(PLEASE NOTE: Transcribed automatically by Vimeo; mistakes are possible/likely. Our apologies.)

TRANSCRIPT - GR 11 01 24 ***"Wire Wars: Battling Infections in Cardiac Implants"*** guest speaker Chris Arnold, MD, University of Virginia

---

Internal Medicine Grand Rounds

- Big screens. Hello, everyone. Thank you. I am Meg Keeley. I am the senior associate Dean for education in the School of Medicine. I'm also in the department of Pediatrics, and I am one of the 2 University trustees for the Bowman Fund, and I'm joined today by Dr. Jean Mcgarin in the Department of Surgery, who is the other University trustee, and this is our annual visit to Department of Medicine Grand rounds, which we very much appreciate, joining you, because it's always for a good reason, which is to honor our 5 Bowman scholars. I 1st wanted to tell you a little bit about why we are here today, and why this is the 47th Bowman annual lecture. So a little bit about Dick Bowman himself. He was a graduate of the School of Medicine. He was originally from Stanton over the mountain, attended Hampden Sydney, and made in American history, and then taught high school for a couple of years, did some graduate work and decided to be a doctor. So he entered medical school here in 1970, and he was found, particularly during the, as his friends would say, he did not distinguish himself at least favorably in the pre clinical portion of the curriculum. However, in the clinical portion of the curriculum he was described as his good nature, maturity, zeal, and common sense set him apart in dealing with patients and their complex problems. He brought together the theory and the practice of medicine in a way which was exceptional for a young physician at any level of training, and as a result his clerkship performance was uniformly outstanding during Medical school Dick met his then soon to be wife Elizabeth. She was attending Sweetbriar College in Amherst, Virginia, and they married in 1974 in South Carolina. He then began his Residency in internal medicine at the New York Hospital, Cornell Medical Center in New York City, and his performance there as a clinician and teacher won him literally the exact same universal respect of his fellow physicians and his students, and significantly, the loyalty of his many patients for whom he provided care. As one of his colleagues at Cornell noted Dick was one of the nicest persons I have ever met a joy to have around. Seldom have I met anyone who got such pleasure from life who enjoyed his work so much, who balanced the conceptual and the practical so nicely.
- He seemed to embody all the best human qualities that make a good physician and a happy man.
- Dick and Elizabeth had planned to return to Charlottesville in 1977, as he was going to start a fellowship here in infectious diseases, but tragically, he died in a sailing accident that May his family, his friends, his colleagues, his teachers, turned almost immediately this significant tragedy into what has become the highest honor awarded to medical students at the University of Virginia.
- We have a nomination committee, which is the clerkship directors who look across the year. It's not a whole year now, as most of you know, they just finished last week, but looks across all of our now phase 2, and chooses the students who they

feel most embody these ideals, and the ideals are integrity and uncompromising strength of character in his or her personal and professional life. Enthusiasm for the acquisition and perfection of those skills which permit the physician to provide the best possible care for his or her patient, and a genuine compassion for the ill which complements a scientific approach to their unique problems, regarding them 1st and foremost as persons in need of help and finally, like Dr. Bowman, Dr. Bowman, the Bowman scholars, should be truly open, accessible, and approachable people with a diverse range of private interests and experiences.

- So we typically find that about half of the medical school class are nominated so that speaks to the quality of our medical students, I think, and then we somehow narrow this down to a smaller number, and then we do a voting process, and unbelievably we narrow it down to 5 Bowman scholars. We honored the 5 Bowman scholars earlier last month. Now, last month, because today's November October 5, th we have a big dinner this year at Greencroft.
- In attendance were the scholars themselves, family friends, deans, their faculty coaches, the clerkship directors, former Bowman scholars, many of whom are on the faculty here, and some that come from far away, and even some of the original founders from 47 years ago. So a big celebration, and then the next day we interview them, and unbelievably, somehow choose one which is the as set up earlier one to receive a scholarship. And then we have today the 47th Bowman lecture. It is always on an infectious disease topic in honor of Dr. Bowman, and we are very pleased to have Dr. Chris Arnold giving that talk today as he was the 2,007
- Bowman scholar, so I would now, before introducing Dr. Arnold, I'd like to acknowledge our Bowman scholars, and I think that at least 3 of them are here. I don't know if I see Teresa so first, st I'd like to tell you about Teresa Blickenstaff. She's originally from Fairfield, Pennsylvania. She went to Gettysburg College, received a bachelor of Science in biology. Oh, thank you. The next slide and she worked for a year in an ophthalmology office during a Gap year, and is now and then joined us here at the School of Medicine, and is, as we speak, applying for residency in diagnostic radiology. So a round of applause for Teresa also joining us today. Liam Giffen, who is originally from Tucson, Arizona, Liam attended Ucla, where he received A. Bs. In physiological sciences. He worked as an Ed scribe at Ucla, Santa Monica for a year, and he is applying for residency as we speak in internal medicine congratulations. Liam tiat tran, who's from Manassas. Virginia attended the University of Virginia, where she received a BA. In human biology, and is now applying for residency in ophthalmology, and keep your eyes open because her artwork in the next couple of months is appearing on the cover of academic medicine. So congratulations to Tia and not at the last moment not able to join us, is Brianna Wilson. She's originally from Statesville, North Carolina. She attended Duke, where she got a BA. In philosophy, neuroscience, and chemistry. She then went to Nc. State, got a Master's degree in physiology, and she's in our Msdp. Md. Phd. Program. So already has received her Phd. In biochemistry and molecular genetics for her work with trna fragments. She is currently applying for residency in pathology. So a round of applause for Brianna and the recipient of the Bowman scholarship. This year is Christina Halstead, originally from Arlington, Virginia, and attended the University of Miami, where she received A. Bs. In biology. She worked for a year in the Coronary care unit at Inova, Fairfax in Northern Virginia, and then joined us here, and she is applying for residency. As we speak in pediatrics. I'd like to invite Christina to come up and receive her scholarship.

