

1 DR. CHUTER: No, I did cadaveric studies.
2 It was in Rochester and it was a very long time and
3 they were very crude.

4 MR. SMITH: And you can't remember the
5 number?

6 DR. CHUTER: I can remember the number.
7 I don't think they're worth quoting in this context.
8 They were very crude studies.

9 The problem with establishing a threshold
10 is that you can still have a device which has a low
11 threshold, but the other clinical benefits of it may
12 be it's I won't enlist them or describe them, but
13 there could be more clinical benefits where you would
14 accept that if the other parameters were better. The
15 same reason you might use a balloon that has a high
16 burst pressure. It's got a bigger sheath, but we need
17 that benefit. So I guess I'm not really in favor of
18 having a defined threshold, but we all know, I think,
19 that it is.

20 MS. ABEL: But the individual manufacturer
21 should have some sort of a threshold. A lot of people
22 didn't. That's the point. A lot of people just had

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1 very vague, this is for characterization only. They
2 don't have numbers. They don't have quantitative
3 acceptance criteria with respect to migration
4 resistance. So the question is should they and is
5 there additional information that would be useful to
6 provide so that they could come up with some rational
7 numbers or are we just going to --

8 MR. SMITH: Why don't we start at the
9 minimal that we could all agree on. When you say four
10 Newtons, it's got to do at least that, right?

11 DR. CHUTER: Four Newtons, absolutely. In
12 real life, we're talking about pulse --

13 COOK, INC.: I would say it's much higher
14 than that. I would say it's 10 or 12.

15 DR. CHUTER: Yes, I would say 10 or 12, at
16 a minimum that we'd all agree within the room.

17 COOK, INC.: Now we're back in the 15
18 millimeter game. And we recognize certain size
19 dependence, so it's very hard to say minimum value.

20 MS. ABEL: Right, what I'm thinking of, is
21 there information that would be of use to
22 manufacturers so yes, you can go out and measure,

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1 whatever, that could help feed back into the
2 manufacturer so they could come up with some criteria
3 that were relevant for the various sizes for their
4 specific devices. Is there some information that's
5 missing? You know, what's the reason why people
6 having done this, that they don't have numbers
7 associated with their testing?

8 MR. SMITH: I'd like specifically what
9 pressure should be used. Obviously 120 over 80 isn't
10 representative of this patient population. Is it 160
11 over 80? Is it 200 or 110? That kind of information
12 would be beneficial.

13 COOK, INC.: I'd like to ask if we build
14 a bridge, we build it 50 times stronger than -- if
15 it's an aircraft, it's 3.5 times what you'd expect.
16 Should it be twice as much or should we have an
17 aircraft three times as much?

18 DR. FILLINGER: The safety factor depends
19 on what the design environment is. If it's an
20 elevator cable you make it a safety factor of 12, but
21 if it's a jet aircraft, you make the safety factor in
22 some cases one because it won't fly if you make it 10.

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1 I mean you'd have these huge -- and so some of these
2 devices we'd like to make the safety factor really,
3 really high, but we'll have this device that's so big
4 we won't be able to get it inside the patient, so
5 there's a real trade off. And just like in airplanes,
6 you need a lot more surveillance looking for cracks in
7 the wings and things like that. That's why in
8 endografts right now, we have a lot more surveillance
9 because we can't design them strong enough to prevent
10 failure in everyone and so you have to just come up
11 with some sort of a trade off. I think somebody
12 mentioned that earlier that in one device you may
13 decide to trade off and not have quite as much pullout
14 force as in some other device.

15 COOK, INC.: I absolutely agree, but in
16 endovascular graft what should our factor be? You
17 seem to know where it is in the lift and you know
18 where it is in an aircraft, what do you think it
19 should be in an endograft?

20 DR. FILLINGER: As high as you can make it
21 and still get it inside the patient.

22 (Laughter.)

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1 MS. ABEL: Do you have anything?

2 VASUTEK: Can I just say we did the
3 literature search to see what force was the minimum
4 and we came up with six as an absolute minimum and 16
5 as a maximum so somewhere in there probably lies the
6 limits. So from a worse case point of view, we took
7 16 Newtons because that was the worse case we'd seen
8 in the literature. So as an engineer, as a
9 manufacturer, that's what we came up with for a basic
10 pullout. With regards to pressure we went to the
11 British Hypertension Society and said what's the
12 maximum pulse pressure that we're likely to see. We
13 shouldn't really be putting these devices into people
14 that are hypertensive, but if we did, what's the
15 likely pulse pressure. We took that as a limit which
16 is probably a little bit higher than I think is
17 required so we got a safety margin there, but that's
18 just how we did it.

19 DR. FOGARTY: Has anybody ever measured
20 these Newtons in a live patient? I'm asking the
21 question. Have these Newtons been measured in a live
22 patient?

1 DR. WHIRLEY: I think you can, with the
2 analysis that I showed -- you can do calculations.
3 You can translate blood pressure into these forces and
4 so then you can ask the question what is the blood
5 pressure in your patients and I think we do have a lot
6 of information about what those ranges can be.

7 DR. FOGARTY: Yes, but that may be -- the
8 forces may be influenced by the viscosity, I thought
9 you said.

10 DR. WHIRLEY: No. I said that even under
11 some pretty severe assumptions the viscosity is maybe
12 a 5 percent or maybe a 1 percent --

13 DR. FOGARTY: And turbulence flow would be
14 what?

15 DR. WHIRLEY: It's still a minor player.
16 It would be a little bit higher, but still a minor
17 player compared with the forces. And so I think the
18 real question you're asking is that you can relate
19 those forces back to the blood pressure and we know a
20 lot about blood pressure ranges in the patients.

21 DR. FOGARTY: We don't know that much.
22 There's no way I know that you continuously monitor

1 direct blood pressure noninvasively over a 24-hour
2 period.

3 DR. WHIRLEY: Again, I think the approach
4 at least that we would take is more to set bounds, to
5 look at what are bounds for chronic hypertension.
6 What are bounds for transient hypertensive events.

7 DR. FOGARTY: Then you're still struggling
8 with that.

9 DR. WHIRLEY: And then work with that.

10 DR. FOGARTY: But they're still struggling
11 with that.

12 DR. WHIRLEY: We may not have all the
13 answers. I think we made some conservative
14 assumptions that this may be excessive, but we believe
15 it's conservative.

16 DR. FILLINGER: There's also the problem,
17 once you set those blood pressure limits, then how do
18 you translate those limits to a pullout test? If it's
19 just a simple sort of straight line pull out, I mean
20 it may be somewhat device-dependent because one device
21 may rely entirely on the books in the NAC * (4:22:39)
22 and another device may have a lot of column strength

1 that then makes it hard if you just do a pull out test
2 with no pressurization of the graft. It may appear
3 that it has much lower pullout force when in vivo
4 patient actually performs much better. So there's a
5 little bit of caution in how you translate the force,
6 the forces that you can calculate pretty well within
7 some sort of limits and then translate that to some
8 test, especially something as simple as just a pullout
9 course.

10 MS. ABEL: Makes sense to me. Can we
11 break?

12 (Laughter.)

13 (Off the record.)

14 MS. ABEL: Welcome back, everybody. Very
15 good. That quiet quickly.

16 Pull test for modular components. All of
17 the testing here has been tensile testing and that's
18 in conformance with the ISO standard and the
19 acceptance criteria varied a lot. So this is as far
20 as the -- again, pull tests for modular components,
21 obviously it's described as a pull test, but what
22 we're looking at again is kind of the potential for

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1 migration between modular components.

2 And the same for characteristics. Oh,
3 we're over this.

4 So we have comparable slides and tables
5 for this as we did for the migration resistance. And
6 we don't want to have that whole conversation over
7 again. Please. But just want to get some idea, like
8 I said, the only test that's in the standard with
9 respect to modular devices and the potential for
10 separation modular devices is this pull test for
11 modular components.

12 Now would it be useful in that fluid flow
13 model that we talked about, ad nauseam, already to
14 incorporate the modules or is it just for individual
15 components you can look at it?

16 Yes? No?

17 MR. SMITH: In my work, pressurized,
18 pulsatile fluids flow model is very difficult for
19 intercomponent migration.

20 MS. ABEL: So it really doesn't tell you
21 anything.

22 MR. SMITH: Haven't been able to do it

1 successfully.

2 MS. ABEL: If Lou can't do, we assume no
3 one can do it?

4 (Laughter.)

5 RY*: Why is it difficult? We should
6 first learn how to * (4:51:28).

7 DR. GREENBERG: I don't agree. I think
8 that you can do a pressurized tensile test on these
9 which is probably the most accurate method of looking
10 at this and it's really, it is component separation
11 that we're looking at and it's probably inaccurate to
12 just look at a tensile strength outside of a
13 pressurized system because most of these devices rely
14 on radial force and the radial force is certainly
15 affected by the internal pressure and that will
16 increase the coefficient of friction between the
17 devices and if you want an accurate component
18 separation measure, it needs to just be a tensile test
19 that's pressurized.

20 DR. CHUTER: Dorothy, there are two other
21 factors that influence the tendency towards component
22 separation. One of them is the distance that those

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1 components have to bridge from their implantation
2 sites to their attachment site on the rest of the
3 stent graft and the other is the stiffness of that
4 component because the components just don't fall out.
5 they bend and then they fall out, and angulation. So
6 I think that just a pullout test tests only one of
7 four factors and therefore I think it's not a terribly
8 useful test.

9 MS. ABEL: So what sort of test would you
10 --

11 DR. CHUTER: I think a pressurized,
12 pulsatile, fluid flow model where you've got the whole
13 stent graft assembled inside a fake aneurism.

14 MS. ABEL: Then why haven't you been able
15 to do that, Lou, tell us all about your problems.

16 (Laughter.)

17 MR. SMITH: Well, let me begin answering
18 by the way we set up that test, it's to look not for
19 complete loss of fixation or complete modular
20 separation, but any movement at one millimeter or
21 above, so that very reason in its own has created the
22 difficulty in being able to measure any movement

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1 between the overlapping components that allows
2 measurement of movement at the proximal or distal
3 ends. So that's really the only reason.

4 The second thing is even -- the tensile
5 test to characterize whether pressurized or
6 unpressurized, the tensile test that characterizes
7 those pullout forces is just that, a characterization.
8 That, in conjunction with the results of your clinical
9 trial, tell you whether you've got a good
10 characterization and can use that comparatively.

