EDWARD CHEN: My name is Edward Chen. I'm a cardiac surgeon at Emory University. And I want to welcome you to a live webinar sponsored by CryoLife.

Today's topic is aortic valve replacement options for the bicuspid valve patient.

The point of tonight's webinar is to provide a case-based discussion, for you to come away with more insight into the various options that exist for these types of patients.

The intent is not to have an hour long didactic session but is intended to learn by practical discussion. And we want to encourage you in the audience to submit questions through the Q&A feature of the webinar link.

I want to thank CryoLife for its ongoing commitment to physician education and the betterment of patient outcome and treatment options.

I'm joined by a distinguished panel of recognized experts in the treatment of structural heart disease.

We have Katherine Harrington, who is a cardiac surgeon at the Baylor Scott & White Heart Hospital in Plano, Texas.

Dr. Hector Michelena, who is a cardiologist at the Mayo Clinic in Rochester, Minnesota.

Dr. Tom Nguyen, Chief of Cardiac Surgery at the McGovern Medical School UT Houston Medical Center in Houston, Texas.

And Dr. Jim Stewart, an outstanding interventional cardiologist at Hamilton Medical Center in Dalton, Georgia.

These are just some housekeeping rules for everyone. We ask that you mute your cellular devices, to avoid interruptions in the program. Please participate in the polling questions after each case example. We will have two cases tonight to discuss and of course, your input is very valuable, in knowing what the community at large thinks about these cases.

Please, again, not be shy and use the Q&A chat function to send in your questions, because we certainly will review those and read those off during the audience question discussion portion of the program. We will respond to those as I said, and when you submit your questions, please state your full name, city, and country, along with your question.

The first portion of this is just to get some basic background into understanding the bicuspid valve patient, including principles and conundrums. And with that, we'll have a short, introductory discussion by Dr. Hector Michelena. Hector?

HECTOR MICHELENA: Thank you very much, Dr. Chen. Before we begin our discussions tonight, I think it is important to look a little bit about what principles and conundrums are currently governing the issues of bicuspid aortic valve. I have no disclosures except for, I am Co-PI for the ProACT Xa trial here at Mayo. Which is a CryoLife sponsored trial, however my interest in it is purely academic.

I stole this slide from my colleague Dr. Hartzell Schaff and I think it's very important, particularly when discussing what types of valves we're going to use for these patients. It ain't what you don't know that gets you in trouble. It's what for sure that just ain't so. Which, to me, is a tale about being beware and being very careful with bias, dogma, and with information that is sold to you and that is just not true. So we need to be, in this area, checking ourselves all the time.

And I cannot find a better quote for the bicuspid aortic valve conundrum and its aortopathy than, everything should be made as simple as possible, but not simpler. And the truth is, that the congenital bicuspid aortic valve condition is a complex one and it's a heterogeneous one. And it is the most common congenital heart defect. So common, that even da Vinci, in his studies of the aortic valve and flows of the aorta, et cetera, actually was able to see, and recognize, a bicuspid aortic valve.

But if we jump ahead to 2020, I wish to show you. This is a complete issue in Progress in Cardiovascular Diseases, where Dr. Sarano and I were editors. And it basically has a number of chapters that cover everything from genetics, embryology, to interventional cardiology, and surgery, for the bicuspid aortic valve patients.

So that I don't put so many references, I'm just going to refer to the chapters of this just published issue.

The first principle to note is that is that bicuspid aortic valve is a valvulo-aortopathy. It involves the aortic valve and the aorta in many of the patients and it is very heterogeneous in its presentation.

And we have recently gotten together and tried to reconcile the clinical and prognostic heterogeneity of this condition, and I want you to pay attention to the typical presentation, which is by far the most common.

And it's the typical young adult or adult that has a progressive valvulopathy and/or aortopathy, that requires surveillance and usually requires subsequent treatment. And the life expectancy is usually preserved, as I will show you in a coming slide. They are of course at risk of endocartisis and aortic dissection.

There is another group that is a complex-presentation valvulo-aortopathy And these are the bicuspid patients that have associated genetic syndromes, associated severe congenital lesions, associated severe aortic coarctation. Where the bicuspid valve is really not such a problem perhaps but the other associated problems are possibly worse. These patients, their life expectancy may be diminished. As we know in Turner's syndrome, for example, or patients with severe coarctation, it is diminished.

And then there is a group of undiagnosed or uncomplicated, which we will not go into.

Now recently, as you know, there are many classifications for bicuspid aortic valve phenotypes including the phenotypes of the valve itself and the aorta. We have actually got together with an international group of bicuspid experts and come up with a new consensus nomenclature classification, which is based on the English language and not numbers and is very straightforward.

The first type of bicuspid aortic valve is the fused type, which is 90% to 95%, and it has the three common phenotypes that we know: right-left fusion, right-non fusion, left-non fusion.

It is characterized by having three sinuses of valsalva. Usually the non-fused sinus is a little bit bigger sometimes. It is very common, up to 70%, to see a raphe in these patients, as you can see in the scheme there.

The other one is the 2-sinus bicuspid aortic valve, which as its name says, it has only two sinus and not three. One sinus, another sinus. And they can be lateral-lateral or anterior-posterior. It's very interesting that these types, usually, the cusps, it's very difficult to tell who's fused, that's why there's no calling right-left or left-non here, and they are very symmetric and they are almost the same size. And this is the 2-sinus bicuspid aortic valve.

Finally, there is a new player, which is the partial--fusion bicuspid aortic valve which indeed has been shown to exist, and it's early in the study. And then we also must reconcile the heterogeneity of aortopathy. Aortopathy is very common in bicuspid aortic valve and by far the most common phenotype is dilatation of the ascending portion, that does not affect the root too much, up to 70%.

However, there is one presentation that affects predominantly the root, which is called the root phenotype. And it's more associated with right-left fusion, young males with aortic regurgitation and potentially associated with more risk of aortic dissection.

Then of course there are extended phenotypes that are mixed with dilatation of the entire aorta.