- And of course the photo bomb. Is that what you said?
- So far perfect so again, thank you all for your time, and for honoring both our Bowman scholars and the memory of Dr. Bowman. And again, we'll now have an introduction of Dr. Chris Arnold, the 2,007 Bowman award recipient. Thank you, Dr. Arnold. Okay so good afternoon. Everyone. It is my distinct pleasure to introduce Dr. Chris Arnold today. So a little bit about him. He was born and raised in West Africa, which influenced much of his interest in infectious disease and international health. He completed his undergraduate education at the University of Georgia, then moved to Charlottesville to attend Medical school here at Uva, and stayed on to complete his Internal Medicine Residency, and was also a chief resident in 2012.
- Afterwards he moved to Durham, North Carolina for an infectious disease fellowship at Duke University Medical Center, and he came back to Uva to join his clinical faculty in 2015, where he maintains a clinical focus in general infectious disease. HIV and hepatitis. C.
- His research focuses on endocarditis and bloodstream infections and I will say generally, grand rounds. Introductions are a little formal, but I wanted to take a moment to offer a brief anecdote about that, I think, portrays Dr. Arnold quite well so when I was a fresh intern. I attended Resident Noon Conference for Workup, Wednesday. It's a workup of a mystery case where a Guest faculty member helps guide the discussion.
- I distinctly remember Dr. Arnold coming in, sitting down, leaning back in his chair, kicking his shoes off to expose socks that had multiple holes in them and all I could think about at that time was, Who is this man, and why is he here?
- And to this day I sometimes still ask that question, but
- I will say this is probably the 1st time we are seeing him in a suit. So please join me in welcoming Dr. Arnold because thank you for that excellent anecdote very honored to be here very honored to be asked as Dr. Keeley intonated, I was fortunate enough to receive the scholarship when I was a medical student. I remember getting that phone call when I was subbed out during a soccer game on a Sunday after having interviewed on Saturday and it was a wonderful experience for me, and very honored to be here every once in a while. If I'm having a bad day, I walk by the library and look at that plaque where my name is getting further and further and further back. And glance at it to remember that somebody. Somebody thought I was good at something at some point in time, which is great.
- So I I do have a disclosure to make. I'm id, so it's no, not financial. so the title of this talk is actually brought to you by artificial intelligence. In the form of these 2. I along with some help from some real intelligence. In the form of this so I walked into the chief's office the other day, said, my talk is done. I don't have a title yet. And they clamored on board to name the talk, and I agreed that I would take whatever they chose. And so this is what they came up with. With the help of Chat gpt, so wire wars, battling infections and cardiac implants. As was said, I'm primarily a clinician. That's what I spend the bulk of my time doing. I wanted this talk to be a clinically focused talk very focused towards the house staff in the same way that Dick was very passionate about education. So
- 1st things why we should care what the epidemiology and risk factors are clinical presentation diagnosis, including some new additions to the guidelines, management and prevention. So 1st question, why is this important? Why should we even care about cardiac device infections, morbidity and mortality. Care is a

pretty significant mortality. Large intimation, sample over 15 years about a 9.2% inpatient mortality.

- That's in hospital up to 18 to 20% at a year. In some other studies. It costs a lot both to the patient and the system. So same inpatient sample mean hospital charges, about $56,000 for hospitalization length of stay 17 days, you know. That's going to continue to to rise. So every time somebody gets admitted. With this mean time you can drop a house staff members salary in the bucket right? And more than half of your rotation on service. So how common is it?
- So? The epidemiology, the true incidence, is really difficult to determine. And that's several reasons. There's not a complete registry. It's not a mandatory reporting type of illness. The rates range in different observational studies, depending on what you look at but what does appear to be true is that the rates appear to be on the rise, despite there being a decline in hospitalizations related to cardiac devices. So if you look over time over a 10 year span, you can see the hospitalizations due to device, related, complications dropping, and yet the rate of those being due to infection rising.
- Who gets it? So risk factors for the disease can kind of be divided into 3 categories, you know, based on the patient, the procedure, the device, you know. you'll quickly realize over half of our Gen. Med. Patients on the top of the list, right? So diabetes, chronic renal insufficiency end, stage renal disease all of the things that we see every day all the time on genmed. One thing I'd like to draw particular attention to when it comes to procedures. Probably one of the biggest risk factors is the need for reintervention or repeat device manipulation. So this is probably one of the largest risk factors here. So you know, patient had a generator change in the not too distant past. Patient has had complications. They've had to go back into their pocket on numerous occasions. These are the types of things that really increase your risk.
- What causes it? So what's the micro? Not surprising? Gram positives predominate by a large stretch? Right. So if you look here on the inner side, here, Gram positives eat this huge chunk of the pie here, and then coag negative staph number one over here, followed very closely by Staph Aureus, and then you have your kind of mixed bag in here of staph enterococcus, and strep out here more common.
- So Gram positive is not surprising. Coag, negative staph and staph aureus numbers one and 2 and I'd like to draw your attention down here to
- one of our fellows who just graduated, who, you know. So part of the reason I landed on this topic is, I just worked on a repeat update to review on this topic for the Id. Clinics in North America, and Dr. Bilich, who was one of our fellows that just graduated, worked with me on Updating that review that we had done originally in 2018.
- So who's the worst?
- Who's the Joffrey Baratheon of cardiac device infection? So I figured it'd probably be about maybe 40 60 of who would get this in the audience. I'm looking at all the gray hair and seeing very little recognition, and I'm looking at a lot of the house staff, and seeing significant recognition of game of thrones. Reference here, too, I also employed Chat Gpt. On this I put in chat. Gpt.
- Give me a list of characters that would be synonymous with the worst, and
- I'm a big fan of game of thrones. I said. That fits perfectly so.
- Before we talk about that, let's talk about. I like I wanted to try tie in a couple of clinical scenarios to kind of tie in some of the points here. So a 57 year old Guy.