11 If we want to move that test into a total
12 pre-clinical prediction situation, then it gets way
13 more difficult. So -- that's -- we use it as a
14 characterization test. If you want to make a change
15 to material or stent design or radial force or overlap
16 numbers we can see if we reduce that, given the fact
17 that we have clinical cohort to look at and say what
18 kind of migration or intercomponent separation are we
19 getting clinically.

20 The problem is if you're always on the
21 success side of the line, if you don't have failures,
22 either clinically or in the test, then you're just

1 confirming to stay above some number.

2 MS. ABEL: Let me just make sure I
3 understand. So you got lucky in your design and it
4 didn't fall apart in your patients and so then you
5 have faith in your pull test as a characterization
6 test, so if you make changes to that --

7 (Laughter.)

8 MR. SMITH: I'm not sure what you mean by
9 lucky --

10 (Laughter.)

11 -- but we didn't have -- I don't think it
12 was luck that prevents intercomponent separation.

13 MS. ABEL: How did you evaluate, how did
14 you decide that you weren't likely to have
15 intercomponent separation in your patients before we
16 went there?

17 MR. SMITH: I'm sorry, that might be too
18 proprietary to go into at this time.

19 (Laughter.)

20 That's always a fallback.

21 MS. ABEL: That's all I'm saying.
22 Obviously, I'm being very sarcastic.

1 MR. SMITH: I think it's a combination of
2 several things.

3 MR. DEHDASHTIAN: I think you were advised
4 that you should have a long overlap and that you
5 should have a lot of radial force between the two.

6 MR. SMITH: And one other thing I would
7 have added is column strength. Those three things in
8 combination determine what potential you have for
9 intercomponent separation.

10 VASUTEK: Could I just suggest that
11 perhaps you got lucky with your acceptance criteria.
12 You just choose an acceptance criteria for your test
13 that give you in hindsight good results. The pullout
14 force, what's clinically -- whatever it is, however
15 you come up with it, it works clinically and you know,
16 can use that to gauge all other tests, all other
17 designs.

18 Going back to Roy's point about using
19 pressure from an engineering point the worst case is
20 a known pressurized one because pressure is helping
21 the anchor force, so if you've got no pressure, then
22 you're assuming you've got no aid from pressure. So

1 just a simple pullout is going to what's key. So if
2 you pass your acceptance criteria in your worst case,
3 then you must be all right.

4 DR. CHUTER: Sure it's the worst case, the
5 patient is dead.

6 MS. ABEL: Can't hear you.

7 DR. CHUTER: I said of course it's worse
8 case, the patient is dead when there's no pressure.

9 MR. SMITH: It's just hard to get a
10 realistic assessment of this. And I think this test
11 becomes much more critical when you start to consider
12 what happens beyond the inferenal aorta.

13 What happens in the thoracic aorta? What
14 happens when you go into the SMA with a branch?
15 Suddenly this test is not just a linded connection,
16 but it's a death.

17 DR. GREENBERG: I want to clarify
18 something about the test and the history of the
19 standard. I mean this test was added at the very end
20 of that standard so it's something -- endografts have
21 been developed without this in a standard.

22 MR. SMITH: That's why we have to evolve.

1 DR. WHIRLEY: But there are examples of
2 endografts that have had component separation and we
3 have now clinical devices that are in use that don't
4 have component separations so at least we have the
5 boundaries set so if we set up some tests, whether
6 it's a pullout force or whatever the test is, we have
7 devices that we can put in that benchtop model and say
8 look, this device had clinical module separation and
9 our benchtop testing replicates that pullout. Here's
10 our device which doesn't fall apart in that same
11 situation and we're testing it against this other
12 already clinically, FDA approved device that's done
13 well clinically and doesn't pull out either. And we
14 have equal pullout force to that.

15 I think we at least have the boundaries.

16 DR. CHUTER: The problem is there are so
17 many other factors that you are not testing that are
18 device specific, that if you want to make device
19 comparisons, you need to incorporate those things.
20 Sure, you can use this test, so long as you use it in
21 a device-specific way and you only use the results
22 clinical and testing results from one device.

1 MS. ABEL: But still, what is keeping
2 those two components together?

3 DR. CHUTER: The components, you could set
4 up a situation where there's no friction between those
5 components and they will not dislocate because they
6 are bridging a gap, but it's so short with an object
7 that is so stiff that it cannot buckle. And the
8 friction is not the whole story.

9 MS. ABEL: But doesn't it have more to do
10 with your acceptance criteria, so if you've got -- I
11 mean the friction is what keeps the two together --

12 DR. MATSUMURA: I agree with Tim. I think
13 when you're designing these, you have a fixed amount
14 of length between the renals and the aorta
15 bifurcation. One strategy might be to make the main
16 trunk very large, put the flow divider of the new
17 graft low so that you have less displacement room, so
18 you -- it's unlikely to move. The other strategy is
19 to make a long overlap zone. Other designs might be
20 to have a positive fixation between the two. So I
21 think that there's a lot of ways to assess it and it's
22 not always having a certain threshold of friction that

1 will hold it in place or column support or whatever.

2 MS. ABEL: Gotcha. So the tensile test
3 doesn't do it all. We don't know that pressurized
4 pulsatile fluid flow testing can actually be done, but
5 we can agree that currently the only test that is
6 identified in the ISO standard which only identifies
7 standardized testing is the pull test and the tensile
8 test and it may be time to start looking at some other
9 options to address this parameter.

10 DR. WHIRLEY: I just wanted to maybe set
11 people thinking a slightly different way, that the
12 tensile test may not be the problem, but the question
13 may be how do you decide what's an appropriate
14 acceptance criterion and you can't take a component
15 and quantitate the forces that Tim was describing
16 associated with being in a bend and having that
17 actually provide extraction force as well as the
18 hemodynamic forces, those can be quantified and rolled
19 into an acceptance criteria that is applied to a
20 relatively simple test and that test could be
21 unpressurized as a worse case or pressurized to any
22 appropriate value.

1 But that's perhaps another way to get at
2 this without making the test so complicated that it's
3 very, very challenging to execute.

4 MS. ABEL: But you are not necessarily
5 testing the mechanism and the design that is keeping
6 the pieces together is what I'm understanding. So
7 that may be relevant in terms of trying to set your
8 criteria for your device, given that you are counting
9 on different attributes to keep it in place, but you
10 may not be really evaluating that attribute. If
11 you're using column strength and you're doing a
12 tensile test, you're not evaluating how well your
13 column strength is keeping it from pulling out.

14 DR. WHIRLEY: You'd be capturing the
15 column strength in the test to set the acceptance
16 criteria wherein, for example, maybe you impose a bend
17 and measure the result of force from that, from
18 putting the component in that configuration. So
19 you're directly measuring the same physical attribute
20 that keeps it together.

21 DR. FOGARTY: There are more parts moving
22 than you think. Not only the angle. It's whether or

1 not the free edges of the stent dig in as you pull it
2 out. You can have a plaque in the way and you're
3 measuring the force to do an enterectomy. There are
4 just too many variables to replicate that and I don't
5 think there's a test that will test all of the
6 multifactorial things involved in displacement of a
7 graft component part. I don't think -- you can't go
8 one test. You can do separate tests that will give
9 you measurements on different things, but there's
10 never one independent factor that causes separation.

11 DR. WHIRLEY: I think I would agree with
12 that. There's probably no one test that tests
13 everything, but --

14 DR. FOGARTY: And there's no one test that
15 tests all grafts.

16 DR. WHIRLEY: I would agree with that
17 statement as well.

18 DR. FOGARTY: You can create a bench test
19 to prove whatever you want and you can create a bench
20 test to disprove whatever you want and you may know it
21 or not know it.

22 COOK, INC.: If you have two components

1 and you determine at what pressure differential and
2 what angle they come apart, then it doesn't matter
3 about all those other parameters because they all
4 summate to work together to hold the device together.
5 So all you need to know is what the breaking point is
6 which is at what pressure differential and what angle
7 did it come apart.

8 You can test all devices with that.

9 MR. HASTING: I think the challenge with
10 the pressurized test, the modifications that you need
11 to make to the graft are going to affect the pullout
12 force to maintain. So if you can modify the graft to
13 maintain pressure, you're going to change the pullout
14 force.

15 DR. FOGARTY: What you're saying is one
16 factor influences the other. Is that what you're
17 saying?

18 MR. HASTING: Right and if you have to
19 modify the devices by sealing them.

20 DR. FOGARTY: Modify the test.

21 MR. HASTING: Or modify the device to
22 maintain your pressure, you're going to affect the

1 pullout force.

2 DR. MARIN: I think you could start with
3 the simple thing and if that tends to drive your
4 design introduction you don't want to go, then you go
5 to the next level down and put more fidelity into your
6 test, so it was suggested that you could take a
7 nonpressurized interface and just do a pull test and
8 if that -- and put loads on it based on the full delta
9 p, maximum blood pressure you want to design to is
10 zero sac pressure. If you can meet that with no
11 assistance from the internal pressure gradient which
12 is creating more friction, you're done. If you can't
13 meet it, it doesn't mean it's not going to work, it
14 means now you have to go one more level deep because
15 you have neglected effects that are helping you. So
16 then you put the delta p in. You could put a balloon,
17 you could make the graft material impermeable with
18 silicon, whatever you want to do to get the pressure
19 load at that interface.

20 If you still can't meet that test, it
21 still doesn't mean the game is over. Now you have to
22 rely on things such as Dr. Chuter mentioned that if

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1 your design is such that you just make sure that
2 you're not spanning large gaps and you have a lot of
3 overlap, that can be what you're relying on and then
4 you have to design a test to prove that. These tests
5 get successively harder to design if your design is
6 less robust, but it doesn't mean that you can't get
7 there.

8 MR. SCHRECK: I'm a little bit concerned
9 where the discussion is going in terms of the type of
10 testing because on the one hand we're proposing some
11 standard tests that may not be relevant and on the
12 other hand we're proposing some characterization of a
13 product on the various conditions, maybe not even
14 acceptance criteria, so we just know how it performs.

15 And I saw that happening about 10 years
16 ago when we tried to establish guidelines for hardware
17 and the end effect was that the test matrix became
18 bigger and bigger and we spent months and months to go
19 for all the testing and the value of the results was
20 meaningless in many cases.

