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Unfortunately or fortunately, I have no financial disclosures. So the objectives today are, number one, identify safe and effective methods of contraception for women with heart disease, number two, identify women with elevated risk for pregnancy-related complications, and number three, identify pregnancy-specific risk factors for cardiovascular disease in women.

So why am I talking about this today? Well, this is really a growing population of women and that's for more than one reason. Number one, more and more women are surviving, childhood with congenital heart disease. So now with modern surgical techniques, about 90% of babies born with congenital heart disease will make it to their childbearing years and many of those women then would like to go on and have their own children. So that is one growing group of patients.

And then, second is more and more women are choosing to delay their childbearing because of pursuing careers or other reasons. And so as our population of moms is getting older, they're more and more likely to have already acquired either heart disease or cardiovascular risk factors that can then develop problems during pregnancy. So while the minority of pregnant women have heart conditions, heart disease is actually the leading cause of mortality and major morbidity amongst pregnant women. And so while it's a smaller group of those patients, it's a very serious condition when it does occur.

So there are a lot of changes that occur during pregnancy from a hemodynamic standpoint. Importantly, cardiac output increases by about 50% and you can start to see some of this rise as early as first trimester. And then, once you reach early third trimester, it sort of plateaus. Systemic vascular resistance also drops significantly as the placenta sort of offloads the heart and ultimately, the blood pressure will stay about the same or drop slightly during the first and second trimesters.

There's also a significant increase in blood volume. So total blood volume is increased by about 50%, primarily related to an increase in plasma volume. And then, there's a small increase in red blood cell volume, but that, of course, leads to this dilutional anemia that we're all very familiar with.

So what types of women am I talking about when we're talking about women with heart conditions when they're pregnant? Well, there's kind of three groups you can think of. The first group is women who have preexisting heart disease before they become pregnant. So that's women with congenital disease, cardiomyopathies, coronary disease, amongst others. So it's very important to counsel these women on their risks of pregnancy and on safe and effective methods of contraception and this is actually recommended by the ACC and AHA.

One reason that this is so important is because the risk is extremely heterogeneous. So women with mild or a simple repaired condition, such as a PDA or a small ASE that's been closed, really have no increased risk among the baseline population when they become pregnant. On the other hand, women with some conditions, such as pulmonary hypertension, carry a risk of death as high as 50% with pregnancy. So it's important to sort of figure out what is a woman's risk and should she proceed with pregnancy and if so, what measures need to be taken.

Many women are taking teratogenic medications, ACE inhibitors, statins, ARBs, medications that we would prefer for them not to be taking while pregnant. And so they should be counseled on that and planning needs to be done. Some women will require imaging or interventions before they become pregnant to either insure that they'll be able to get through pregnancy safely or make the pregnancy safer for them. There are a lot of women on anticoagulation for a history of DVT or PE or mechanical heart valves and anticoagulation planning will be important for them. And then lastly, women who have congenital heart disease are at elevated risk of having babies with congenital heart disease and they need to be counseled on that and have screening planned, as well.

So what complications are most common during pregnancy? Arrhythmias, heart failure, and thromboembolism are the three big ones. Most of these complications actually occur shortly after delivery within the first couple weeks, but they're also very common during the third trimester. There are many different ways that we can estimate a woman's risk. Lots of different groups have come up with different risk factors and risk screening protocols. The CARP RAG is probably more modestly accurate than some of the others, but the nice thing about it is that it's fairly easy to use and actually the population used to develop it, it contained congenital disease, acquired disease, and arrhythmia. So it can kind of be applied to any patient that you might be taking care of.

And so basically, they have identified that there were four risk factors for complications. The first is, has the woman had a prior arrhythmia or cardiac event, such as an MI? If so, that's one point. Is their baseline New York Heart Association class more than two or are they cyanotic? That's a point. Do they have severe left-sided heart obstruction-- so coarctation, severe aortic stenosis, significant mitral stenosis. That's a point. And then, do they have a reduced systemic EF? Normally, that's your LV ejection fraction, but if they have transposition or for some reason have a systemic right ventricle, then it would apply to that.

So basically, you just add up the number of those risk factors. And if they have none of those and their estimated risk of complications is about 5%, one puts them at about 27%. And if they have more than one, their risk is about 75%. So as you can see, it's kind of a crude method of estimating risk, but I do think it's pretty commonly used and it's easy to remember and easy to use.