History of a pacemaker placement for a high degree AV block. I know how Staff are saying he's 57. That's so old. Why would we do anything? But we're going to try to help him, anyway?

- This could be Jerry's much, much younger brother. So 9 months ago, put in presents with fevers, malaise myalgias, found to have staph aureus bacteremia. Urine culture is also a staph aureus, no obvious source on his history, or exam how likely is he to have device infection? And does he need to be worked up or a device infection?
- So staph aureus staph aureus is the Joffrey Baratheon of cardiac device infections right here, kind of the worst. So associated with over a 50% chance of definite cardiac device infection. So right off the bat, you have somebody with a cardiac device. They have staph aureus in their blood. Your pretest probability. You're already up over a coin flip chance that they have cardiac device, associated infection higher rates with earlier bacteremia. So if you look, if it's been within a year of the device place, you're up to 75% chance. So already, 3 quarters chance that your device is going to be involved here.
- If you're a little further out, it drops a little bit, 28% definite. 71% falls into this possible kind of category where they can't say definitively that it is, but there's suspicion, for it has a high probability of recurrence and mortality over time. So not
- great bottom line, very high index of suspicion. When you see somebody with Staph aureus bacteremia, and they have a cardiac device in place.
- What about Gram negatives?
- All right. So this guy's twin brother. He's also 57. He has a pacer for high degree AV block.
- It's bad genes. It was also put in 9 months ago, ironically, so he has fevers, malaise vomiting he's found to have e coli bacteremia. His urine cultures have, so have e coli. He has some mild stranding around his right kidney. He defervesces after 2 days of Iv. Ceftriaxone.
- How likely is he to have a device? Infection? Does he need to be worked up for device infection?
- So gram negatives, so 7 year. Retrospective study out of Mayo, only 6% with gram negative bacteremia had either definite. And when you say 6%, you look at the numbers right, 2 or possible one.
- The 2 that had definite had obvious pocket infection. So they had red pockets pus coming out of their pocket. It was not subtle.
- There might be an exception with a couple gram negatives. So there was one study mascarinic out of Duke. They had looked at Pseudomonas and Serratia Bacteremia patients.
- They had rates actually approaching that of staff warriors. I'd say the caveat here is a lot of them. Were Lvad patients, which is a little bit different animal than just, you know, a pacer.
- So what's the bottom line? Set all this stuff? What do we take from that? So it's a very low index of sufficient for device infection in patients with gram negative bacteremia without evidence of clear pocket infection. So you see, Staph Aureus in the blood. 1st thing you should be thinking about. Be thinking about that. See Gram negatives in the blood. Last thing you should be thinking about more careful attention, maybe, to those with Pseudomonas and Serratia, maybe an extra moment of pause and thought there, especially if they have an Lvad in place.