It is critical to talk about the complications. What complications does a patient with the bicuspid valvulo-aortopathy face in their life? Well if we look at a population-based study for a very long follow up, we will realize that surgically speaking, aortic valve replacement is by far the most common surgical complication. And

Aortic valve replacement, due to aortic stenosis as the cause, is the most common complication. So this is the bread and butter of the typical bicuspid aortic valve valvulo-aortopathy.

Of course, we also have aortic regurgitation and I want to get your attention to the age distribution of this valvulopathy. Here is not like the tabular in tri-leaf aortic valves that are mostly in their 70s and 80s. This is a whole different story because, as you can see, as you go down in age, aortic regurgitation predominates. As you go up in age, aortic stenosis predominates.

But you can see that they're about the same, or close to the same, at that age of 50 to 70. So we have an ample distribution of valvulopathy. And indeed, the two largest population- or regional-based studies have shown, one in Canada and one in the US, that the survival of the typical patient with bicuspid aortic valve, not the complex one, is not different than the general population.

Perhaps when you take a tremendous amount of patients, 2000 here, 2000 here, and you look at tertiary referral hospitals, or when patients are tertiary referred for a VR, then you can probably, because of statistical power, get a little bit or observe a little bit, of penalty in survival in these patients. But in general, these patients have a very good outcome.

Now, the treatment conundrums are very interesting. Here we have a bicuspid aortic valve with stenosis, by transitive of deal like well here we have one regurgitant, with the typical eccentric jet.

First thing to note tonight is that AVR substitutes one disease for another. And what I teach my fellows about the and/or principle that if you're thinking about doing something to a patient, be it percutaneously or surgically, that might hurt them, you better be sure that you're offering an improved mortality and/or improve morbidity and/or improve quality of life. If you're not offering those things, you're in trouble.

If we look at bicuspid aortic valve stenosis, current options include surgical aortic valve replacement, then TAVR. And if you look at the regurgitation, they include surgical aortic valve replacement and repair.

Now when we talk about surgical AVR, immediately we think about mechanical versus bio. The first thing that comes to mind is Coumadin for the mechanicals and degeneration for the bioprosthesis. And that's what the old studies, the VA trial, and the Edinburgh trial in the '70s and '80s showed, that there was a significant difference in bleeding versus degeneration.

But now we know that the thrombosis risk is about the same for both. And that is a fact and

Of course, one has to ask, should I promise my patient a valve-in-valve, tell them to get a bioprosthesis, and that will do a valve-in-valve in the future, and there's going to be no problem?

And then of course, there's TAVR that's coming up. And one has to immediately position your mind into, is it going to be a balloon expandable or a self expandable situation here with the TAVR, and is it ready to be used in bicuspid valves, and is it better than surgical aortic valve replacement?

Now when we're talking about AR, we're talking about a much younger population, population that runs in the mean age of in their 40s, mid 40s, while bicuspid aortic stenosis runs in the mid 60s or so. So we have of course the surgical AVR, which has the same issues as we have discussed here, but in a younger patient.

And of course, we have surgical repair which, I have to say, and this is and this is very important. It has made tremendous strides, particularly by groups in Germany and Belgium, on the success of repair, but it's limited because you can't do it on every valve. And there are conditions that you must meet, including the training of the surgeon.

And don't forget, just to end, that in addition, we are dealing with a tremendous age spectrum here. Remember that the patients with bicuspid aortic valve may have aortopathy, and if you look at trials evaluating TAVR for example, in bicuspid valves, sometimes you see exclusion of patients with more than 45 millimeter aortas, et cetera.

And then, of course, the question pops up, do we need a bicuspid SAVR versus TAVR randomized controlled trial, yes or no? Is there equipoise to do this, yes or no? And finally, the patient's wishes which, at the end the well-informed patient is the one who is going to make the final decision as to what type of treatment they want. With that, we will begin our cases

EDWARD CHEN: Thanks so much, Hector, for that comprehensive overview of the spectrum of bicuspid valve disease and the surgical options.

Our first case is a 62-year-old gentleman that was referred for progressive dyspnea on exertion. He works at a liquor store. He began to develop symptoms where he could not carry heavy boxes. He smoked about half a pack a day. Had about three or four drinks a day. Lived alone, had class III NYHA symptoms.

His past medical history: he had severe AS with Sievers type 1 bicuspid valve with right-left fusion. His EF was about 40% to 45%. This was a new finding, a new decline, in his ventricular function. He had hypertension, paroxysmal AFib, he had been on apixaban for two years but no history of bleeding, mild COPD, a preoperative cath with a focal mid LAD lesion, and an ascending aorta measuring about 4.3 centimeters in diameter.

His pre-op echo images as shown here, again his EF is about 40%, 45%, his max velocity was 3.9 meters per second, mean gradient about 38. You can see on the right hand panel on a long axis, you have the root heavily calcified, valve with a minimal excursion of the leaflets, thick LV seen on the left side of the panel.

And because of the inability to adequately visualize the left ventricle outflow track, valve area was not able to be calculated. But as you can see anecdotally, it is pretty small. His dimensional velocity index was 0.17, consistent with severe AS. So

On CT imaging, he was confirmed to have a Sievers 1 bicuspid valve with right-left fusion. You see the calcium burden on the cusp and all those kind of small-- there's the annular dimensions, the LVOT diameters are shown in the slide there. I think the valve area, based on this imaging, was 0.62 square centimeters. On

The intercommissural distance was 33 millimeters. And you can see the sinotubular junction diameter was about 34, and the sinuses were about 41 millimeters or so.

His left coronary height was about 2.3 centimeters and the right coronary height was 2.4 centimeters.

This is a 3D reconstruction of his access vessels. You can see adequate iliac caliber through the femoral arteries, some mild tortuosity of the abdominal aorta, but minimal calcium or athoscerotic burden through the distal aorta and common iliacs.

Using the STS risk calculator, his risk of isolated AVR carried a mortality 2.4%, 3% risk of renal failure, small risk of stroke, and small morbidity or mortality, about 14%. Length of stay about 6.4, short length of stay about 33%, only over 6% chance of a longer length of stay.