21 So I don't want to go down that road again
22 and create a lot of testing matrix that is not

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1 relevant to specific designs. I think what we can
2 agree on and we did that in the hardware guidelines is
3 that we define all physiological conditions in terms
4 of pressure, flow rate, typical diameters that we see
5 as sort of the clinical conditions and then it ups to
6 the manufacturer based on the specific design they are
7 developing to define worst case conditions, if you
8 infer the design they want to test for and then
9 develop very specific tests.

10 We can use some of the recommended tests
11 as a guideline, but I wouldn't make a requirement.
12 Because when you look at the various parameters we
13 talked about and we talked about migration, it ended
14 up at 13 parameters that should be evaluated. If you
15 just look at three values per parameter, you end up
16 with 2,500 test points to characterize your product
17 under the various conditions. That's where I
18 definitely don't want to go, but what you can do is
19 you can take those variables and then justify what
20 value you're taking in terms of angulation, in terms
21 of diameters, in terms of pressures and define the
22 specific tests. So I don't want to have, I wouldn't

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1 want to have a standardization with respect to very
2 specific tests for various performance parameters if
3 it's left up to the manufacturer.

4 MS. ABEL: I think that when we talk about
5 which of the characteristics need to be incorporated
6 in the test, we weren't assuming they're going to
7 evaluate individually to those independently and what
8 have you. It's just how do we make a more useful
9 model, a better test. And so we're not talking about
10 coming up with five million tests. We're trying to
11 take the tests that we have and make them a little
12 more relevant.

13 As far as not having standardized testing,
14 you have to understand that that puts us in a very
15 difficult situation and I say us meaning everyone who
16 is interested in these devices because quite honestly
17 the capabilities of the various manufacturers is not
18 standardized. So the very least that we can do is
19 standardize some of the testing so that we get, at the
20 very least, baseline information from individuals.

21 And for us to be able to evaluate
22 completely different testing methodologies for each

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1 and every device that ever comes along, based on what
2 the individuals at that one manufacturing place
3 believed to be correct regardless of what their level
4 of expertise is because we don't know, it makes it
5 very difficult, makes it impossible to compare results
6 between devices. Right now it's not very relevant to
7 compare, but it's not impossible. I mean you can get
8 some sense, like if you do your tensile test, your
9 pull test for your modules, and you come up with some
10 numbers, we can kind of say wow, don't those seem
11 pretty low compared to what we've usually seen and we
12 can question it. But if you design your own test,
13 it's completely different. You're the only one that
14 really has the information available to you to be able
15 to determine whether or not it's an appropriate test
16 and an appropriate acceptance criteria and you're
17 going to have a hard time explaining to people outside
18 of the manufacturing plant what the value is of that
19 information.

20 I think it's always relevant to do
21 additional testing. I think it's always important to
22 do some standardized testing.

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1 COOK, INC.: I think I'm missing
2 something. I have this concept in my mind that you
3 have an aneurism and you have modular parts inside it.
4 And there should be a test that says when the aneurism
5 sac is zero, if you like, or whatever, and the inside
6 pressure is X, then we want to test to a pressure
7 differential of 100 millimeter of mercury. Can your
8 device withstand pulse pressure of 100 millimeter of
9 mercury? Can it do that? Whatever holds it together.
10 And if it falls apart it doesn't meet the standard.
11 That's my concept or have I missed something?

12 MS. ABEL: I guess what I heard is that it
13 is very difficult to design that test. I mean right
14 now we've got the simple tensile test and we're trying
15 to figure out if there are tests that could be done
16 and we suggested the pressurized pulsatile fluid flow
17 model and what we've heard is that it sounds good on
18 paper, but it's hard to actually accomplish it.

19 So I think if you could do it, that would
20 be fabulous. That will give you something to do next
21 summer.

22 MR. CARDELLA: Could we clarify just a

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1 term? I keep hearing this over and over again. I
2 think it's a source of confusion still. Pulse
3 pressure is a defined term, the difference between the
4 systolic and the diastolic pressure. If you're
5 talking about the aortic lumen to sac gradient
6 pressure, maybe that should be given a different name,
7 because that's confusing. Every time -- pulse
8 pressure is a defined term. It's the difference
9 between the systolic aortic pressure and the diastolic
10 aortic pressure. If you're 120 over 80 your pulse
11 pressure is 40. You could have a sac pressure from
12 zero to 100 and the gradient is a completely different
13 number.

14 DR. FOGARTY: I thought everybody
15 understood that, but you may be right, they don't.

16 MR. CARDELLA: Your last comment suggested
17 that it wasn't understood. That's why I brought it
18 up. I'm not trying to be problematic.

19 COOK, INC.: I understand it very clearly,
20 pulse pressure and the differential pressure I'm
21 talking about is -- would be the difference between
22 the systolic inside the graft and the sac pressure

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1 which probably doesn't vary with much of a pulse
2 pressure.

3 MR. CARDELLA: That should probably then
4 be designated like a peak systolic aortic to sac
5 gradient. I mean that's sort of its name, you know?

6 MS. ABEL: I think, at least I understood
7 what Michael is trying to say and then maybe I missed
8 it up by saying what we proposed was pressurized
9 pulsatile fluid flow model. So maybe some of his
10 words got mixed up with mine to come up with the
11 differential. I don't know that -- or the --

12 MR. CARDELLA: You ought to probably talk
13 about an aortic lumen to sac pressure gradient, inside
14 the lumen versus outside the lumen, but yet contained
15 in the aortic aneurismal sac. If that's what you're
16 talking about being zero, or zero most of the time, if
17 that's what people think it is, then you could have a
18 peak systolic aortic to sac gradient of 120 if the
19 patient's systolic blood pressure was 120. It would
20 be 120 by zero, against zero.

21 MS. ABEL: And Michael said 100 instead of
22 120, but I think we're all talking about the same

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1 thing.

2 MR. CARDELLA: I hope we are. I'm not
3 sure of that though.

4 MS. ABEL: I think Michael just confirmed
5 that we are.

6 Yes. Let's go to the next slide. And so
7 this exercise that we just went through before that
8 terrorized the people in the back of the room -- maybe
9 it would be better instead of going through all of
10 these forces again and these various aspects because
11 I think they may be comparable is to just list the
12 sorts of things that like Tim was mentioning and if
13 anyone has anything else and if you could list those
14 again, the other issues that you need to consider with
15 respect to separation and components. And you have
16 length of distance between --

17 DR. CHUTER: The distance that the smaller
18 of those two components -- the distance that it's
19 bridging, the stiffness of the component. Roy added
20 the internal pressure.

21 MS. ABEL: Distance bridging.

22 DR. CHUTER: The stiffness of the

1 component. I'm not suggesting these are all things
2 that need to be incorporated.

3 MS. ABEL: We're just trying to capture
4 some of the --

5 DR. CHUTER: And the transmural pressure
6 gradient, inside to outside.

7 MS. ABEL: Transmural pressure gradient.
8 So that would be the difference between the pressure
9 inside and outside at the endovascular graft?

10 I just wanted to make sure that we were
11 all understanding.

12 DR. FOGARTY: How would you measure that,
13 Tim?

14 DR. CHUTER: I'm just suggesting that
15 these are factors that would influence it. All I'm
16 saying is that we test the pullouts as Roy so rightly
17 said. If you test the pullouts at zero, you're not
18 going to get an answer that reflects reality. You are
19 going to get the worse case scenario just as if you
20 test these in the previous things where you were
21 assessing flow or the affects of pressure. If you
22 assume the external pressure to be zero, you're going

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1 to get the worse case scenario, but I think you have
2 to be aware that it's a factor.

3 DR. CHUTER: I'm not suggesting that we
4 try to measure it right now. We can make assumptions
5 about what it is based upon some of the observations
6 by Diaz and other people, but I don't know that we
7 need to do that at this point. I think worse case
8 scenario at best.

9 DR. MATSUMURA: Can I just put out a
10 supposition? I don't know if it's true, but I'd like
11 to hear people comment on it. When I think about this
12 discussion, I've been thinking mostly about iliac
13 pullout from a trunk either with a two iliac limbs or
14 one iliac limb in a trunk ipsi * (5:16:43). But when
15 you're talking about aortic end components and aortic
16 component migration, I think at least in my mind I
17 know a lot less about what factors affect that, how
18 clinically important it is. I do know that some
19 devices may use only a single digit percent whereas
20 other devices may be 40 percent or more or even the
21 design they use aortic cuffs and I wonder if what
22 we're talking about so far has all been about the

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1 iliac limb or if it's all optimal to aortic as well?

2 MS. ABEL: I think it has been primarily
3 focused on iliac and I think you're right that that's
4 a whole other issue and we're going to try later in
5 the workshops to talk about accessory devices and I
6 would like to put the cuffs, the aortic cuffs in with
7 that because I do think it's slightly different. So
8 if we could stick to iliacs right now.

9 DR. GREENBERG: I think when we're trying
10 to categorize component separation it tends to be a
11 graft to stent or graft to graft interface that's
12 failing, whether it's an aortic component or an iliac
13 limb it shouldn't matter. They should be tested in
14 the same manner. If you're testing an aortic cuff
15 that's being placed into an artery, then it's a graft
16 to artery interaction and that's a migration
17 assessment. So component separation has to be tested
18 in the same manner for the two components. The
19 displacement forces on an aortic graft that has a
20 downward displacement force with it, if it's attached
21 to an aortic cuff above it that has whatever three or
22 six, however many centimeters is going to be

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1 drastically different than an iliac limb, but the test
2 is the same.

3 MS. ABEL: But theoretically you may have
4 some different factors that would influence the
5 potential for separation.

6 DR. GREENBERG: I don't know what they
7 are. I look at it in the very kind of pragmatic way.
8 There's angulation. There's cross sectional area
9 reduction. There's stenosis. Everything that we have
10 already listed here. They're exactly the same. It's
11 just you have to design your test a little bit
12 differently because now you're testing the interface
13 between a bifurcated aortic graft to an aortic cuff.
14 But it's the same test and it's the same failure mode
15 which is very different than a migration failure mode
16 which is the interaction between a graft and an
17 artery.

18 MS. ABEL: That's fair.

19 MR. LU: One possible scenario with regard
20 to aortic, Andy said you may have to bifur * (5:19:04)
21 first and then from the inside you put a cuff. Our it
22 might be vice versa where you put a cuff in before you

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1 put a bifur * in which case bifur gets you inside, so
2 obviously they would have a little bit of a difference
3 in the * depending on the specific design.