- So what does it look like? What does the infection look like? How does it present? What's the clinical presentation? So we kind of distinguish you have pocket infection, and then you have deep infection. Aka CID systemic infection aka CID infective endocarditis. You'll see a lot of terms that are kind of used interchangeably and synonymously.
- There so pocket infection is not really earth, shatteringly confusing, right so confined to the pocket containing the generator and subcutaneous portions of the lead, it stops before you get to the transvenous portions of the lead right? And it's not usually that difficult to diagnose deep infection. Now you've gotten into the transvenous portion and the endocardium, or the epicardial portion and the epicardium.
- So what does a pocket infection look like? Well, when it's early? It's less than a year usually not super subtle. Right pain. Erythema, swelling warmth, dehiscence, with or without drainage.
- How about when it comes in later than that? What does it look like when it's older, greater than a year, more likely to present with just device erosion. So you have the device eroding through the pocket. They may not have a lot of pain swelling erythema, but device. Erosion is presumed to be infection, and is treated as such.
- They rarely present with systemic symptoms or positive blood cultures.
- Then the presence of those things should make you think about looking deeper when you see systemic symptoms or positive blood cultures in the setting of a pocket infection, because they don't have to occur mutually, exclusively. You can have deeper infection that started as a pocket pocket infection.
- So what's the differential for pocket infection? So there's several things that can look very similar. So early. Superficial side infection happens early on, as the name implies, right within 30 days of implantation or manipulation. It's a superficial skin infection that doesn't get down into the pocket. It can be really difficult to distinguish from a pocket infection unless there's like a frank stitch abscess. So it gets very dicey trying to trying to parse those 2 out as does early post inflammation, implantation. So this is you get some pain, but you don't have Exuda. You don't have dehiscence, you don't fluctuates, it's not infectious, and it's self-limiting. Again, we'll get into kind of diagnostics. And how do you parse these out but it can be, it can be difficult. And then pocket hematoma is usually less confusing. So usually early, early, and swelling and discoloration of the skin, usually along with that. So oftentimes in the 1st 24 h.
- What about deep infection? Well, you're more likely to have systemic symptoms, about 80% or more present with fevers often presents similar to subacute bacterial endocarditis.
- Which means the diagnosis often gets delayed. People have nonspecific symptoms. I don't feel well, i've been having some intermittent night sweats and feel bads and fevers, and sometimes people get, you know messed around with as an outpatient trying to kind of figure things out. I had a lady one time who had come in, and she had congenital heart disease and A. And a pacer, and her Pcp. Had thought she had lyme disease, and gave her doxycycline and she felt better on Doxycycline for a couple weeks, so it must have been lyme right, and then stopped the doxy, and she felt worse, so her lyme must be back, and lo and behold! She had quite negative staph growing in her blood that was associated with her cardiac device. But it was several months in before somebody got blood cultures and kind of figured out that this was not lyme disease.

- You can sometimes see recurrent pulmonary infections, pneumonia, lung abscess embolism that has been described as as a more unusual presentation.
- So how do I diagnose it? How do I manage it?
- So we're back with another one of their brothers. There must be triplets. So there's another 57 year old guy with high agree high degree AV block. You don't want any part of this family's genes 3 weeks ago had some tenderness of the pocket exam. Shows mild erythema. He has no fluctuations to hiss, and strainage or systemic symptoms.
- What are the possible diagnostic and management options? And we're going to go through. We're going to hit several scenarios right here, and then we're going to go through stuff and we'll come back and revisit these folks you got another one of them.
- He was also 3 weeks ago.
- He's got pain, Erythema, and fluctuates over his pocket. He's got some dehiscence and some minimal, purulent drainage. His swab shows Mssa what diagnostics does he need at this point like, what? What more do we need to do for this guy?
- What are the next best steps in his management?
- You got another one of them 7 years ago.
- Fevers, malaise, high grade, Mssa bacteremia. He has a tte, followed by a tee, and shows a veg on his mitral valve.
- What do you do with him?
- What about this guy? 7 years ago? Staph in the blood? No vegetations on his tee?
- You do an extensive search, and you can't find where his bacteremia is coming from, and his blood cultures are still positive. 4 days into Nafillin.
- What do you do with this guy?
- What about this guy 7 years ago. Fevers, malaise nausea e coli bacteremia urinalysis is unremarkable. He has no other localizing signs. He's still febrile. 96 h into Ceftriaxone and his blood cultures are not clearing. He has a tte done, and then the tee done with one of our, you know, favorite reads possible mild thickening of one of the pacer leads. You know. What do we do with that guy?
- So let's talk about some stuff and come back and see if we can figure out what to do with some of these folks.
- So pocket infection largely a clinical diagnosis, often very straightforward, right? They should get blood cultures because what we talked about. You know it's not mutually exclusive. They could have deeper infection with a pocket infection.
- The recommendations are not to go sticking needles in pockets. The yield is pretty low, and it has a lot of associated risks with that. So usually, what we want is cultures from the extraction which we'll get to in the management, because inevitably that's where we're headed so tissue better than a swab and then a big caveat to interpret lead tip cultures very cautiously in patients who have no systemic symptoms and negative blood cultures. As you can imagine, you're extracting this thing out and sometimes dragging it back through the pocket and so getting, you know, a 1 colony of coag negative staph on the lead tip culture, and somebody who had no systemic symptoms and negative blood cultures and negative echocardiography equating that to like oh, he must have had deep infection. You've got to interpret that with caution. So in more subtle cases, especially within 30 days. You may need to consider some other things to help you sort it out. So what might those be? Sometimes it's a short antibiotic challenge, with close follow up, depending on the scenario and then we'll talk about pet-ct, which

has been recently added to the guidelines both for endocarditis as well as for cardiac device infection. We'll kind of wade through that a little bit and see what we think about that.