So based on the data, we thought we would poll the audience and give four choices. So based on the patient details and imaging that's presented in case 1, which procedure would you choose the following options.

One, transcatheter AVR, two, isolated surgical AVR with the tissue valve, C, isolated AVR with a mechanical valve, and D, surgical AVR with either tissue or a mechanical valve, combined with ascending aortic replacement.

So I think as we give a minute here to let the audience vote, we'll go to the next slide and touch on some of the key discussion points that we felt were important as part of this case.

Remember, I want to remind you, if you have questions, please channel those through the Q&A session of the link.

So in terms of discussion points, obviously what type of SAVR valve would you use? Would you use a TAVR valve, tissue versus mechanical in the relatively young patient? Implications for future intervention, either through a redo operation surgically or valve-in-valve intervention.

What do you do about the aorta? And of course, the pitfalls or things that one must be cautious of when performing TAVR in bicuspid valve anatomy.

So the poll here shows that about half of the audience is favoring isolated AVR with mechanical valve. The least favorable is transcatheter AVR. Some favor tissue valve and about a quarter of the patients prefer a surgical AVR with ascending replacement.

Based on his anatomic features, what are you considering in him as you weigh out the various options?

TOM NGUYEN: Thanks, Dr. Chen. It's funny, I actually had this exact patient come to my clinic today who was referred from our cardiologist for a TAVR. I think there's really important for us to understand. Just because we can do something, just because we can do TAVR, doesn't mean that's the right thing to do.

We know there's a green light to do TAVR in this patient cohort. But I would argue there's actually very little data to do TAVR in this patient cohort. And just a quick reminder, all the randomized trials we have for TAVR versus SAVR, bicuspids were excluded. The low risk trial for TAVR, the average age of 73, 74, this patient's 62, I believe.

So you have very little data for a 62-year-old TAVR I don't think that even should be an option at all. And then even it was an option, even the patient was 73-ish, the longest follow up we have for a low risk patient is roughly two years. Intermediate risk patients, five years.

So we don't have more than two years data comparing TAVR versus SAVR for low risk patients. So of the options we had to choose from, I think B, C, and D are very reasonable option. And the way I approach it, I have a very honest, transparent conversation with the patient.

I think it's reasonable to a tissue valve in a 62, 63-year old, knowing that there's a good chance that he or she would probably need something to be done down the line.

I probably would prefer a mechanical valve in this patient cohort. But something you cannot forget too, the patient's ascending is 4.3. In a bicuspid, we know the guideline to intervene in a bicuspid is 4.5.

We also know those guidelines are very, very loose. So I think it's not unreasonable in a very healthy, robust 62-year-old, who doesn't want to worry about his ascending getting larger to actually go in there and fix it, and he can just call it a day, so not to worry about it.

That's what I would do. I would have a very honest conversation with the patient and then give them the option of either B, C, or D. It was me, a loved one, I'd probably choose, I think option C was one where you do the mechanical valve, no ascending. That would be my choice.

EDWARD CHEN: Katherine, with your experience in Plano, are you, I mean 4.3 is probably slightly below some of the guideline recommendations and even those have mixed opinions in a BAV patient. Would you take age into consideration considering ascending replacement, or how would you approach this patient in terms of ascending replacement?

KATHERINE HARRINGTON: Yes, thank you. Yeah I tell the patient that it's always going to be kind of a game time decision. I will also take into account like when you cut into it for aortonomy , how thin it seems or if it's good tissue. But I also like to look at their kind of index to their BSA and index it to what their proximal descending size is.

Sometimes, a 4.2 on someone looks drastically bigger than the rest of their aorta, sometimes it looks the same. So it depends on the size of the patient and the size of their other normal aorta. Say if this patient was choosing a mechanical valve, I would be more likely to replace it because the reason that they're choosing a mechanical valve is because they never want to have open heart surgery again, essentially.

That's the trade-off for Coumadin. So if they choose a mechanical valve and they want this to be their last sternotomy, then I'm much more likely to replace their ascendings to try to give them that payback for that.

If they're choosing a tissue valve, especially if we think, a younger patient, we know we're going to be back for a reduced sternotomy, then I'd be more likely to leave it. Because that would give it time. At our next sternotomy, it would be an easier redo without an ascending graft and you could replace it at that time, if it's grown.

EDWARD CHEN: Hector, when you look at bicuspid valves and consider the application of TAVR, irrespective of the patient age, what kind of factors are you looking at to tell you, this is going to be a more successful TAVR procedure, or I'm a little worried about this one, maybe we should send this one to surgery, you know, things like that. What kind of clinical or anatomic factors--

HECTOR MICHELENA: I think we have been pushed to do TAVR on bicupsid aortic valve patients, particularly those that are very high risk for surgery. And we do TAVR for these patients. And there are other more loose societies, perhaps Europe and so on, where they are using it perhaps in lower risk patients as well.

That being said, I think that one has to be very careful. And there is new data, some of which we're going to show in a minute, explaining or discerning, what are the important aspects to take into account when you are going to consider TAVR for a patient with bicuspid aortic valve?

I do have to say, these TAVR can save somebody's life. Let there be no doubt, especially a very high risk patient. And then you just go with what you have, and do the best.

EDWARD CHEN: Thanks so much. There's a few questions from the audience. But I think, before we answer those, let's go ahead. This was Dr. Stewart's patient, Jim maybe you could just go through the treatment plan and what you did for him.

JAMES STEWART: Sure. So all of the points in favor of surgery in this case are well taken. That's quite honestly the way we were trying to lean, but the patient was resistant. He had a brother who died on the table with open CABG.

We were also, because of his young age-- 60 is roughly kind of the crossover point where we would generally consider doing a mechanical valve, but the patient really didn't want to do Coumadin.

His physicians were nervous about Coumadin use, with his alcohol intake that we thought was probably more than he told us.

Then ultimately, even though the STS certainly puts him in a low risk category-- he is low risk, people thought that he was higher risk than he might appear on paper.