4 DR. GREENBERG: I agree. This relates to
5 the effect of pressure, not just on radial force, but
6 to the effect of the coefficient of friction between
7 the two components.

8 MR. LU: And the common test would be a
9 pull out test.

10 DR. FILLINGER: There is some difference
11 wherein most of the time the iliac limb component
12 overlap is out in the sac where the aortic cuff most
13 of the time, the component overlap is within the neck
14 because you've basically deployed the device too low
15 or something like that. There are minor differences.

16 DR. GREENBERG: But frequently the iliac
17 overlap is in the iliac.

18 DR. FILLINGER: No, I would say most
19 devices, the iliac overlap is up in the sac.

20 DR. GREENBERG: Now you're talking about
21 cuff to lateral limb.

22 DR. FILLINGER: It's device specific.

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1 Yes, cuff to lateral limb extension. Realize that
2 there are variations in all of these. There's
3 frequently going to be cases where the iliac limb is
4 entirely in the iliac artery and the overlap is
5 entirely in the iliac artery.

6 DR. GREENBERG: Absolutely.

7 DR. FILLINGER: So everything has to be
8 tailored.

9 DR. GREENBERG: It should be device and
10 location specific.

11 MS. ABEL: Back to the concept of
12 separation or of acceptance criteria.

13 And would you say that the same discussion
14 we had with respect to migration would apply to this
15 test in terms of it makes sense to establish some
16 acceptance criteria that's more than just saying this
17 test is only for characterization?

18 So we can just apply the last
19 conversation.

20 MR. DEHDASHTIAN: I think, Dorothy, based
21 on -- because we don't know all the factors, both
22 physiological and specific design, that influences

1 this after implant, influences the migration or
2 separation of the device. I think we can -- at least
3 we can come up with an acceptance criteria. You could
4 use it only as use of characterization of the device.

5 MS. ABEL: We should at least have
6 acceptance criteria.

7 MR. DEHDASHTIAN: Acceptance criteria for
8 that specific device.

9 MS. ABEL: I mean you have a number.

10 MR. DEHDASHTIAN: You have a number. You
11 definitely would get a number to separate them. I'm
12 not sure if that correlates with -- we can title it
13 acceptance criteria for that device. I'm not sure if
14 that really -- it relates to reality after implanting.
15 I'm not sure -- you're going to have to kind of overdo
16 it, over design it for that.

17 MS. ABEL: So should there be, I think you
18 always have the option, like the burst strength of
19 surgical grafts has such a huge safety factor so you
20 don't have to correlate. We're cool with that. But
21 you would either need an extreme safety factor, I
22 would think, or you would have to go through what

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1 Robert was talking about and come up with some sort of
2 a rational number. Is that reasonable?

3 MR. DEHDASHTIAN: I mean the safety factor
4 is -- it comes into play if you know what is required.
5 And I think what's required for every device is
6 different and I think Tim explained every little
7 aspect of the design influences the test or response
8 of the separation, the designs are different.

9 DR. FOGARTY: There's deadening silence.

10 MS. ABEL: It's preferred to listening to
11 you.

12 (Laughter.)

13 DR. FOGARTY: That's a compliment coming
14 from Dorothy.

15 MS. ABEL: Can you strike that from the
16 record, please?

17 (Laughter.)

18 Audience, you've got an opportunity to
19 throw in your two cents. We're actually obviously
20 letting you do so as we go along, but any other
21 thoughts?

22 AUDIENCE MEMBER: I'm afraid I have a

1 couple of questions rather than answers.

2 MS. ABEL: We need answers, Dan.

3 AUDIENCE MEMBER: Is this whole topic
4 separate from seal integrity at modular components,
5 the acceptance criteria in terms of force or
6 displacement or something like that or are we creating
7 a type 3 leak? You had listed up there as clinical
8 failure modes, separation of components. If you have
9 a type 3 leak, chronically, isn't that a failure of
10 the modular connection?

11 So again, separation, I guess, is not the
12 only failure mode that needs to be consistent,
13 considered here. It's the creation of a type 3 leak.
14 And the second point I wanted to make, that's the
15 second or third time we've put up safety factor and
16 what's an appropriate safety factor. And we just have
17 to keep in mind that if you specify a safety factor
18 and you have to specify how you calculate it and for
19 something simple like a Goodman analysis safety
20 factor, there's four inputs into the equation and
21 exactly how you calculate what strengths you use and
22 under what conditions you calculate your stresses has

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1 to be specified to the nth detail. So it's nice to
2 say that an aircraft has a safety factor of 1.2 or a
3 bridge has 30 or something, but don't go down that
4 path unless you're ready to specify in detail how you
5 calculate it.

6 I've been trying to do it for 15 or 20
7 years and couldn't get any consensus.

8 MS. ABEL: Those are very useful comments
9 and we did neglect to talk about type 3 endoleak and
10 can folks just help me out, how often do you see a
11 type 3 endoleak without problem with respect to the
12 components actually moving between each other or
13 something like that? I just don't know.

14 DR. GREENBERG: It depends on whether it's
15 an established device or you're working on a new
16 device, but it's certainly critical to evaluate both
17 preclinically on a new device because you can design
18 a device that will fixate very well, but leak and vice
19 versa. So - but it would have to be tested
20 separately.

21 MS. ABEL: I mean what sort of thing
22 would you be looking for?

1 DR. GREENBERG: Let's say you take a 10
2 millimeter device and in order to get good pullout
3 force you have to put a 15 millimeter device in it
4 which creates all these little infolds. So you get a
5 type 3 leak, but you have great pullout force.

6 MS. ABEL: But is there a test? I mean
7 that's kind of -- that kind of goes with like you say
8 designing the device as opposed to testing, looking
9 for a type 3 leak. I mean are we doing the upside
10 down aneurism test or?

11 DR. GREENBERG: No, I think there are two
12 -- it's actually modular joints are much easier than
13 the arteries to test. You test the modular joint with
14 a pullout test or a pulsatile flow pullout test and a
15 seal test. In a seal test you pressurize it with
16 pulsatile flow to a certain design standard of pulse
17 pressure of 80 or a mean pressure of 240 or whatever
18 it is you come up with and you see if there's a type
19 3 leak.

20 MS. ABEL: But you have to -- how do you
21 deal with permeable graft material and stuff like
22 that?

1 DR. GREENBERG: Make them nonpermeable to
2 test it.

3 MS. ABEL: And then you alter the
4 interaction between the components?

5 DR. GREENBERG: Yes, there's no perfect
6 design, but it makes sense to do this before you put
7 it in someone.

8 COOK, INC.: Maybe you should test same
9 strength as well, some device may have a seam in it.
10 You want to know at what pressure the seam would bust.

11 MS. ABEL: The seam? Yes, that's a
12 separate test that we have listed, yes.

13 Way to pay attention, Dan. You'll be glad
14 to know that it's getting more complicated because
15 we're going to talk about radial force now and there's
16 a lot of disagreement in terms of what that term
17 actually means. And there's also very wide variety of
18 tests. Most of the respondents indicated that they
19 tested under compression. About half tested under
20 both expansion and compression. And people were smart
21 enough to test the appropriate locations, so that's
22 exciting.

1 Again, the acceptance criteria varied.
2 Some was characterization only and other times the
3 actual values specific to the test conducted. We all
4 know what can happen with respect to the failure
5 modes. Some can be related to too much radial force.
6 some can be related to not enough radial force and the
7 same old characteristics that people thought could
8 affect radial force that weren't addressed in the
9 testing were listed.

10 So for radial force, first of all, would
11 someone like to try to explain what radial force is in
12 the context of our discussion? Can we have a
13 definition of radial force?

14 Robert, do you want to give it a go?

15 DR. WHIRLEY: Okay, I'll give it a go
16 although at 5:30 that's a very challenging task. Why
17 don't we try the total force on 180 degree segment of
18 a tube into which the stent is deployed. We're not
19 really deploying it in a tube. It's just the total
20 force on any half circle.

21 MS. ABEL: So it's the outward force
22 pushing onto the vessel?

1 DR. WHIRLEY: That's right.

2 MS. ABEL: All the way around. Is
3 everyone okay with that?

4 DR. WHIRLEY: The total force pushing on
5 the entire vessel is zero, otherwise the vessel would
6 accelerate.

7 (Laughter.)

8 So it's the total force pushing on any
9 side.

10 COOK, INC.: It's the radial pressure
11 times the contact surface area, okay? And that gives
12 the total force. So the more surface area you have,
13 you've got that radial pressure pushing out, that
14 gives it the total force.

15 MR. CARDELLA: At the risk of mixing it up
16 with people that obviously know a lot more about this
17 than I do, I would be more concerned with a point load
18 on a blood vessel, a point load, not so much concern
19 what the force is over half the diameter of a vessel
20 or half the circumference. Because if you're going to
21 push a component through the wall, or you're going to
22 necrose a component, I would be more interested in

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1 that if I were trying to analyze it.

2 MS. ABEL: Well, that gets to trying to
3 determine whether you'll have equal distribution of
4 the forces and what we're trying to look with radial
5 force testing in the context of sealing and fixation
6 effectiveness is the -- and I use all the wrong terms,
7 don't look at my engineering degree. So the forces or
8 the strength or the power of the device to stay in
9 place and to keep it from having leaks. That's what
10 we're looking for.

11 DR. FILLINGER: If you have the outward
12 radial force then you have the contact surface of the
13 stent, then you can get what you're asking for, if you
14 assume how the forces are distributed across the
15 stent. So it's at least a starting point for that and
16 I was going to add that it needs to be in the context
17 of the degree of oversight.

18 MS. ABEL: And that's important.

19 DR. CHUTER: We're talking just about the
20 overlap zone here, not anywhere else like implantation
21 sites?

22 MS. ABEL: We're talking about the ends,

1 attachment.

2 DR. CHUTER: To the arteries as well?

3 MS. ABEL: Pretty much.

4 DR. CHUTER: That covers a much wider
5 range of diameters.

6 COOK, INC.: Question. Would it be better
7 to talk about radial pressure instead of radial force
8 because the force is depending on the diameter and on
9 the length of the stent as pressure gives you kind of
10 a device independent value.

11 VASUTEK: Or probably even more relevant
12 would be the raw tension produced by the -- as if
13 you're putting a * (5:32:06) oversizing and then you
14 can induce it in tension because that's what probably
15 is most relevant from a clinical outcome point of
16 view.