- So here's for what the guidelines show as an algorithm for a suspected pocket infection. I kind of divided this up for you between obvious and subtle right? So you kind of go down this side over here you've got erosion or purulence fluctuates a sinus tract. Right? This is pretty obvious, right? So you're going to get some blood cultures if they're negative devices coming out. Still if they're positive you're talking about echoes to look for deeper stuff, and lo and behold the device is coming out, no matter what right. So on the subtle side, right? So you maybe have some erythema or induration tenderness. But you don't have any of this purulence or sinus tract or erosion still going to get some blood cultures. And then you get down into this thing where they talk about time from implantation. Right? If you're very early you might consider a short antibiotic challenge and see how they respond, and if they don't respond, then we'll get into this about like would pet have some utility here, and if they're greater than 3 months, maybe Pet might have some utility in those folks. If there's a high enough suspicion.
- So that brings us back to one of our friends right, who came in with some tenderness at the pocket site. Mild erythema, no fluctuance, drainage, or systemic symptoms, so he would probably fall on this kind of subtle side right here, right? And he was 3 weeks ago, so he's probably going to fall down here in this early side, so he might be somebody that you might consider a short trial of antibiotics, and watching him real close and making him prove it, that he's got a pocket infection versus his friend here.
- Who did have pretty obvious stuff right? Drainage fluctuance swabbed Mssa out of his drainage. He's going to be over here right? He's going to get some blood cultures same thing. But he's going for device extraction, and he's getting an echo if his blood cultures are positive. Right?
- So what about deep infection?
- So you want blood cultures right to help you out you need to take into consideration receipt of antibiotics prior to blood cultures being obtained right? So if you have somebody who has a lot of systemic symptoms and they got antibiotics, especially for a significant time before they got their blood cultures. You're going to have to take that into account when you're trying to make decisions about Echo? No echo. And how much do I believe that they don't have a deep infection. Imaging? Echo, pet Ct. We'll talk about it so which ones are worth a thousand words. Right pictures! What pictures do we care about? What's the deal with imaging? So echoes multiple studies showing the higher sensitivity of te over tte. So you're going to see us in? These folks say we have a high suspicion for device infection. Right? Negative. Tt, we're not going to stop there. We're going to ask for a tee for a better look.
- It's tee itself is not a hundred percent sensitive. So if you have a high index of suspicion sometimes that still doesn't stop you so you consider treating as you can consider treating it as, or you can consider the use of Pet. Ct. If you still have a very high index of suspicion.
- So you know, where might you think about this? Well, in staph aureus and coag negative staph, they have persistent, positive blood cultures. It's pretty pretty suggestive. You might just go ahead and treat this presumptively as a device infection, even with a negative tee something else where it's another organism, with

no alternative source. That's where we get into the guidelines starting to fit in well with Pet. Ct. Add some value here in helping to parse this out.

- So you know, we look at this here, and you see where where they've kind of fit in. We'll talk about Pet Ct. Here in a second, where they've kind of fitted in down here. So if you follow this down, you had positive blood cultures. It's not cognitive staph or staph aureus. It's something that's likelihood is maybe a little lower. They have an echo.
- The echo is negative, but you're not finding an alternative source, and maybe they're still bacteremic, or there's something that makes you suspicious. I haven't really figured this out, that where it might be, where pet Ct. Might have some additive value here at this point, I can tell you. This is newly added. We have not done this much. I can't think of a time that I've actually asked for a pet Ct so far, but it is stuff that is worth knowing about, because it's out there, it's making its way into the guidelines, and it's worth knowing a little bit about the data behind it.
- So what is the data behind it? So meta-analysis, 11 studies on pet, Ct pooled sensitivity and specificity around 87 and 94% much better for pocket than for deep infection. If you look at that meta-analysis, another meta-analysis, bigger 1, 26 studies, 1,300 patients. More recent bold sensitivity and specificity, not super fantastic. Right? 74 88. But if you boil down and you look for native valve it was actually fairly crummy. Right sensitivity only point 3 1 for native valve, but prosthetic valve and device bumped up significantly, especially in the prosthetic valve folks so potentially some utility there.
- And they looked at it in congenital heart disease patients, right? They usually have a lot of prosthetic material in place. It's a very high risk group and when they added it to the Duke criteria, it improved all diagnostic metrics for endocarditis. So if you look at the new Duke criteria additions, you'll kind of find them here.
- So now, under major criteria, under imaging where we had our good friend Echo here, which we all knew about, they've added Pet here for those with, especially with prosthetic valve and and graft material, and then you'll also find it down in the minor criteria. What makes it minor over, Major? It's this timeframe here. So if the device as if the thing has been put in, the prosthetic stuff, has been put in within 3 months, it kind of lowers its predictive value right? Because there can be post implantation, inflammation, and stuff that makes it a little more difficult to interpret. So it kind of drops the utility down to a minor criteria. But it's been added, it's it's now part of the Duke criteria. So, and as you can see, we've talked about, it's been added to the guidelines for cardiac device infection, which we kind of already went through these pathways, and you'll see it right here in the pocket infection pathway. And right here in the deep infection pathway.
- So what's the bottom line for the pet Ct. And cardiac device infection? What do we do with this information it may have some utility in select circumstances for distinguishing a pocket infection from other early inflammatory process. If you're really having a hard time teasing it out. It may be helpful in diagnosing a much more subtle pocket infection in the workup of non-staphylococcal bacteremia with a high suspicion despite negative negative echocardiography that might be a spot where we might think about using it.
- It's likely less useful in staph bacteremia cases. Given that the high, the index of suspicion is already so high for endocarditis and device involvement. So that brings us back to one of our friends here. Right? So this is somebody where you might actually consider pet, right? This was our guy. He had Gram negative, so is pretest

was low. But you haven't found a source. He's got ongoing bacteremia, despite appropriate antibiotic therapy that's now over 96 h into therapy. He's not doing well. You haven't found anything anywhere else. He had this kind of subtle reading on his tee. This might be somebody where you might think about pet Ct. In helping parse that out so I've got it. Now, what do I do with it.