I agree with everyone's points. The specifics of a particular clinical situation are important. This happens to be a very simple LAD lesion. Certainly, more anatomic complexity would have pushed us towards a LIMA to the LAD, in addition to his valve surgery.

Then as AFib as well is worth mentioning too. Had we been considering a bioprosthetic valve, he would also probably be more likely to choose surgery because of being able to ligate his left atrial appendage should maybe obviate him from being on any blood thinner.

That being said, the decision was made, and we elected to use a self expanding TAVR valve.

This speaks to some of the heterogeneity, and in particular, anatomic points Hector's mentioned, but this was a very heavily calcified valve. Sizing wise, it was actually even outside the recommended upper limit for a balloon expandable valve.

Here's what we did, here's how it turned out. The fluoroscopy-- you can just appreciate how just a tremendous amount of calcification is here. The valve was actually, when we crossed it, had an invasive peak to peak gradient pushing 70.

So our echo image, we knew was poor quality, but definitely underestimated the severity of the stenosis here.

We pre-dilated the valve. We were concerned that our self expanding valve may not fully expand if we didn't. So we performed an alveoloplasty ahead of time, which is not something we always do, in most cases.

Our initial placement of our evolute was a bit high. You can see in this LAO view, we're kind of above the non coronary annulus there.

And our second attempts, we were we were very happy with our placement, at least our depth for the valve. So we release the valve and the patient was very stable. The valve position was stable.

What concerned us however, was a view that in the RAO. In the RAO view, the valve was just absolutely pancaked. So even though in the 90 degree LAO view, it looked well expanded, we could appreciate that even though we had pre-dilated, the inflow of the self expanding valve hadn't expanded.

We were stuck figuring out what to do. We knew we needed to at least post-dilate the valve. The question was, could we even withdraw the nose cone of the deployment system safely without pulling the valve out?

As you can tell from these pictures, the answer is no. We probably-- of course, hindsight's 20/20, should have stuck the other leg and put up a valvuloplasty balloon and dilated it without removing the nose cone but we thought we could sneak it through.

We caught the bottom of the frame of the self expanding valve, and we ended up dislodging it and embolizing it.

Thankfully at this point, on the right panel, even though the valve is above the native valve, we're not obstructing the coronaries, the native valve is still closing and competent, there's not severe AI.

The patient was actually completely stable. So we again revisited the surgery question. This is a patient still, we felt like we made the wrong decision in choosing TAVR. Could we now reverse course and go to surgery?

Ultimately, that's not what the team thought would be feasible to accomplish. We brought up a balloon expandable valve, positioned it, deployed it, and essentially hoped for the best.

And as you can see on the final aortography here on the right of the screen, at least in the acute situation, we were able to bail ourselves out of trouble.

No one, I think, will argue that this is an ideal outcome, with a CoreValve floating in the ascending aorta there.

But the patient was actually stable, there was no AI, there was very little gradient across the valve. And we decided to stop there and live to fight another day.

TOM NGUYEN: Dr. Chen, can comment real quick? It's a subtle point that I'm not sure the audience can fully appreciate. Dr. Stewart can comment and Dr. Michelena.

This patient has bicuspid that's severely calcified. Transcatheter options are either a self expanding valve or balloon expandable valve.

The pros and cons of both- and they obviously chose the self expanding valve. The advantage of a self expanding valve in the valve that's really calcified is, you have a lower risk of annular rupture, but you do have a risk of PVL and you have a little higher risk of the valve not seating, which happened here.

With the balloon expandable valve, which they ultimately did, you have less of a risk of the PVL, but you have a higher risk of having issues with aortic annulus.

Can you explain a little bit your thoughts, Dr. Stewart, on how you choose balloon expandable versus self expanding and it looks like, in the end, you did balloon expandable and things worked OK. Do you regret not doing the balloon expandable to begin with?

JAMES STEWART: Sure. The chief reasoning was just the degree of calcification. The CT scan that we showed, without being able to manipulate them, don't do quite enough justice in my opinion to how heavily calcified this valve is. That is really the single greatest factor to predict annular rupture risk.

He had both heavily calcified leaflets as well as calcium that extended down into the LVOT which, you can even see this bulky calcification just get physically pushed out of the way as we do the balloon expandable valve in these two videos.

We ultimately chose self expanding because of our fear of the catastrophic complication of an annual rupture. And typically, I sort of use sizing. The other thing that gave us a bit of pause is that the innercommissural distance there for this fairly ovoid-opening bicuspid was much greater than the largest diameter of the biggest balloon expandable valve.

Calcification, degree of calcification, location of calcification, is the biggest factor I use but sizing can figure in as well. In this really large valve, I wasn't entirely sure at 29, Sapien valve would fit.

Ultimately it did, but there's just no great way to model that ahead of time and predict. As you pointed out, each valve has its downside. And we certainly found out the downside of the self expandable valve in this case.

TOM NGUYEN: One last really, I think, important teaching point is, any time the valve doesn't get deployed where you want it to go, you maintain wire access, which you did, because then you have control to do other things.

The last thing you'd do is lose more access and the valve can come out.

JAMES STEWART: Yeah.

EDWARD CHEN: We've got a couple of questions from the audience. Margaret Rodgers is asking, how would COPD impact the selection of valve choice? And Katherine, I wonder if you could comment on that. Say this guy had, you know, marginal, moderate, severe COPD versus no lung disease at all.

Would you lean more to a tissue value in someone who's a little sicker? How would you approach that?

KATHERINE HARRINGTON: I mean, if he has moderate to severe COPD, depending on his FEV1, that certainly could push him out of the low risk range. His STS would probably be higher. We currently strongly discourage TAVR in bicuspids in low risk people, but we certainly will consider them in people that are high, intermediate severe COPD, especially on home [INAUDIBLE] TAVR candidate. For us, there's good data with home oxygen use. But if we elect to do surgery, that would certainly push me more towards a tissue valve, due to his life expectancy with moderate, severe COPD.

EDWARD CHEN: Hector, I wonder if-- I'm going to forward to the next slide. We talked a little bit about the calcium burden of bicuspid valve aortic stenosis.