17 MR. SMITH: I'd like to try to at least
18 clarify a little bit.

19 In the ISO standard we called it radial
20 force because that's actually what you measure. You
21 get a force number out of the test. So yes, it's
22 related to the pressure exerted by the device, you

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1 know, times the area, blah, blah, blah, blah, but the
2 reality is for measuring a force in some cases by
3 uniformly compressing and then allowing to expand the
4 device in a loop that's attached to some load
5 measuring equipment.

6 So that's really what this is all about.
7 How much force can or is the device exerting upon
8 whatever it's going to be in contact with over a range
9 of diameters. That's really the concept of this test
10 within the stent.

11 MS. ABEL: Okay. Does everyone understand
12 where we're at? So as Lou mentioned, it can be under
13 compression or under expansion. Does it need to be
14 tested both ways or not?

15 Dan?

16 AUDIENCE MEMBER: I reviewed these data
17 for about 15 years and I never knew how to interpret
18 them. In terms of the device integrity, whether it's
19 the seal of the device into the native artery or the
20 security of modular components wherever this may be an
21 influencing factor, we already have tests that
22 evaluate the performance of the device with respect to

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1 that particular failure mode, whether it's the
2 migration test or the seal integrity test, modular
3 connection strength. So is a knowledge -- is the
4 measurement of the radial force applied by the stent
5 really important if we're already measuring what we're
6 really after which is device integrity. And I would
7 suggest maybe we don't need to measure it for that
8 reason. Now the point that was brought up before in
9 terms of potential damage, endoluminal damage due to
10 excessive force being applied by the stent to the
11 native artery, may be a separate safety issue that
12 we'd want to consider in measuring this quantity, but
13 it's a useful quantify to use in device development,
14 but as far as a standard is concerned or the data that
15 we need to determine if the ultimate endovascular
16 graft is going to function as intended, I think we've
17 already covered those bases.

18 MS. ABEL: See I would disagree from the
19 standpoint, I think we all acknowledge that the other
20 test that we've talked about are very flawed and I
21 think what we're trying to do is get the best body of
22 testing that we can possibly get and if the mechanism

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1 for holding the device in place and the mechanism for
2 sealing the device is the outward pushing against the
3 vessel wall and we have a way of measuring that
4 directly, why wouldn't we need to measure that?

5 AUDIENCE MEMBER: Somehow we've survived
6 15 years with people using stents and endovascular
7 grafts with people measuring radial force by at least
8 a half a dozen different methods, none of which are
9 comparable. They don't even have the same units and
10 we're succeeding. So I would say that we've succeeded
11 very well without quantifying this particular
12 attribute.

13 MS. ABEL: I think it has been quantified,
14 you're right, there's been variability in a way that
15 it's been done. I would say please don't bring up
16 stents in the context of this particular workshop
17 because it's totally different. How often do you end
18 up with migration of your stents because of problems
19 with radial force. We've got a lot of forces pulling
20 down on this one little attachment mechanism, so this
21 is not a stent. It's an attachment mechanism that has
22 to put up with the abuse that it's being put under in

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1 the clinical condition.

2 AUDIENCE MEMBER: The only reason I
3 brought it up is because the methods for measuring it
4 are very similar.

5 MS. ABEL: Method and measurement are
6 similar, but the necessity for the information, I
7 think, is different in terms of we do see problems
8 related to radial force, related to the inability of
9 the device to stay in place and you know, I think we
10 need to do the testing, any testing that we can to try
11 to at least characterize it so that if you make
12 modifications, once again, or if we ultimately learn
13 that there's a problem, you can say okay, we had a
14 problem, this one slipped out too often. We're going
15 to make modifications and now our radial force is
16 whatever it is.

17 AUDIENCE MEMBER: I think we talk about
18 radial force without somehow normalizing it for the
19 radius or the diameter of the vessel in which you're
20 measuring this radial force doesn't give you a
21 realistic measure of what this is good for because
22 those of us who work with balloons know * (5:37:14)

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1 applies and the pressure, you have to relate it back
2 to some measurement of wall tension in order to be
3 able to correlate it with something meaningful because
4 a small vessel with the same radial force will not act
5 the same way or the device will not act the same way
6 as a large diameter with exactly the same radial
7 force.

8 MS. ABEL: But does that get to the
9 validity of the test? I'm confused in terms of what
10 your comment is. I mean I think I would agree that
11 your acceptance criteria have to be specific to the
12 device and that --

13 AUDIENCE MEMBER: That's my point.

14 MS. ABEL: Okay.

15 MEDTRONIC: Dorothy, I have a suggestion.
16 I think at the last standards meeting we discussed
17 this particular issue and then we said that Lou was
18 right, yes, we measured the force, but I thought that
19 we concluded that we're going to convert that back to
20 pressure so you guys can actually compare the results.

21 MS. ABEL: Do you remember the -- do you
22 have the test measurement with you?

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1 MR. SMITH: Yes, but I put them up in the
2 room at lunch. Sorry.

3 I can recall that. What we did do was
4 because people used different lengths of the device
5 under tests that if they report the length and also
6 divide their force number by the lengths so you get a
7 force per unit length in order to compare. That is
8 something that we did discuss.

9 MS. ABEL: So getting back to compression
10 and expansion, what different information do you get
11 under compression versus expansion?

12 MR. LU: You know, if we think about the
13 materials, if were testing a nitonal base structure,
14 then we need to think about compression and expansion.
15 If it's a stainless steel structure, then you can
16 perhaps rationalize that when it's required, perhaps
17 it's compression.

18 MR. SMITH: The reason we came up with
19 that in the Standards Meeting is because of the
20 histories.

21 MS. ABEL: No now it should be both.
22 And stainless should be --

1 MR. SMITH: You could choose compression.

2 COOK, INC.: We've done similar
3 compressing expanding stainless steel and we do it a
4 few times and start to get hysteresis, so you might
5 want to put that in there as well.

6 MS. ABEL: What's that?

7 COOK, INC.: If you do it more than once,
8 if you try to test a couple of times, which I don't
9 know is realistic or not, you start to get different
10 answers, you get hysteresis of middle folds or
11 internal buckles or something like that.

12 MR. LU: Does that mean you need to test
13 it repeatedly and then wait for it to become
14 normalized and then report the average?

15 COOK, INC.: That's what I'm saying. I
16 don't know if that's realistic because in the real
17 instance, it's just expanding it once.

18 MR. LU: Well, your test may be single
19 socket. But in reality when it's used, it's --

20 COOK, INC.: Yes, it's used only once, but
21 we just found this because we wanted to retest it to
22 see if we got consistent results and we weren't

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1 getting them.

2 MR. LU: I think the only realistic way is
3 to simulate the actual condition the stent is going
4 through when it's basically a catheter and then
5 deployed. So it actually takes to the correct place
6 in the stress/strain curve.

7 MS. ABEL: I'm sorry, I didn't quite get
8 that.

9 MR. SMITH: My understanding of what the
10 gentleman said was we've got a test loaded on the
11 catheter position to the deployed position.

12 MR. LU: That's correct.

13 MS. ABEL: So regardless of the type of
14 material you would only test under expansion? You
15 wouldn't do compression.

16 DR. FOGARTY: Does a heart only beat once?

17 (Laughter.)

18 MS. ABEL: I think during our standards
19 meetings it seems that it wasn't that difficult to do
20 it both ways and so if it's more conservative to do it
21 both ways, why not just do it both ways?

22 DR. WINN: The other thing to consider is

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1 you may have hysteresis of the stent material, but the
2 other possibility is you may have some hysteresis in
3 your test set up itself that may not know about it and
4 so you can actually fool yourself unless you check
5 both directions.

6 MR. LU: The other thing is, I'm no
7 expert, but my understanding is that if you further
8 balloon expand it after it initially relates, you can
9 also reset its point on its hysteresis curve and
10 generate a separate set of forces. Anyone can confirm
11 that?

12 DR. WINN: Yes, you should expect to get
13 that. How much you balloon, it how much you dilate
14 it. You should really be careful about that. And I'm
15 moving into a different --

16 MR. LU: Right, I understand. There can
17 be a significant change in the -- it's going to result
18 in force after the reset.

19 MR. SMITH: Your deformation has to be
20 significant before you start experiencing that.

21 DR. FOGARTY: And that's why I would argue
22 when you self-expand a stent that is then balloon

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1 touched up, those forces aren't necessarily
2 significant. The word significant then comes into
3 play.

4 MR. LU: Do you know in a typical case
5 with your device, what kind of force changes have you
6 done?

7 MR. SMITH: Generally, very minor.
8 Because generally, at least with our device with a
9 balloon touch up you're not trying to super-expand the
10 device. You're just trying to make sure it's opposed
11 to the wall. So really, you're not necessarily trying
12 to change the dimensions whatsoever. You're just
13 ensuring full deployment.

14 DR. CHUTER: So you require a compliant
15 balloon.

16 MR. SMITH: You require a compliant
17 balloon when you do it, yes.

18 DR. FILLINGER: So the balloon is required
19 in your deployment. Do you require that as part of
20 your testing, so you deploy it from the constrained
21 position, then you balloon it, then you do hysteresis
22 to get the -- you get expansion compression and then

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1 you get your answer or do you leave out the balloon
2 part of it all together?

3 MR. SMITH: We use the balloon in the test
4 when it's required in the IFU.

5 DR. FOGARTY: Are these tests with nitinol
6 done at room temperature or body temperature or
7 different temperatures?

8 MR. SMITH: Body temperatures.

9 MS. ABEL: If the properties of the -- how
10 does that go? If the properties of the device could
11 be affected by the temperature, test condition shall
12 incorporate --

13 MR. SMITH: Physiological temperatures, as
14 appropriate.

15 MS. ABEL: Yes. Its' repeated multiple
16 times and test methods for endovascular grafts, if the
17 parameter could be affected by temperature, then you
18 need to test under temperature, physiologic
19 temperature.

20 DR. FOGARTY: Just to complicate things,
21 do you use cath. room temperatures or OR temperatures?

22 They're often different.

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1 MR. SMITH: How often do you deploy a
2 device outside the body in the OR?

3 DR. FOGARTY: No, but you fix it,
4 sometimes manipulate and expose it to OR temperatures.
5 There are devices you compress at room temperature or
6 at the OR temperature which is different than the body
7 temperature and it can be different by 20 degrees. I
8 believe that's correct.