- So, to quote one of my longtime mentors, and everybody will recognize his face. Right? It's not purely a roots and herbs problem. It's 1 of my favorite quotes, and I use it probably every day rounding with Marie. Now, after hearing it from Brian as much as we do. And it's slowly getting through to some of the surgeons. Maybe. So management device removal is recommended for all definite pocket or systemic device infection. Right? That's it's not really debatable like. If you have it, you should pull it.
- Percutaneous is favored over surgical, and this is a debate more for folks that are not amongst us right here. Right? So there's a debate on vegetation size, and should you do it surgically or percutaneously? This is a discussion amongst the cardiologists and the surgeons, and all of that, you really should do them at a center that has thoracic surgery, backup, cardiac surgery, backup, because we have had people who have perfed ventricles and other things with removing devices. When they're when they're complex you should strongly consider device removal in staph aureus or coag negative staph high grade bacteremia without another identified source, even with negative echocardiography and multiple studies have shown higher failure and relapse rates when retention is attempted. So one retrospective study showed a sevenfold increased 30 day mortality with antibiotics alone. So that discussion about do we really need to pull it ideally? If it can come out, it should come out as far as patient outcomes go.
- Bottom line is grip it and rip it right? So it needs to come out and it needs to come out early ideally. So they've looked at. This early removal is better and associated with lower mortality. So you can see up here, you know, extraction versus no extraction. Mortality rates are not subtle, and then the early extraction versus delayed extraction, and they define this as within 10 days of it being indicated to come out. So if you waited more than 10 days, your mortality went up across multiple studies so ideally. Once you've decided on, this is a device infection, we should pull it. We really shouldn't be sitting around waiting for long periods of time to remove the device.
- So when can we put it back? Right? That's the next question everybody's gonna ask. So when can we put it back? So we can discharge the patient right?
- So timing of reimplantation really depends on what you see? Do they have vegetations? And if so, where are those vegetations? So if you kind of look at this and you kind of come down here, you got a veg on the valve supposed to stay out for 2 weeks of negative blood cultures. Right? You got a veg on the lead, only you're talking about 72 h, and the concept there is right. It takes a lot longer to sterilize the vegetation than it does the bloodstream. Right? So if the veg was on the lead. You've pulled the device out. You've presumably pulled the bulk of the infection that nidus out. And so it's really about is the bloodstream clear. If the veg is on the valve, you've pulled the device out that veg is still on the valve. So you want to make sure that thing is closer to sterilized by the time you put a new device back in, because the last thing you want to do is put a device back in, have it get reseeded and have to start all over again.
- In a few months when they come back.

- This is why you will see us advocate, and this has come up on patient. We're consulting on this week where cardiology has come by and said, You know, we're going to pull the device. We agree. It needs to come out, even though the echo we don't have a good echo. And so I guess you know, there was a discussion. I guess we don't need a tee, since we've already decided to pull it and say no. The te is still pertinent for us, because it tells us, when can it go back in we need to know of where the vegetation is? If there's a vegetation, so we can decide when is the appropriate timing for replacement of the device.
- What if we can't remove it?
- Right? So you can attempt antibiotics followed by chronic suppression. It's really recommended. Only if extraction can't be done, and you know, can it be done? And one study showed a Median survival about a year and a half 1.4 3 year survival with an up to 18% relapse rate in those who retain their devices and attempted po suppression. So it doesn't work perfectly. We have this discussion in infectious disease clinic all the time with folks about antibiotic suppression. How well does it work? And the real answer is, who knows how well it works? Because it's very difficult to study. We've all had patients where we put them on po suppression, and they stopped taking it. For whatever reason I forgot, I don't like it. I ran out, and I didn't realize I was supposed to refill it who don't come back with problems. And we've had plenty of people who take their po suppression, who do come back with recurrent infection, and you have everything in between.
- The reality is we'd have very. We have nothing else really to offer folks who have retained hardware in an attempt to try to minimize recurrence. And so this is what we end up with in a lot of circumstances.
- So let's go back to a couple of our earlier folks with what we've just talked about. So this guy with his high grade staph bacteremia te is done, and shows a veg on his mitral valve. What's the appropriate management? Well, you all know. Right, it's got to come out, and how long does it have to come out for? Well, he's got a veg on his valve. It's going to have to wait another couple weeks before this thing goes back in.
- What about this guy who had high grade bacteria? And his echo is negative, but his blood cultures are staying positive. He's 4 days into nafsil, and he's still not clearing his bloodstream, and he's got ongoing fevers and a device. Well, you should really strongly consider taking this guy's device out empirically. The pretest probability is very high, and then wait for at least 72 h of negative blood cultures. Given his lack of vegetation on his imaging.
- Well, it's not only a roots and herbs problem. We can't forget the roots and herbs so antibiotics. And for how long?
- And you start pulling at this, and you'll find
- the well kept secret by Sid. Physicians is most of our durations, for a lot of things are not based on fantastic evidence, right? We don't have a lot of great randomized, controlled trials on a lot of entities that we treat for how long to treat.
- That leads to a large variation in practice even amongst id specialists. When this was studied and looked at and id specialists were polled in cardiac device infection, they got many different answers so how long, then we don't care that you guys don't agree. Just tell us how long it is. Right? So most resources, including the most recent guidelines, will show something along the lines of a pocket. Infection, 10 to 14, a pocket erosion without 7 to 10, and then I have a so if you ever want to lose hours of your life.