This is just some follow up on the patient. He's on Eliquis. He's back, feeling well, his mean gradient's six. He's really doing well. But I would like you to share some of the data that you shared with us in our discussions about the use of TAVR, the success of TAVR, the outcomes in them, based on calcium burden.

HECTOR MICHELENA: Bottom line is that we know a lot about the calcification patterns and quantification of calcification by CT for tricuspid aortic valves, but we don't know much for bicuspid aortic valves because, as Tom said, they have been excluded from prior studies.

So the first lesson here is that CT needs to be the gold standard for evaluation of these patients prior to undergoing TAVR.

And what they did in this study, which was just published by Jung in JACC, and by Raj Makkar, is, they did a systematic and blind CT Core Lab evaluation of 1,000 bicuspid patients or so, with a combination of qualitative and quantitative assessment of pattern of calcium distribution, presence of raphe and amount of calcification of raphe.

As you can see, they divided the patients in no raphe, non calcified raphe, calcified raphe. But they also, in a quantitative manner, used the amount of total calcium or excess calcification.

What they find out, if you see here in panels E and F, or particularly in panel F, this is a patient with exuberant calcification, including the raphe and the belly of these cusps.

What they showed is that all cause mortality was significantly increased at two years in patients that had both a calcified raphe and an excess of leaflet calcification. And I think that this talks a lot about the case that we just saw.

There needs to be, number one in my view, studies of calcification patterns and calcification accretion, and quantitative studies of calcium by CT with a Core Lab , to determine who are the candidates, or who are not the candidates, for TAVR in bicuspid aortic valve?

If you go to the next slide, this is another study that has been recently published from the BEAT International Registry with a lot of patients as well.

You can see that the death of balloon expandable versus self expandable there on your right in a matched cohort, is about the same. However, as we have discussed, there was higher annular rupture in balloon expandable and this was significant.

There was a higher increase of more severe pre-valvular leak in self expandable. I believe, before we attain state of the art TAVR treatment and recommendation for patients with bicuspid aortic valve, such that we can do a state of the art TAVR randomized trial versus state of the art SAVR, which we already know what it is. We need to improve these aspects.

EDWARD CHEN: I think we'll move on to the next case. Thanks so much for that very thorough answer, Hector.

Case number two is a 58-year-old gentleman, 6' 3", BSA 2.32. Had an AVR eight years ago for a bicuspid valve stenosis. It was a 23 Edwards Magna Ease. He was having severe symptomatic prosthetic AS.

He works on a ranch. Initially chose a tissue valve because of lifestyle considerations with injury, working on the fence lines. He was somehow told, when he had his original surgery at age 50, the valve would last 20 years.

He presented with class III, class IV symptoms. Continue working until he had a episode of collapse. Had critical AS. His STS predicted risk of mortality was 0.7% and no risk of frailty.

This is the echo images, and you can see the stenotic valve sitting in the aortic position. Reasonably good ventricular function, peak gradient of 101, mean of 60, V-MAX of five meters per second. Clearly this confirms, again the torn leaflet off the post, and a lot of AI and AS.

This is just a coronal view of the CT scan showing the valve sitting in the native aortic root.

So based on this particular case presentation, the details, we'd like you to answer from the audience. What option would you choose for this otherwise active, previously active person with a history of a biologic AVR?

Transcatheter valve-in-valve replacement, redo surgical AVR with a tissue valve, redo surgical AVR with mechanical valve, or redo root replacement with a stentless bioprosthetic tissue valve?

These are some of the discussion points that we in the faculty felt were important. The application of SAVR versus TAVR, how does age affect longevity going forward, the likelihood for PPM in a patient that was already of large stature, and the implantation, previously, a 23-sized tissue valve, the management of Coumadin in a young patient, and ultimately, the overall lifestyle.

So Tom, if you saw this patient, what are your thoughts, as you think about the options for him?

TOM NGUYEN: Yeah, you know, so first of all, disclaimers. I actually am a big fan of transcatheter technology but I think we should have another data behind that. Similar to the last kind of message, I think a valve-in-valve is not the right option for this patient, particularly because he is still relatively young and relatively low risk.

I think there's not enough data out there. There's not enough durability data out there for valve-in-valve, for us to make the right decision in someone who's relatively low risk. But there actually is a fair amount of durability data under the redo SAVR on this patient, and knowing what to expect.

We know from the valve-in-valve registry about 30% of patients who get a valve-in-valve have a mean gradient greater than 20, but we know that we do a redo operation, if we do it right in the necessary root margin, we can get the gradients down to at least less than 10.

So I'd have an honest conversation with this patient. My inclination would be to do a redo. I'd probably put a mechanical valve in because he's relatively young. I try to get the largest valve possible in when I can, and not have to to worry about a redo operation in the future.

EDWARD CHEN: Jim, if you saw this patient, would you attempt valve-in-valve TAVR or would you send this patient to one of your surgical colleagues for redo AVR?

JAMES STEWART: Well I think solely based on age alone, I almost don't have to see anything else before I ask myself, why can't the patient have surgery?

I agree with Tom that we can-- valve-in-valve TAVR is relatively easy to do. It'd be nice to see some of the CT planning, to look out for a handful of anatomic pitfalls. But especially in a, what was it-- 23 surgical valve in a 58-year-old, you're not going to end up with optimal gradients regardless of the technique you use, regardless of fracturing the surgical valve frame.

You're kicking the can down the road, in my opinion, if you did a valve-in-valve TAVR, rather than solving the problem, hopefully lifelong, for the patient.

EDWARD CHEN: Hector, do you agree with Jim?

HECTOR MICHELENA: I agree big time with Jim. And I think that this is critical because the audience was asking this, how do you convince the patient to do the right thing?

Well I think the younger the patient is-- this guy's 58 years old. The lower risk the patient is, the more you have to go to the truth. Be honest, and tell them what you really think.

Then, it's when it becomes important to put yourself and say, this is what I would choose for me. This is what I would choose for my father, this is what I would do, because of this and this and this.

