testing, we recommend that you include both Gram-positive and Gram-negative bacteria that may be common causes for joint infections and include at least one motile species of bacteria, such as *Pseudomonas aeruginosa* or *Escherichia coli.*

iii. Methods used to prepare the challenge organisms

- We recommend that each challenge organism be prepared and tested separately.

iv. Method of device contamination/inoculation

v. Rationale for the inoculum volume and concentrations

vi. Time, temperature, humidity level, and culture procedures for collection of samples from contaminated device, volume of sample aliquot measured, and rationale for the location of sample collection from the contaminated device

vii. Type of environment in which the study was conducted (e.g., biological safety cabinet vs. non-sterile bench), a rationale for selection, and its effect on results

viii. Limit of detection and limit of quantitation of the microbiological method

- Assays should be sensitive enough to detect small numbers of microbes, e.g., less than 10 colony forming units (CFU).

i) For testing of the backflow-prevention valve with a chemical marker (e.g., dye), your protocol should include:

i. Marker concentration

ii. Diluent used

iii. Consideration for the use of wetting agent (e.g., Triton X-100, propylene glycol)

- If a wetting agent is used, a rationale for the wetting agent chosen and its concentration should be provided.

iv. Limit of detection and limit of quantitation of the assay

j) Investigation and discussion of the potential for false negatives that may occur if microbes/dye markers that have penetrated the backflow-prevention valve are flushed out when the pressure at the simulated joint site is reduced

i. Your protocol should be designed to eliminate the potential for false negatives, which can provide a false sense of security regarding the safety of your device.

k) Explanation of how any microbiological or dye test can evaluate the risk from expected clinical contaminants, including viral blood borne pathogens

(3) Microbial Ingress Testing

A connector that facilitates connection/reconnection of sterile device components may increase the patient's risk of infection, because these features allow the entry of microorganisms into the sterile fluid path. We recommend that you conduct microbial ingress testing on these device components. This testing is intended to simulate repeated connection/reconnection of the device's connector components.

Microbial ingress testing should simulate the use of the device in a clinical setting, i.e., the number of microbial challenges in the study should approximate the greatest number of user interactions with the connection site that would be expected clinically. The testing should demonstrate that the disinfection procedures you use are effective.

We recommend that you provide a detailed protocol for your study, which includes the following:

a) Study procedures for the subject device

b) Amount and identity of challenge organisms commonly associated with contaminated arthroscopic devices (i.e., two Gram-negative and two Gram-positive organisms)

c) Methods used to prepare the challenge organisms

    i. We recommend that each challenge organism be prepared and tested separately.

d) Method of device contamination/inoculation for all device sites inoculated

e) Description of all sites inoculated and rationale for site selection (we recommend that, at minimum, the sites include the position immediately adjacent to the fluid flow path)

f) Rationale for the number of challenge microorganisms used as inoculum (it is recommended that you use a minimum of 10^3 CFU per device) and that each organism be tested separately)

g) Connection/reconnection procedure

h) Time, temperature, humidity level, and related culture procedures

i) Type of environment in which the study was conducted, a rationale for selection, and its effect on results (e.g., if a biological safety cabinet is used, is it representative of actual risks incurred when connections are made under actual clinical use conditions?)

j) Positive (non-disinfected device) and negative controls used in the study

k) Validation (using microbiological techniques) of the disinfection procedures for connection and reconnection of the connector, as stated in your labeling

K. Labeling

The premarket notification must include proposed labeling in sufficient detail to satisfy the requirements of 21 CFR 807.87(e). Proposed labels and labeling, sufficient to describe the arthroscopy pump tubing set, its intended use, and the directions for use must be provided.

As prescription devices, arthroscopy pump tubing sets are exempt from having adequate directions for lay use required under section 502(f)(1) of the Federal Food, Drug and Cosmetic Act (FD&C Act) as long as the conditions in 21 CFR 801.109 are met. For instance, labeling must include adequate information for the intended user of the device, including indications, effects, routes, methods, frequency and duration of administration and any relevant hazards, contraindications, side effects, and precautions (21 CFR 801.109(d)).

Labeling for arthroscopy pump tubing sets that identify multi-patient use (e.g., "24 Hour Use," "Up to 8 Procedures") should be validated according to the recommendations described in Section III.J. Since the risk of cross-contamination cannot be completely eliminated with multi-patient use tubing, labeling should inform users that there is a potential risk of cross-contamination associated with re-use across multiple patients.

The user manual should additionally include the following information:

a) Terminology that is consistent with the definitions provided in Section II, above;

b) Clear instructions for installing the arthroscopy tubing system, including valves, connectors, and tubing, etc.;

c) Identification of the port/inlet to which each device component connects;

d) Identification of compatible arthroscopy pump systems and arthroscopic instruments and accessories (or criteria to determine compatibility);

e) Identification of all irrigation fluids intended for use with the device;

f) Clear identification of the device or component that includes a backflow-prevention valve or other backflow-prevention feature;

g) Directions for proper handling and associated practices to prevent backflow or contamination of the device (e.g., tubing containing backflow-prevention valve not to be placed in a horizontal or inverted direction, using sterile technique to handle the connectors);

h) Directions to flush the irrigation system containing the multiple patient use tubing sets with irrigation fluid after each patient procedure (following removal of any tubing containing the backflow-prevention valve);

i) Identification of each device or component that is part of the proximal irrigation system or the distal irrigation system;

j) Identification of the device as consumable or reusable;
   i. Consumable Device
      - Identify the device as "single-use device" or "24-hour multi-patient use device," or clearly specify the maximum validated use life (e.g., Up to 8 procedures).
        - Note: Multi-patient use devices used over a specified time period (e.g., 24 Hour Use) should not be labeled "single-use" or "disposable."
      - Consumable devices should not include reprocessing instructions.
      - Labeling should include disposal instructions and should specify that the device should be discarded after every patient use for single-use devices, or after the maximum validated use life for multi-patient use devices (e.g., 24 hours for 24 Hour Use devices). The labeling should also instruct the user to discard the multi-patient use device components if any breach in sterility or potential for backflow occurs (e.g., improper handling of sterile connectors, pump warnings of excessive pressure in the joint during the case).

      Table 1 describes the appropriate actions for the various consumable irrigation system components. The table describes the recommended action that should be implemented to minimize risk, assuming that the irrigation system includes a backflow-prevention valve and performance data as described above has been provided.

Table 1: Recommended Labeling and Actions for Consumable Device Components in Arthroscopy Pump Tubing Sets Intended for Multiple-Patient Use

Consumable Device Component	Recommended Labeling and Action
Components of the Distal Irrigation System	Label to include "single-use device" Discard after every patient use
Components of the Proximal Irrigation system	Label to include "single-use device" Discard after every patient use OR Label to include "24-hour multi-patient use device" Discard after specified time period, e.g., 24 hours (multi-patient use without reprocessing between patient uses)

ii. Reusable Device

- Identify the device as "reusable."
- The validated reprocessing instructions should indicate that the device is to be reprocessed after every patient use. Reprocessing instructions should be consistent with the recommendations described in the FDA guidance document entitled "Reprocessing Medical Devices in Health Care Settings: Validation Methods and Labeling."[14]

[14] https://www.fda.gov/regulatory-information/search-fda-guidance-documents/reprocessing-medical-devices-health-care-settings-validation-methods-and-labeling.