9 MS. ABEL: You manufacture the device and
10 you load it on the catheter. And so in this test you
11 would have to use one that's gone through the
12 manufacturing process and it's been loaded on the
13 catheter and then you're deploying it so then you're
14 testing it in the condition of the physiologic. So
15 no, we don't make the gang come over to the operating
16 room with their devices and let them hang out there.
17 First, you bring them back to the testing facility.
18 I'm a little confused. I'm sorry.

19 MR. LU: The other questions that relates
20 to the temperature response zone with nitonal system
21 is what happens if the patient undergoes hypothermia
22 procedure by open heart or similar. I mean should we

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1 also know the safety factor under those conditions?
2 For instance, when you're in surgery or cardiac?

3 MS. ABEL: That fall sunder trying to
4 address each and every potential problem that can come
5 along. You know we have comparable issues with
6 thoracic devices. Do you need to evaluate what
7 happens in thoracic device if the patient has CPR?

8 Now would you say you've got thoracic
9 device and don't do the CPR? No. And if you've got
10 a patient who requires that sort of condition or
11 requires that sort of a treatment, they need to do it,
12 I think it's reasonable that everyone should know when
13 patients have any sort of medical device implanted.
14 If they undergo any sort of a treatment that could
15 have an effect. You need to figure out whether there
16 was an impact, but to test to make sure whether it can
17 withstand that sort of thing would just be to extreme
18 given the relatively small patient.

19 MR. LU: Right. I don't so much mean as
20 a submission barrier, but it's a case where I think
21 data should be made available given how common a
22 patient with AAA has open heart and various other kind

1 of procedure, so I think it would be worthwhile to
2 know that number say if the temperature is down to --

3 MS. ABEL: If there ever was an adverse
4 event associated with it, I'm sure that there would be
5 a necessity to make sure that that was communicated,
6 but to my knowledge it hasn't.

7 DR. GREENBERG: I think from the
8 perspective of just characterizing it, much like we
9 characterize the device in terms of its MRI
10 compatibility It's the same sort of thing. And MRIs
11 may be more common than a hypothermic circulatory rest
12 procedure, but in our patient population circulatory
13 rest procedures are certainly common with even a mild
14 degree of hypothermia and it's probably important to
15 let people know without making it a design standard or
16 something.

17 MS. ABEL: John, what were you going to
18 say?

19 DR. MATSUMURA: I was going to suggest the
20 same thing. I think there's really an endless number
21 of clinical situations that you could test for
22 lithotripsy, cardiopulmonary bypass, * (5:47:57), the

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1 blood is flowing craniate in the aorta. If we can
2 characterize it fine, especially for MR, but to
3 recommend testing for all of that is really, you could
4 go on forever.

5 MS. ABEL: I think we'll just talk about
6 a can of worms. I don't know if we know what to do
7 with the MR information that we already are trying to
8 deal with.

9 DR. MATSUMURA: I just had a question for
10 Tom. Were you testing the device because some
11 physicians in their practice will infuse saline
12 through the deployment catheter, so they're inserting
13 it when it's cooler? Is that what you're talking
14 about?

15 DR. FOGARTY: That's one of the reasons.
16 There's a certain stent grafts that could be
17 compressed at either cath room temperatures or OR
18 temperatures that would change the characteristics at
19 a different temperature which is say body temperature.

20 MS. ABEL: And that's where I'm not
21 following. What do you mean they'll be compressed?
22 You mean they come preloaded on a catheter? But I

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1 just don't know?

2 DR. MATSUMURA: You could compress them
3 into the catheter system at the time of the procedure.

4 MS. ABEL: Home made devices pretty much
5 --

6 DR. MATSUMURA: No, no, these wouldn't be
7 home made.

8 MS. ABEL: Well, then I think --
9 obviously, if you're talking about a unique situation
10 where someone is now going to provide a device that's
11 not loaded on to a delivery catheter, then you've got
12 to test under the conditions that would be used, which
13 is different than what we're talking about here.

14 DR. MATSUMURA: Yes.

15 MS. ABEL: Sorry, I misunderstand.

16 DR. MATSUMURA: They started talking about
17 nitonal and that's what precipitated that question.

18 MS. ABEL: Gotcha.

19 COOK, INC.: I have a very simple
20 question, but it's probably due to my ignorance. Is
21 it going to be 360 degrees or 180?

22 MS. ABEL: Should be 360, is that the

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1 question? It's got 180.

2 MR. CARDELLA: You said the course over
3 360 degrees is zero.

4 DR. WHIRLEY: It's way too late to debate
5 that.

6 MS. ABEL: What she has written, it
7 currently reads definition of radial force, total
8 outward force on 180 degree segment of the two pushing
9 onto vessel in context of degree of oversizing. We'll
10 -- it's close enough. It's not completely inaccurate,
11 we can finesse it.

12 The reason why I wanted to go into the
13 definition was just so we understood the sort of
14 parameter that we're talking about because it's used
15 differently by different people. So we'll make sure
16 that we put in the ISO definition. That's what we
17 were talking about.

18 Potential modifications -- Lou, can you
19 just describe the various types of tests that are in
20 the standard, most of which no one reported on using
21 -- so there's the clamshell. There's the -- Lou?

22 MR. SMITH: Yes. There were several. In

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1 the radial force test itself, it gave several options
2 because manufacturers at the time it was being written
3 were using several things. One would be a complete
4 loop around the device. That gets pulled in opposite
5 directions. The other was a clamshell or V block
6 which is basically something shaped like a V that's
7 just going to squeeze down on it. And then there are
8 other tests, local compression and crush resistance
9 which will require different fixture and we're not
10 really talking about those. So it's really all about
11 what type of fixturing you're using on the device to
12 measure the forces.

13 VASUTEK: Could I just say then that the
14 180 degrees relates to a compression V block type? If
15 you use a hoop test, it's 360.

16 MR. SMITH: Correct.

17 VASUTEK: It depends on the test method.

18 MS. ABEL: That's fair.

19 DR. WINN: I think if anybody actually
20 used an Iris test, the Iris-designed test?

21 MS. ABEL: Iris? I think to Dan's point,
22 it's very difficult to figure out what this

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1 measurement means and I think it's even more difficult
2 to look at in the context of what if you don't have
3 it, the device isn't implanted -- what's the right
4 term? What if you end up with an oblique end to your
5 device?

6 Mark, when you were talking about you want
7 it to sit like this, but it sits like this. What's it
8 called?

9 AUDIENCE MEMBER: Tilting.

10 MS. ABEL: Tilted, thank you. So then the
11 radial force, what you measure on the bench top is
12 like that. Someone talk for me.

13 (Laughter.)

14 But now you've got it in a tilt, you know,
15 does that number mean anything any more. Should you
16 be measuring at a tilt also? Should be trying to
17 figure out other ways or are we just satisfied with
18 the fact that this testing is so limited anyway,
19 there's no reason to push it beyond it's already
20 limited --

21 DR. WHIRLEY: It seems to me that radial
22 force is a structural characterization of the device.

1 It's not an attempt to characterize the device and the
2 anatomy and if you take that view, then really taking
3 these various disease states and anatomic
4 characteristics into account may not be appropriate in
5 the particular case of radial force testing.

6 MS. ABEL: I think that's fair. Does
7 everyone agree?

8 (Yes.)

9 You'll agree to anything at this point,
10 will you?

11 (Laughter.)

12 MR. CARDELLA: So is the suggestion that
13 you're talking about that the radial force measurement
14 has to be made with the device in a perfectly coaxial
15 position? In other words, you don't want to talk
16 about crooked or offset radial force. You want
17 perfectly coaxial radial force and that's likely to be
18 a benchtop test that you're not going to duplicate in
19 a human body very often.

20 MS. ABEL: That's correct.

21 DR. FILLINGER: It's because the things
22 that are bad about angulation and asymmetry and that

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1 sort of thing are tested by your pullout tests and
2 your seal tests and your other things so that
3 basically the radial, the outward radial force is
4 characterizing the device, but the properties that you
5 care about will be measured in some other test and
6 we'll get at those, more realistic setting and how
7 that radial force is distributed then will effect this
8 migration resistance and sealing and that sort of
9 thing.

10 MS. ABEL: That's very good. Thank you.

11 MR. LU: I think one final thing is that
12 obviously in terms of the radial force, there needs to
13 be notice of whether it's balloon expandable or still
14 expanding. Obviously, if it's still expanding you
15 can't compress it all the way down, but with balloon
16 expandable, you compress it down and you don't have to
17 see it back.

18 MS. ABEL: Self-expandable, balloon
19 expandable.

20 MR. LU: The * (5:56:09)

21 MR. CARDELLA: When I was doing old
22 fashioned stent work, we used to talk about balloon

1 expandable stents having hoop strength. In other
2 words, resistance to being crushed. Self-expanding
3 stent probably should have some description of a
4 radial force that it can exert. I mean a balloon
5 expandable stent or a balloon expandable device
6 doesn't have any radial force that it exerts until the
7 balloon creates that force.

8 MR. LU: It's a very different interaction
9 between the vessel wall and the subsequent steady
10 state established.

11 MS. ABEL: I think you're right. I'm
12 saying no to him. I mean you're right. There's
13 differences, both of you, between balloon expandable
14 and self-expanding. There's no question.

15 MR. SMITH: In one, it's the self-
16 expanding, it's the force with which it pushes outward
17 and with the balloon expandable it's the force that it
18 will resist. So it can still be measured.

19 MR. LU: Yes, it certainly can.

20 MS. ABEL: Okay, acceptance criteria
21 again.

22 (Pause.)

1 Is there additional information that we
2 need to figure out so that we don't run into the
3 problems with having the problems with the excessive
4 radial force which I think is more of a point load
5 that gets to the discussion previously. I mean do we
6 know what forces are that are going to cause problems?

7 Is there a way to figure any of that out?

8 MR. LU: The only way to know that is
9 really through histology, isn't it? Or very long term
10 follow-up. And I mean with a neck * (5:58:53) or any
11 changes, it happens gradually over time so invariably
12 there's going to be some sort of structural change and
13 in which case you're talking about looking at the *
14 size of fenestration, the elastic content, the
15 collagen content. All that sort of stuff gets pretty
16 heavy during the investigation, but yes, again, you
17 want something that, as you recall, I've pointed out
18 earlier, the animal studies, you know looking at the
19 biological responses, not only looking at the luminal
20 and intimal responses, but at the same time maybe just
21 look are the vascular smooth muscle cells decreasing
22 in number, the content of elastin and collagen, you

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1 know, whether that will give you any indication of any
2 potential, as a kind of a start of certain event,
3 remodeling or atrophy or what have you.