And you show the data to the patient so that they understand. I would definitely try to present aortic valve replacement with a mechanical valve as potentially a definitive solution for this patient, yes.

EDWARD CHEN: And so I think the important points from the audience are-- excuse me, from the panelists, are that one, just because you can do something doesn't mean you necessarily should do something.

I think one of the nice things about the panelists is, we've got both surgical and interventional viewpoints, and all seem to be in agreement, at least for this particular patient, that surgery is the better option.

We know from a large series of national databases as well as single institutional studies, that redo AVR in an otherwise healthy patient, a young patient, is associated with low operative of risk.

So in terms of the panel, the audience, I think the majority feel that this patient should have a surgical AVR with a mechanical valve, 2/3 of our audience. A low percentage, only one person voted for AVR with a stented bioprosthetic valve. 13% voted for stentless bioprosthetic valve and 18% chose valve-in-valve TAVR.

TOM NGUYEN: Dr. Chen, can I add something real quick? I think what we really don't know is, that TAVR valve-in-valve versus redo surgery in maybe intermediate risk patients. I think if it's a high risk patient, it's pretty obvious. We should do a valve-in-valve if the patient is not going to be around very much longer.

I think there is a huge opportunity for research in this arena. We don't have really any data comparing redo surgery versus TAVR valve-in-valve in a non meta-analysis, observational type study. I think there is a huge opportunity to try to learn more from that.

EDWARD CHEN: Absolutely. And I think that, one of the things we do know is that in some of these TAVR publications, we do know that leaving a patient with PPM is associated with worse outcomes. So that's extremely important, especially in a robust, active person.

Katherine, you were the surgeon taking care of this patient. Maybe we'll have you talk through the treatment options as to what you did here.

KATHERINE HARRINGTON: Yes, the key point. I obviously agreed with everyone in the panel and the attendees. I was really trying to push him towards a mechanical valve and I went about that three different ways.

One was the longevity of a tissue valve. Obviously, he was kind of erroneously told that it would last 20 years, but we all know that younger a patient, the less it's going to last.

So, I think, once he had only gotten eight years out of the valve that helped. We're not just looking at two more valves, we're looking at three or four in him if he continues with this same pattern.

In terms of PPM too, I think it's important to mention that if we had gone back and put another tissue valve in, a 23 is still relatively small for a man of this age. So a mechanical valve also offers a higher EOA for the same size.

I talked with him about Coumadin management with our newer valves, like the On-X, about a lower INR and he was really pleased about that.

One of his main issues with getting a mechanical valve in Texas here was that when he was deer hunting, he was afraid that the deer would hear the ticking. I'm not joking.

So I had to get a valve and bring it in his room and click it at the door, and have him figure out if he thought the deer could be able to hear that or not. So that was the final straw that we had to get it in.

So we did indeed do a-- I do all my redos through a mini too, so he was pleased about that, less pain and get back on the ranch earlier. So we did him through a mini-sternotomy redo and put in a 23 On-X, so a straight 23 for 23, but again, that has a better EOA than a tissue 23. He was discharged on post-op day four, no problems.

Obviously we'll keep them at a two to three INR for three months and then we will go down to the 1.5 to two. I'm also a PI in the ProACT trial with Dr. Michelena so hopefully, we will maybe enroll him in that trial after three months as well.

EDWARD CHEN: One of the nice things about the ProACT Xa trials, you can enroll pages retrospectively in SA-AVRs. We all look forward to those results.

The On-X valve, as you alluded to, has great humanomics. And one of the nice things, it's FDA approved for INR 1.5 to two after three months.

Katherine, if this patient had a previous CABG, would you have gone through a redo mini, because I've done that and gotten into some vein grafts. I'm just curious, is it just redo isolate AVR? What kind of--

KATHERINE HARRINGTON: I do all my redos, even CABGs, through a mini. So far, so good.

EDWARD CHEN: Good job, then. You know, what about, Tom--

KATHERINE HARRINGTON: I just let the mammary beat.

EDWARD CHEN: Tom, one thing we haven't talked is the Ross procedure. Where does the Ross fit into your overall treatment paradigm? I'm going to ask Katherine the same thing in terms of treating patients like this, that robust person, a potentially life long solution.

[INAUDIBLE] of excellent survival in an otherwise healthy patient. You might be a little bit on the older side but certainly, there are centers in Canada and other places in the world that have used the Ross ensure an outstanding result in patients over 50 years of age. I think there's publication forthcoming on that.

Would you consider the Ross in a patient like this and if so, what criteria do you use to include exclude patients?

TOM NGUYEN: Yeah, thank you. I think the theme is for us to know the data, and then really kind of have a shared decision making process with the patient.

I think the Ross is an excellent option, or was, an excellent option for the patient his first go round. Because you have some data, pretty good data, in younger patients who get a Ross, and some durability data.

There's not as much data for a Ross in redo operations. Technically, it's going to be a little more challenging as well.

So in this patient, I probably would not do a Ross redo but the first time go round relative to the young patient I would definitely entertain that option.

EDWARD CHEN: Katherine, was the Ross ever part of the discussion with you and this particular patient?

KATHERINE HARRINGTON: Yeah, we do select redo Rosses as well at my center. We're pretty aggressive with the Ross. I find, like Dr. Nguyen was saying, it is a little riskier. I tend to save it for, say, the younger females who are still trying to conceive.

I've had a couple where they put in like a 19 tissue valve and they had PPM after two years, and we switched it out to a Ross when they were still in their childbearing years.

So I think that's certainly an option but definitely the technical aspect is much harder in a redo and it should be reserved for experienced centers.

We also should note that as he has an old bicuspid valve, the aortopathy extends to the pulmonary artery as well. So when you do a Ross on a bicuspid patient, we do all of ours supported.

So we put the allograft in a Dacron graft, kind of like a pre-David, before we sew it, and we've had really good results with that.

EDWARD CHEN: I think one of the challenges-- a significant portion of the Rosses I've done have been in reduced previous tissue AVRs that then became stenotic and there was no evidence of aortopathy.