- Start pull going, pulling at this thread and try to see where it leads. It leads down a rabbit hole to nowhere. I can find no evidence to support, and I don't know anybody. I myself have never done it. I could be wrong, obviously based on those polls of people doing all kinds of stuff. There probably are folks out there. I have never once in my life treated somebody with a veg on their lead for 2 weeks.
- But I did try to delve into this to figure out, you know, untangle this mess about where this is coming from, and it's coming from not really much other than expert discussion and and other things.
- So when you look at this, you know, you'll see like I said, you'll see different. So so this is pulled here from an article, and it kind of outlines exactly what we just talked about.
- The the wording gets very complicated because they talk about te negative non-staph aureus
- 2 weeks, and then they talk about a valve.
- They talk about lead vegetation uncomplicated. Well, when you try to figure out, what are they talking about? Well, they're saying complicated septic, emboli, osteo, etc. But they'll also list endocarditis under complicated right so. And in my mind you got a veg on the lead.
- You essentially have endocarditis, because you have lead. That goes into endocardium endocarditis. So which is what you see. If you look at how the guidelines word it here endocarditis ie. 4 to 6 weeks. So what does that boil down to? That boils down to? This is kind of how I view it. This is one of the reviews that what we that we wrote you follow this down, you get a te that has a valve or a lead veg, you follow the antibiotic therapy guidelines for endocarditis for that organism?
- How about we just stop it before it starts? How about we just prevent cardiac device infection. And then we don't have to remember any of this stuff anymore be nice. They've looked at a few things, so can we prevent pocket hematomas?
- What about prophylactic antibiotics? As we all know, Amy's in the back back there. More antibiotics is better all the time. Right? Every antibiotic why don't we just give them all and antibiotic, impregnated envelopes, and then some newer device technologies. So this is what's been looked at so very briefly. Pocket hematoma prevention, 2 big trials, bruise control, one bruise control, 2. All the like. Non-true id studies have all the cool names, and you know we don't really have much cool stuff. So this looked at continuing warfarin versus bridging with heparin and it showed an 80% reduction in pocket hematoma in those who just continued the warfarin, rather than trying to bridge them with heparin.
- This was continuing your doac versus interrupting your doac and it was stopped for futility. There was no difference, 2.1% versus 2.1%. After the 1st 662 patients which had to have been pretty infuriating.
- The conclusion from this is that the Aha would recommend. So for all of you out there who have patients, and they're talking about this stuff. And what do I do with their anticoagulation. It suggests, continued or, interrupted Doac, are both acceptable strategies, and it's reasonable to do the implantation while they're on their chronic warfarin with an inr of 2 to 3 and a half.
- What about prophylactic antibiotics? So multiple studies have shown benefit to the 1st generation. Cephalosporin. Within an hour or bank before within 2 h. If an allergy is present, what has not been shown to be helpful is getting fancy. So the padded trial tried to get very fancy with Cefazolin and Bank pre, and then this bacitracin pocket wash intra, and then oral keflex for 48 h afterwards. And I mean

we're doing a lot more stuff. So it's probably better right? Because I mean, look at all the things that they got. And no, it wasn't better. So almost 20,000 patients, and no statistical difference in infection at a year. And so the bottom line of that is, we aren't fancy you do what has been proven. And that's, you know a 1st generation cephalosporin, within an hour bank with before within 2 h before procedure.

- What about antibiotic, impregnated envelopes? So the rapid trial 7,000 patients at increased risk. They randomized them to an impregnated envelope versus a standard envelope and worked pretty well, has a ratio of point 6 at 12 months, and then they extended that follow up out to 21 months, and there was still maintained benefit to doing this. The question is how do you define high risk? And there's still an ongoing quest to find the best scoring system to identify who will benefit maximally from using these antibiotic, impregnated envelopes, who is considered high enough risk for that.
- And then, lastly, newer technologies. So leadless pacers, they're implanted directly into the Myocardium. It obviates the need for an extended lead and a generator pocket.
- There were no cases of infection in phase. One phase, 2 or one year follow up correspondences, and then, as with most things in Id. The bugs find a way, and there are case reports of infections that have emerged post this data. So they are out there. They're not perfect but they seem to have much lower rates than you know. Standard pacers. There's also no indications and contradications published yet in the guidelines, for who gets a leadless pacer.
- What about a subcutaneous Icd, so I I needed a picture to wrap my head around what they're talking about here. But so they place under the skin in the lateral aspect of the chest wall, this electrode, and then it wraps around here and then epicardial implantation there. So you can still get erosions due to local infection that's been described.
- It's a class, one recommendation in the Aha guidelines for patients with complex anatomy or venous access, who don't require pacer or desync functionality.
- So what summarizing all this, you know? What? What do I think are the take home points? So it's an important disease that has significant morbidity and mortality reinvention and device. Manipulation are the strongest risk. Factors for infection. Your physical exam, blood cultures and tee are all important diagnostics. There may be a role for pet Ct. In some select circumstances. You're not going to see it widely used yet, but there might be some scenarios where it could have some utility device. Extraction is the key to successful therapy, and earlier extractions associated with better outcomes.
- Your time to when you can put it back is based on your echo features primarily as long with microbiologic features. How long clearance of bloodstream!
- And then the optimal duration is not based on randomized studies, but in general is 7 to 14 for a superficial and 4 to 6 for a deeper infection and patients at high risk may benefit from some of these newer technologies to try to reduce their risk for recurrence.
- And you know, to quote Forrest Gump, that's all I have to say about that. So.
- I appreciate you all listening. Thanks.
- No the floor for questions. If you all have.
- Chris, you say something more about pet Ct. It seems like it'd be like really nice thing to have in a patient. Yeah, I I think like, I said the scenarios were useful. I feel like come up infrequently for us on the inpatient side. You know, because grim