4 MS. ABEL: I'm sorry, but when we talked
5 about the animal studies we determine that there's at
6 least one case where there was excessive radial force
7 in the device and it wasn't detected in the animal
8 model and various types of animal models and I'm
9 wondering if there's anything that we can learn
10 clinically that will help to give an indication of
11 what sort of forces are going to cause problems or
12 what sort of forces are needed?

13 MR. LU: You know, we'd have to test the
14 elastic properties of the vessel which has been
15 implanted in lots of different directions to be able
16 to describe that very, very accurately and describe
17 that for a very, very broad population of patients as
18 well. Something like that would require intensive
19 amounts of characterization of actual arteries and
20 then understand what the correspondences from your
21 device and then see if it exceeds it. That's the only
22 way I think you could approach it.

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1 MR. QUIGLEY: It's very complicated when
2 you add calcification. With calcification, the neck
3 just stays where it is and you can put a lot of force
4 on it, but nothing happens.

5 Whereas, the noncalcified --

6 MS. ABEL: Right.

7 MR. SMITH: I'd like to take a different
8 tact on that answer. Dr. Fillinger's answer was very
9 elegant in saying and also Dr. Whirley, this is a test
10 that characterizes structural property of the stent
11 and we have all these other tests that determine its
12 functionality and you need to go back maybe to this
13 test, if you needed to change something about its
14 radial force to exhibit something different in those
15 functional tests, the component separation or the
16 migration. All this is different than the animal
17 study or histological approach.

18 MS. ABEL: But what we're talking about
19 here is trying to establish appropriate acceptance
20 criteria for radial force.

21 MR. SMITH: For radial force, so I hate to
22 say this word because I know it's blasphemy, but it's

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1 really based on the design of your device, the radial
2 force as a characterization. so in your functional
3 tests, you've determined that it's functionally
4 adequate, let's just assume and we get there and so
5 then I know what the radial force is. Let's say I
6 know the radial force and I go and determine that my
7 components are going to separate all the time. Now I
8 have a benchmark to go back in my design, this is all
9 preclinical, of course, to say okay, I need to
10 increase the radial force. I can do that a bunch of
11 ways. I can make the wire diameter more frequent or
12 more --

13 MS. ABEL: The only thing I'm suggesting
14 --

15 MR. SMITH: So it's iterative. But I
16 think it's just like the various uses for preclinical
17 testing. So this characterization is not a bad one.
18 That's one thing I listed twice, as a matter of fact.
19 But then also they're trying to predict clinical
20 performance and is there anything that we can improve
21 upon the acceptance criteria for this test to help
22 avoid any additional cases of problems associated with

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1 radial force?

2 MR. SMITH: The only answer I can think of
3 besides what I just said is also if David and Stuart
4 would share what their upper number was that caused
5 problems, then we can all stay away from it.

6 (Laughter.)

7 VASUTEK: I'm going to let you into a
8 little secret here. We did change the radial force,
9 so -- there are few sharp loops there. We changed the
10 oversizing. It's all to do with force and how it
11 interacts with the vessel. I've probably said too
12 much already.

13 (Laughter.)

14 There's nothing that we could add that
15 would help us assess how the significance of radial
16 force to product performance. So we would
17 characterize radial strength or radial force and we
18 don't have a figure, even though we solved this
19 problem, we don't have a figure.

20 DR. FILLINGER: That's why on the previous
21 screen we said that this needs to be reported in the
22 context of the degree of oversizing. That's why

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1 that's so important.

2 MS. ABEL: Sure.

3 DR. FILLINGER: So that we can
4 characterize that. For the balloon expandable, I mean
5 the way it works is basically you expand out beyond
6 the diameter of the vessel so it's the vessel pushing
7 back in as opposed to the stent pushing out and so you
8 have to know it in that context and that's why that's
9 so important.

10 MS. ABEL: Okay, and I'm just asking the
11 question. If the answer is there isn't anything that
12 can possibly be done, then that's the answer. We
13 can't come up with any numbers that will push you over
14 the edge one way or the other.

15 MR. LU: It's really a correlation with
16 clinical follow up. It's a matter of characterizing
17 your stint. And then there's a difference between the
18 non-nodal base stent which it's not -- my
19 understanding is the radial force is not exactly
20 linear to the degree of compression versus a stainless
21 steel which is much more linear, you increase X
22 percent internal compression if you increase the

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1 radial force by that percentage. And it's a matter of
2 having a * (6:04:47) as Mark said relating to how much
3 of a degree of oversight that's going to increase your
4 rate of neck dilatation. It's * neck feedback system
5 to give you the answer.

6 DR. WINN: I guess the one thing I would
7 add to that too is that it may be difficult to come up
8 with one particular radial force number that everybody
9 needs to match because it goes back to different
10 designs and what you're using radial force for. If
11 you're using radial force primarily to resist
12 migration you may need a specific number whereas if
13 you have active fixation and you're just using radial
14 force to expand the implant, you may have drastically
15 different numbers. So it may be very difficult to get
16 --

17 MS. ABEL: I agree.

18 DR. GREENBERG: But what we're looking for
19 here is something like the maximum amount of force at
20 a given point, so if you want to say as a safety
21 factor how much -- what's the maximum force exerted in
22 any square millimeter of the aorta and does that

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1 exceed the resistance of the aorta to injury and to do
2 that you need to know what the resistance of the
3 aortic injury is. We don't have that number. It make
4 sense to try to characterize what the maximum force
5 per unit area is for every given device, just in terms
6 of characterization. I don't think any of us have the
7 knowledge to say what an aorta can sustain.

8 DR. WINN: I can see that on a maximum.
9 I'm thinking on the other end on the minimum it may be
10 very difficult to set up.

11 MS. ABEL: I think that's fair. I think
12 I'm more interested in the maximum. That's a very
13 good point.

14 Tim, did you want to say something or did
15 you forget?

16 DR. CHUTER: No, I think it's been said.
17 I think it's just characterization. The radio force
18 is performing a number of different functions,
19 attachment and sealing and if there are other
20 attachment mechanisms present then obviously that
21 influences the way we interpret the radial force
22 numbers.

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1 My personal take on the way that the stent
2 is damaging the aorta is that it's stretching the
3 aorta. It's making the aorta get bigger. Well, you
4 know what? All of these stent graphs do that. All of
5 these aortas dilate up until they reach the diameter
6 of the stent graft or as much as the stent graft
7 allows them to. I think what happens then depends
8 upon the fixation mechanism.

9 So I don't think you can establish
10 numbers. If you look at the stents that are out there
11 that functioned well, they cover an enormous range.
12 At the bottom end you've got the inner neck guidance
13 east end, at the top end you've got others, very stiff
14 stents. It's hard to say which is going to function
15 best out of context of the other specifics.

16 MS. ABEL: That's fair.

17 MR. LU: You do have to differentiate
18 between the balloon expandable and self-expanding.
19 Self-expanding, you will continue to exert the force
20 until you've reached the natural steady state and of
21 course, balloon expandable, you know, in its expanded
22 form, that's already kind of an equilibrium state.

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1 DR. CHUTER: I agree with you, although
2 what I think what you're seeing is just the same thing
3 over a shorter time period. The balloon expandable is
4 expanding the aorta to the diameter of that stent and
5 then stopping. The self-expanding stent gets to the
6 same point. It just takes longer to do and covers
7 maybe a slightly bigger range because it can do that,
8 but I think that the ultimate end point, that is an
9 expanded aorta and a stable stent graft in terms of
10 diameter is what you achieve with both of them, so
11 it's not quite as different as you might think.

12 MR. LU: But the difference there with the
13 balloon expandable it plateaus off. I mean that's --

14 DR. CHUTER: Then you know what?

15 MR. LU: Tends to recoil back, but whereas
16 the self-expanding if you oversize by 30 percent,
17 there will be a continuous --

18 DR. CHUTER: You can think that, but I'll
19 tell you you balloon expand that aorta and it recoils
20 back on to the stent, but I wouldn't believe that it's
21 going to recoil forever. My sense is that the wall
22 tension in that aorta is going to be at the same level

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1 as it's going to be after five years with self-
2 expanding stent in there.

3 It's just a question of how much it's
4 going to go.

5 MR. LU: That's all related to remodeling
6 and so forth. I think there's still a lot of signs to
7 be answered on that one.

8 MS. ABEL: May I suggest you guys discuss
9 that over a beer tonight so we can move on? Very
10 quickly, just bear with us, 10 more minutes. A very
11 good discussion. I think it's an important point, but
12 we just want to make sure we don't lose everyone.

13 Simulated use, again a wide variety of
14 tests were used. And I just want to mention that not
15 all use perforized glue fixtures. Only four mentioned
16 flow model and two people actually did use artificial
17 plasma.

18 So if we can just, in general, talk about
19 what is this test really good for when we talk about
20 simulated use and the ISO standard says look at
21 deliver and deployment failures. Is it also good for
22 looking at acute migration and I suppose that would

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1 depend on your test model. As far as endoleak you can
2 look at conformity to vessel wall and simulated use
3 model and I'm not sure -- we can just forget about
4 that vessel dilatation. I'm not sure why we have
5 there.

6 Someone had reported that as something
7 they had seen clinically that was not evaluated in
8 simulated use. I guess I wouldn't think that you
9 could evaluate it in simulated use. That's why I'm
10 throwing it out.

11 So obviously, you look at delivery and
12 deployment during simulated use testing. Is it good
13 for looking at acute migration if it's designed
14 appropriately? Yes. Okay. And also as far as
15 endoleaks.

16 DR. GREENBERG: What the heck is acute
17 migration?

18 MS. ABEL: Just associated with delivery.

19 DR. GREENBERG: You mean if you screw up?

20 MS. ABEL: Yes. But your device is
21 designed such that when you deliver it it jumps.

22 MR. LU: But that's more placement

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1 accuracy, not migration.

2 MS. ABEL: Right.

3 MR. SMITH: That's not the context in
4 which I wrote that in there.

5 (Laughter.)

6 I was the respondent who wrote acute
7 migration. I think what I mean by acute migration is
8 within the first five or 10 minutes after deployment.

9 MR. QUIGLEY: But the model that you're
10 using to place it in may not be physiologically
11 relevant. I mean you're placing this in a silicon
12 tube, for example.