One of the challenges is digging out the AP window. I think the aortonomy, depending on how it was done, especially if they used pledgets and erode into the pulmonary artery, you can injure the potential autograft conduit, and so that's something to be very mindful of.

KATHERINE HARRINGTON: Yeah, I definitely take note of pledgets on the CT scan, the little cotton forest you can see sometimes.

EDWARD CHEN: Hector, in a patient like this, do you have a mechanical valve of choice for patients like this, that are going to have a mechanical valve? Do you always use the On-X valve? What does your institution favor?

HECTOR MICHELENA: To be very honest with you, I work a lot with bicuspid aortic valve patients and with patients with aortopathy and patients that are going to require specific treatment for these things. And I work with two surgeons that are bicuspid and aorta specialists. The reason why we are participating in the drug trial is because we have so many patients with On-X now.

EDWARD CHEN: Katherine, we have one question from the audience that I think would be very useful for the surgical attendees. In a redo mini, and this patient had severe AI, how did you end up initially protecting the heart? Did you use anesthesia to place a retrograde catheter, how did you protect the heart?

KATHERINE HARRINGTON: Yeah, we have very good anesthesia colleagues here. So on all of our minis, we place both a endovascular pulmonary vent and endovascular retrograde coronary sinus catheter through the right IJ. So I do have a retrograde in, luckily.

So, I like to give maybe 100 or 200 cc, just to get some AI down-- some antegrade down. At least, the conal branches of the right coronary that aren't going to get good retrograde.

And then, as soon as the heart fibrillates, or starts beating, I switch to retrograde. That normally only takes 100 or 200. And then I give handheld down the right coronary as well after I open my aortonomy.

EDWARD CHEN: And what were the gradients at the end of the case?

KATHERINE HARRINGTON: Funny you should ask. I have a slide right here. So here is the post-op TTE. As you remember, we were 106 max and a 62 mean, and now he's down to 12 and seven. If we had used a tissue valve, we probably would be closer to 10, maybe above 10 when he was awake.

That's another thing that I look at when I look at people, if they're on the border between tissue and mechanical and they're asking for me to push them one way, we do TAVR CTs on everyone pretty much who's getting an aortic valve, so I can see what their annular size is pre-op.

If I know, say they have a higher BSA but a smaller annulus and they're on the border, I will push them towards mechanical valve, just to maximize EOA.

EDWARD CHEN: Yeah, absolutely. And how would you sew in the mechanical valves, particularly On-X or another type?

KATHERINE HARRINGTON: I like the anatomic or the conform cuff of the On-X. Those are designed to be put in non-everting, or ventricular to aortic, as opposed to the thicker inner tube cuffs.

On-X has a cuff like that. And the St. Judes that are meant to be put in intra-annular and so, everting. But I like the conform, or the anatomic cuff, so I can do it non-everting and not lose essentially a size by that everting. So that maximizes your size as well.

EDWARD CHEN: How about pledgets versus no pledgets?

KATHERINE HARRINGTON: I'm no pledgets. [LAUGHS]

EDWARD CHEN: How about you, pledgets or no pledgets?

TOM NGUYEN: You know that's a good question. I've been transitioning to no pledgets. There's a paper I've read somewhere recently showing that there is lower gradients if you don't use pledgets.

And I think now that a lot of us-- you guys use COR-KNOTs? I think now that we're using COR-KNOTs, I think it's actually rare, very, very, very, very, very, very rare to get PVL. And there were some studies about that too-- a cool study, people using COR-KNOT, and people tying.

If you use COR-KNOT, or if a medical student does, the knots are consistent pressure and a higher pressure circumferentially that can be tied, as many of the surgeons out there know, when you're tying, especially around the post, especially if you have a resident or a fellow do it, sometimes behind that post, it's a little bit hard to get that knot to really sit.

So to answer your question, I use COR-KNOT. I'm increasingly not using pledgets because I feel pretty comfortable that I can get a nice, tight seal.

KATHERINE HARRINGTON: I feel pledgets expose them to pannus later down the road in mechanical valves, although it depends on which valve you're putting it in the hinge mechanism.

TOM NGUYEN: Dr. Chen do you use budgets? You have to answer your question.

KATHERINE HARRINGTON: Yeah.

EDWARD CHEN: I do not use pledgets at all because for the exact reason-- the pledgets cause turbulent [INAUDIBLE] and that leads--

KATHERINE HARRINGTON: Pannus.

EDWARD CHEN: We've usually taken out valves that have had the COR-KNOT that has some pannus on it, although it's on the aortic side.

One of the things that's very interesting when you operate on a patient that's had a previous AVR, either tissue versus mechanical, and you cut the knots and pull them out, sometimes as you said, Tom, they're varying lengths.

So that means sometimes there were air knots and now it sits down all the way, and sometimes they were done just right. So sometimes the knots are this long and some times they're that long on the same patient.

So you can tell a lot from how the work was done, when you go back in and inspect it.

Hector, you had some nice slides about-- a lot of us are aware of the New England Journal paper from a couple of years ago, looking at tissue mechanical valves, a large California database, maybe you can share that data real quick with us.

HECTOR MICHELENA: Yeah. Look, I think it's important to remember the audience that when we're giving patients valves, we are giving them another disease. It's just the disease, that it's lesser than the one they have right now, and that hopefully will not kill them, OK?

So we need to look at what the data is out there. And if you go to the next slide, that New England Journal of Medicine article from 2017 should be there.

But I would like to remind the audience that two big randomized trials were of course the VA trial and the Edinburgh trial. And those showed of course more bleeding with Coumadin and more degeneration with bioprosthesis.

It is now shown that the thromboembolism affects both valves about the same. This is a interesting study because it's an administrative database. I think it's very important because it tells you the limitations of it right off the bat.

Of course, when you're doing things through ICD codes, you can miss ICD coding, of course. And it utilized the inverse probability weighting, which is a form of making both groups have the same prognosis.

But of course, it is not the same as a randomized trial. It covered a tremendous amount of time and frailty was not fully assessed but it's interesting what it showed, especially in light of previous data.

So if you go to the next.