negative device infection is so uncommon and so you know, having a bug that's not staph or cognitive staff. We're already much lower, right? And then, having the echo findings be equivocal. We're already much lower. And so it's a very kind of niche group there and then. A lot of the pocket infection stuff that we see in the patient is not subtle, right? They've come in because they have turulence or fluctuates or draining, and so we don't really need it there. So I think

the number end of times that it would be useful inpatient is very small, and I know that, based on my experience here getting pet Ct inpatient for other things, fu workups and other stuff has been quite challenging, and we don't have a great enough and to need it for this that I think we could push for like. Oh, this needs to be protocolized here as as something to to utilize.

- But it definitely is out there, and some of those you run into one of those cases that falls in that niche area. It's something that you know. What do we do from here, where it might be worth pushing for that in that scenario, and you would have some data to fall back on to say this. What has value added here?
- Are you cool?
- For the leadless pacemakers? For the case reports where there was an infection. Were those bacteremia? Were those infections local to the device? I believe at least one of them was bacteremic. I can't remember off the top of my head. What I listed them in here you can go and look, but it's definitely it was, you know it was. I feel like it was kind of inevitable, but a huge bummer. Right? You know all this data phase one phase, 2, nothing. But I think, as with anything. When you have prosthetic material inside you. There's always going to be a way that nothing's going to be, but certainly much much lower rates that you wouldn't certainly don't have to dig into the literature to find case reports of, you know standard pacers being affected in this patient population, especially the patient population they're putting it in, are already high risk. So when you're looking at case reports of a patient group that's already super enriched for developing this infection for it to be case reportable level is pretty good, at least so far.
- Oh why, the greater amount of gram-positive infections versus gram.
- Yeah, I mean skin soft tissue, and a lot of stuff starts at the pocket. And then also, you know, as we know, you know, Staph, just such a high predilection to seed when you do get even transient bacteremia. And that so it's just, you know, and coag negative staph is such a huge monster for prosthetic device infection, and some of it is time of implantation, and you know it can slow smolder. And some of it is folks that have lines, and you know frequent re-accessing of lines. And you're talking about skin, Flora being the stuff that gets there. So those 2 are just huge, huge as far as that goes.
- In thinking about increasing that in for your patients for pet. Ct is there any data out there on for like other? yeah. So I mean off the top of my head. I don't know, you know. We certainly fu. There's there's stuff it's been utilized. We use a lot more like tag white cell scan, and like vascular grabs and that than Pet-ct. But I'm sure that there's data out there on other pockets. It's not robust, you know. You know, definitive. You have to do this kind of data.
- The Prince kind of alluded to this, but I'd like to hear your definitive answer. So you have a lead vegetation devices taken out

- PE is obtained.
- Maybe my job. I'm treating like endocarditis, so they're getting 6 weeks for me, you know. I guess if it's a strep species you can talk about the fall under the 4 week rubric. But for me by definition, you kind of have endocarditis, because you have lead involvement, transvenous lead that's implanted into. You know the the Myocardium for me. It's it's it's endocarditis. So so the follow-up question is not representing a cardiologist. But it does beg the question. Well, it's certainly because it influences your time to reimplantation up to 5 significantly. So if it's on the lead, you know, it's only 72 h it has to stay out. If it's on the vet on the valve, then it's 2 weeks. And so, you know, we're having that same discussion with them on 2 patients that I'm following right now who they had agreed that, you know, Staphylococcal bacteremia, and they have a you know, kind of a crummy tte with, like, we technically difficult study. And we can't really see. And they've agreed empirically. We think this needs to be removed, and our point was well. We still need the tee, either at the time that you do it. Sometimes they can do it at the time they remove it like down in the echo or down in the ep area, just for timing of reimplantation.
- Or the other issue may be surgical.
- Yeah there are those cases where you're leaving the pacemaker clearly infected with Stat. They want to take it out.
- Is there a clear role for rifampin versus no rifampin in the foreign body? It's a discussion that we have all the time. Yeah, I mean, it's still recommended for prosthetic, you know. Prosthetic endocarditis, prosthetic valve endocarditis, and we use it certainly. And I use it whenever I can, in a prosthetic infection with a staphylococcal species.
- So I mean in my mind, I'll take every inch I can get in that patient, because I think their failure rate is really high. And so if there's a chance, I might get some better biofilm activity with the rifampin added. Then I feel like I have barely little to lose in that situation. I mean worst case scenario. They evolve, or famine resistance. Okay? Well, I won't use it in the future. But you know what you're tearing down the barrel of, for that is is all you have to offer is, let's give them 6 weeks. See if we can clear and then see if we can suppress it. So
- I would advocate using it. Now we run into a lot of situations where we can't. A lot of folks are on oral anticoagulants and other stuff that have not. And I don't.
- you know, argue, burn the house down to to get the rifampin on board. If I can't get it on board, I don't use it.
- Alright. Thank you. Guys.