13 MR. SMITH: No, I'm not. But that's not
14 up for discussion.

15 (Laughter.)

16 MR. LU: So are you thinking about in terms
17 of the effect on the proximal attachment position as
18 a result of some difference in the deployment
19 technique on the distal end as in the lower end, sort
20 of pushing up and that kind of -- sort of function?

21 MR. SMITH: No. I mean it's the same as
22 the migration test I described earlier where you

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1 deploy the device in a pulsatile fluid flow
2 environment at temperature, at appropriate pressures
3 with the appropriate flows and observe whether
4 migration occurs. That's all it is. It's just a
5 simple characteristic that any migration occur after
6 deployment during the first few hundred pulses. If it
7 did, that's probably a bad thing. Even if it was in
8 silicon or if it was --

9 DR. CHUTER: How much migration are you
10 talking about here?

11 MR. SMITH: Millimeters.

12 DR. CHUTER: Because if you're using a 3
13 millimeter long barb to secure its position, it's
14 going to be most effective once the barb is all the
15 way in and that is passively deployed requiring
16 migration.

17 MR. SMITH: Right, I agree.

18 DR. GREENBERG: I would actually prefer to
19 define migration as failure of the fixation systems
20 and as you're defining acute migration it's before the
21 fixation systems have engaged. But this is really a
22 technical deployment issue. I mean it may relate to

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1 the device design, but it's not a true migration.
2 It's a deployment issue.

3 MR. LU: Well, it's a designed function of
4 the system. I mean it's part of the engagement.

5 DR. GREENBERG: You're saying you're
6 pulling a device out because the delivery system
7 attaches to it.

8 MS. ABEL: No, that's not --

9 MR. SMITH: That's not what I'm saying.
10 And I'm not -- a three millimeter migration, that's
11 not necessarily a failure, but it is a measurement.
12 I mean that's all. I'm just talking about
13 measurement. Is there movement after the anchors are
14 engaged, before they're engaged, whatever. Is there
15 any movement.

16 MS. ABEL: And actually what this relates
17 to is the first task, do you need to look for
18 migration resistance as just a simple tensile test or
19 do you also look at it under some sort of fluid flow
20 situation and so before I think you agreed that it may
21 be rationale to look at it that way.

22 DR. FILLINGER: And if you're deploying it

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1 in an angulated neck and it sits there and tilts and
2 then moves after three pulse cycles, then that may be
3 something valid to measure. When you start to
4 introduce things like angulation --

5 MS. ABEL: Sorry to interrupt. I think
6 angulation is obviously one of the parameters that we
7 want to talk about in the next slide, please.

8 You know we had a lot of people doing
9 things differently. They weren't under flow. They
10 weren't under physiologic pressures, that sort of
11 thing. And so what you're suggesting is it may be
12 appropriate to incorporate angulation tortuosity into
13 the model. Is that true?

14 MEDTRONIC: Just one more suggestion. I
15 think if we're talking about this, I think we should
16 also add the fact that the models should create the
17 pressure differential of transmural, whatever we want
18 to call it because if you don't seal the graft, if
19 you're using * (6:14:38), you won't create the
20 pressure differentials, you won't catch anything.

21 Another thing too is that the frictional
22 properties of the mock artery or whatever you're using

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1 should replicate the physiological ones, otherwise
2 this is not relevant.

3 MS. ABEL: And in the simulate use test
4 method, it certainly talks about appropriate selection
5 of a mock artery or should if it doesn't.

6 MEDTRONIC: It's not within the test.

7 MS. ABEL: I mean I think, in general, I
8 believe that there's agreement that this test should
9 be more closely assimilated use model than what people
10 reported than it was and I just want to make sure that
11 we would agree to that.

12 Does it make sense to have a pulsatile
13 flow?

14 AUDIENCE MEMBER: Just one question. What
15 do you mean by atherosclerotic diseased vessels? How
16 much of a simulation of that can you really get?

17 MS. ABEL: That was a no.

18 AUDIENCE MEMBER: Okay.

19 MR. LU: There's another parameter that
20 might be worth looking at when you look at trying to
21 deploy a tortuous, simulated tortuous neck and that
22 would be one of contact surface area, you know, given

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1 most people use a clear tube, potentially that aspect
2 could be looked at and this relates to our previous
3 discussion in relation to ability to seal as was the
4 friction forces attachment. And obviously, I think
5 it's common sense that the greatest surface contact,
6 the greater attachment as for the ability to seal. So
7 in such an angulated neck, if you find that on one,
8 the inner curvatures aspect you only have five
9 millimeter contact, while on the outer surface you
10 have a much longer or a separated contact, top part on
11 the other surface and the medial portion of separated
12 from the vessel wall. I think that would also provide
13 with some sort of indication in terms its long-term
14 durability as far as any subsequent migration post-
15 implant.

16 MR. QUIGLEY: If you want to look for
17 that, then I think you've got to specify the
18 compliance of the tube or the model.

19 MR. LU: Absolutely.

20 MR. QUIGLEY: Otherwise your conformance
21 would be different.

22 MR. LU: Absolutely. I think what I was

1 thinking is that you may be across through ISO group
2 what have you, to come up with -- since everyone uses
3 60 degree angulation to come up with a tube of defined
4 compliance everyone agrees on, everyone deployed a
5 graft into there and then from FDA regulatory agency
6 point of view, you can at least have a comparison
7 between how each of the grafts compared in terms of
8 their respected contact area and the ability to
9 accommodate, to conform to that particular angulation
10 and it might be something, a useful piece of
11 information when interpreting subsequent clinical data
12 and so forth.

13 MS. ABEL: At this point in time, I think
14 we can agree that we need additional discussion,
15 additional information with respect to identifying
16 appropriate compliance. Do we know the pressures in
17 the flows and everything else that should be
18 incorporated? Do we know the angulation that we
19 should be using and all that sort of stuff? Do we
20 know it and just haven't incorporated it or do we not
21 know it yet?

22 DR. FOGARTY: Do we know if we can develop

1 these tests?

2 MS. ABEL: Yes.

3 DR. FOGARTY: We're taking that
4 assumption?

5 MS. ABEL: No, I've seen people do it.
6 Not everybody is doing it.

7 DR. FOGARTY: All the things that were
8 suggested?

9 MS. ABEL: No, I'm talking about
10 compliance pressure flow, angulation.

11 DR. FOGARTY: Surface area?

12 MS. ABEL: That's just measure the surface
13 area.

14 DR. FOGARTY: I guess I don't know how to
15 do that.

16 MS. ABEL: Micrometer.

17 DR. FOGARTY: I don't know how to do that.

18 MS. ABEL: You've got a clear tube and you
19 look at how much is touching the tube.

20 DR. FOGARTY: And it's not -- it's an
21 elastic tube?

22 MS. ABEL: Yes, it is an elastic tube?

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1 DR. FOGARTY: I guess there are ways of
2 doing it then.

3 MS. ABEL: Obviously, that may be
4 something that ultimately might not be quantitative
5 measurement, may be qualitative again, looking at
6 conformity of the vessel, all looking at whether
7 you've got all the parts of the device touching the
8 neck area that you thought should be touching the neck
9 area and I wouldn't worry about whether it's
10 specifically can be incorporated right now. I think
11 it's a useful thought with respect to you should be
12 looking at how much of the device is actually
13 contacting because that means you've got some
14 differences with respect to potentially how it's going
15 to be contacting the clinical environment with similar
16 conditions.

17 DR. FOGARTY: Well, the issue is very
18 often you have initial contact with something that's
19 very soft and that becomes less soft and then you
20 don't have contact or at least you don't have contact
21 with the same force.

22 MS. ABEL: Yes, but again we can't measure

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1 for everything. We can't account for all of the
2 various things that you're going to be facing in the
3 clinical situation, but we can look just in general,
4 you know, do you have a device that is able to be
5 deployed in an angulated neck and have a reasonable
6 amount of the attachment zone in contact with the tube
7 so that you can have reasonable faith that it's going
8 to stay where it needs to stay when it's used
9 clinically.

10 DR. FOGARTY: AT the point of fixation.

11 MS. ABEL: Yes.

12 DR. FOGARTY: Well, I think they were
13 suggesting something different.

14 MS. ABEL: It goes a bit beyond.

15 MR. LU: Yes, I mean in terms of actual
16 graft and vessel wall surface contact, I mean
17 obviously that relates to the ability to seal. That
18 lets us know we have angulated neck on the outer
19 surface you may have, if you have a high pitched
20 stent, the potential is you may have contact on the
21 proximal portion and then contact the lower portion,
22 the remedial portion, there's a separation and so --

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1 DR. FOGARTY: That exists now in every
2 aneurism. I don't know why you have to measure. You
3 should measure the fixation points if you can, but
4 everybody knows there's a big space in an aneurism and
5 you're contacting a lot of it.

6 MR. LU: We're talking about the neck
7 here.

8 DR. FOGARTY: Well, you weren't talking
9 about the neck.

10 DR. FILLINGER: It's also device dependent
11 in that some devices might be designed to have
12 fixation and sealing with two stent rings that are
13 very short and another device might be designed to be
14 10 centimeters long and therefore depending on the
15 length of the neck, you might get a very large contact
16 surface area in one device and a very short contact
17 surface area, but that's just the way they're
18 designed.

19 MS. ABEL: But you know, is it being
20 deployed? Does it look like it should, according to
21 the design in your mock artery.

22 MR. LU: And the other issue there is for

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1 the same, exactly the same device, straight tube
2 compilation, I mean a straight compilation, what is
3 the contact area and then if your instruction for use
4 is claiming he's able to do 60 degree angulation, then
5 what is your contact surface area at 60 degree and
6 again, relates to neck length in the instruction for
7 usage. So I think there's a good comparison in terms
8 of your performance characterization.

9 DR. FOGARTY: You can call it an NIH grant
10 to figure it out.

11 MS. ABEL: Tom, you have so much money,
12 you can figure this all out by yourself.

13 (Laughter.)

14 All right, I think what we're going to do
15 is adjourn for the day before I get more obnoxious and
16 we'll summarize this session tomorrow quickly before
17 we get into fatigue.

18 (Laughter.)

19 (Whereupon, at 6:23 p.m., the meeting was
20 concluded.)

21

22

CERTIFICATE

This is to certify that the foregoing transcript in the
matter of: Workshop on Preclinical Testing
 for Endovascular Grafts

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