Now, it is important to understand that the VA trial and the Edinburgh trial showed no difference in mortality initially. However, one of those trials was followed further into much longer period of follow up, and showed that patients with mechanical valves had a survival advantage.

Now, people may think that I'm showing these slides because this is a CryoLife presentation. Our data from the Mayo Clinic utilizing matching, propensity matches, also shows that there is a survival advantage with mechanical valves over biologic.

But this particular trial, as you can see, showed that there is a probability of death larger in biologic for particularly, the younger people. 45 to 54 years old.

Somebody in the audience was asking, this patient was 50 when he thought that a biologic valve and is coming at 58. This patient clearly was not done a favor by their physicians in recommending, or being happy with, a bioprosthesis when he was 50 years old.

Now he faces a redo sternotomy, with the risks that that brings. You can see clearly that the risk of death is increased in biologic, particularly in the younger patients, less than 50-year-old patients, you can go to the next one.

And it is important to note that a lot of these less than 50, 55-year-old patients are bicuspid patients. Because they have early degeneration of the valve, number one. And because number two, aortic regurgitation presents at a relative early age in patients with bicuspid valve in their 40s. You can go to the next one.

EDWARD CHEN: I think that's the last slide.

HECTOR MICHELENA: That's the last one.

EDWARD CHEN: Well that's very interesting data. I think it's very important as we consider all the options, because I think as we think about young patients in their 40s and 50s, you're not just thinking one intervention. You must think about the second even the third potential intervention as you weigh out these options. So that's very important

I'd like to ask the panelists if there is any other closing comments that you may have related to this case or the previous case. Jim?

JAMES STEWART: I think we've highlighted the importance of age. I think those slides were appropriate to end on. In particularly younger patients, with surgical options, that's the proven therapy.

There's more data available. Tom highlighted very well earlier that in low risk-- all the low risk trials, all the TAVR trials, bicuspids have always been excluded. We've finally got one or two that have some really small, continued access availability to bicuspid valves, but those weren't even randomized, actually.

As physicians, when we recommend therapies, we need to understand what data is available and then really take all the factors into account. Sometimes, what the patient comes for, if they're asking for a TAVR, that's not always the right choice.

And how to carefully guide them towards a decision for what truly is a better therapy, is kind of an art form, the different techniques you use.

EDWARD CHEN: Katherine, do you have any comment at all?

KATHERINE HARRINGTON: Yeah, I think not all bicuspids are created equal. I think there are some Sievers ones that are practically like a tri-leaflet. And there are some, like Dr. Stewart's case, where we have a lot of calcium and a lot of LVOT calcium, and that can be quite difficult.

I think Dr. Michelena's slides about the calcium pattern and the burden of calcium are really important in these decisions.

And I'd like to also say, I think the heart team concept is key. When we see all of these patients-- we see all our AVR patients in the same clinic, and when I tell them the surgical options, to have the cardiologist sitting there agreeing with me that yes, this is the best for you, with bicuspid valve at your age is, I think it's very helpful for the patient to hear it from both sides.

EDWARD CHEN: Yeah, I think you're absolutely right. The heart team concept, I think, as we go forward treating these complex diseases, it should be disease focused. It's not surgery versus cardiology.

It's how can we tackle disease in a multidisciplinary fashion. I think those are the programs that are really showing that they have great success and outcome. Tom, I'd love to hear your thoughts.

TOM NGUYEN: I was going to echo what Dr. Harrington said. I think bicuspid isn't treated equally. We know that there are different types of bicuspid. I think the paper that Dr. Michelena highlighted, I think it's worth reviewing again.

When we see a patient that's bicuspid , we just can't say, oh just bicuspid. We really need to dive deep and figure out how much calcification is there and try to stratify accordingly. Because there could be a difference in outcomes depending on the distribution of the calcification on a bicuspid, and the type of bicuspid disease there is.

And the last point, I always try to hammer down, is kind of what we know or we don't know. We don't have a lot of long term data, even in these lower risk and intermediate risk patients.

I don't think it's wrong to do these newer technologies by any means, but I think we just need to be very transparent with our patients and let them know what we do and don't know, and then ultimately, have a shared decision making process and do what's best for the patient.

EDWARD CHEN: Hector, you started us off with a little summary. Maybe you could just have the final word on your thoughts tonight?

HECTOR MICHELENA: Well, I will-- if I can share my screen. Am I sharing it?

EDWARD CHEN: Yeah, we can see.

HECTOR MICHELENA: All right, I will just tell you this because I think Dr. Harrington's comment was very important.

These valves are extremely different from a phenotypic standpoint. And if you look at the fused bicuspid aortic valve, the one with the three sinuses, you can see that as Dr. Harrington said, some of them are almost equally in terms of bicuspidity, and some are very close to a tricuspid aortic valve as well.

We need to understand these phenotypes and we need a lot of study, in my view, to come to a state of the art use of TAVR in bicuspid aortic valve. Which would lead us to do a randomized trial comparing TAVR versus SAVR in bicuspid aortic valve. I'm going to unshare.

EDWARD CHEN: I think it's important-- the anatomy, the morphology of these valves is on a continuous spectrum. I think when we discuss intervention, particularly transcatheter intervention, it's important to be very specific in terms of what morphology specific anatomic features we're discussing.

Well listen, I want to thank all the panelists. It's clear, as hopefully the audience has been able to glean, that these are recognized experts in the treatment of bicuspid valve and structural heart disease.

I want to thank Jim and Katherine for providing great cases for a robust discussion. Hector, for the background. And Tom, you always give insightful comments. I always learn something from you every time.

I also want to thank CryoLife, the CryoLife staff, and the whole team at CryoLife for their commitment to excellence in patient care as well as their commitment to education, as evidenced by sponsoring this very nice webinar.

So with that, I'll wish everyone a pleasant evening and we look forward to seeing you guys in person one day, either at CryoLife or some meeting. Hopefully we can make a virtual platform in the future a supplementary, not the main way that we interact and exchange educational ideas. Thank you very much again, everyone.

HECTOR MICHELENA: Thank you, everybody.