Another much more-- probably the most complicated one to remember is the World Health Organization classification of risk. And I think it's actually probably the most effective at establishing a woman's risk, but it's difficult to remember, because there are a huge-- it's basically a big graph with lots of things to remember. What I like to say, though, is if you can remember the things that are class four, meaning absolute contraindications for pregnancy, everything else then is either yes, it's fine to get pregnant or maybe. It might be OK to become pregnant.

So the most important thing is recognizing the people who absolutely should not and then everyone else, we can sort of sort it out. So people who have absolute contraindications for pregnancy are people who we estimate have a risk of death of more than 10%, which I think most of us would agree is an unnecessary risk to take for a young women. So pulmonary hypertension is really the highest-risk condition, with estimated risk of up to about 50% of death.

Marfan syndrome with a dilated aorta-- this is not for Marfan syndrome with a normal-sized aorta-- bicuspid valve with a dilated aorta, severe left-sided obstruction, such as aortic stenosis, mitral stenosis, coarctation, severe LV dysfunction-- so an ejection fraction less than 30% or New York Heart Association class three or four-- and then if they've had prior peripartum cardiomyopathy with any residual impairment of LV function.

So notice that prior peripartum cardiomyopathy with completely recovered ejection fraction is not an absolute contraindication and we'll talk about that in more detail later. So these are the people you should counsel against pregnancy. And everyone else, as I said, is yes or maybe. So many women were taken care of-- even if they just have hypertension, maybe taking medicines that are potentially teratogenic.

So the four big ones that we really want to avoid during pregnancy are ACE inhibitors and ARBs, statin medications-- although there are some ongoing studies looking at statins and preeclampsia so that may eventually change-- and aldosterone antagonists. Those we should really stop before a woman becomes pregnant or as soon as they become pregnant if they're on it. Most other cardiac medications, we really just need to weigh the benefits and the risks of them.

So beta blockers are actually-- I have many patients on beta blockers during pregnancy. The main risk is that the babies tend to be a little bit smaller. They're not usually truly growth-restricted, but they tend to be on the smaller side. And so counsel my patients on that and if it still is more beneficial for them to be on it, then I would continue the medicine. The big exception to that is atenolol, which has pretty clearly been associated with growth restriction.

Aspirin at low doses is actually safe for pregnancy. At higher doses, the 325, it's associated with premature closure of the PDA. So we try to keep them on the baby aspirin. Calcium-channel blockers have a very good history of safety during pregnancy. Diuretics, it's one of those weigh the risks and benefits. The major risk is that if you overdiurese a woman, she can get placental hypoperfusion. But if you're keeping her euvolemic with the medication, then it's safe to continue.

Antiarrhythmics, such as sotalol particularly, we have safety records for. We prefer to avoid amiodarone because of the potential for fetal thyroid toxicity, but if mom is really sick, the way I look at it is if mom is ill and mom is hemodynamically stable, that's not good for the baby, either. So you always have to sort of look at the risks and benefits. Digoxin is actually first-line therapy for fetal arrhythmias so we do have a lot of safety data with that, as well.

And the most important one I can possibly stress is Plavix is OK during pregnancy. I have seen many women who have fresh regulating stents who then became pregnant and were recommended to stop their Plavix immediately. That is not safe for mom. It causes some plan-- we have to do some planning when it comes to time for delivery, but it's certainly safe to be continued throughout the majority of the pregnancy.

So as I mentioned before, certain women would benefit from imaging or potentially procedures before becoming pregnant. So women with Marfan syndrome, if they have a dilated aortic root, often we would recommend prophylactically replacing the root to make the risk of pregnancy safer. Regurgitant valvular lesions actually tend to be very well tolerated in pregnancy. Pregnancy is a volume-overloaded state and they tend to tolerate that OK.

On the other hand, stenotic lesions, particularly left-sided stenotic lesions, are not well tolerated because the degree of that pressure gradient is related to the amount of flow and as cardiac output goes up during pregnancy, the pressure gradients go up and that leads to pulmonary edema. On the other hand, right-sided stenotic lesions, such as pulmonary stenosis, even if they're in the severe range tend to be very well tolerated.

But I think another important thing to think about-- and I see this a lot in women with repaired congenital disease-- is often, women are under the impression, I had a surgery when I was two. I'm fixed. I'm good to go. I have no problems. But a lot of congenital conditions still have residual abnormalities that can develop later on in life. And so it's important to have them evaluated to make sure they haven't developed any of those complications that can increase their risk, even if they've been repaired.

Now, hypertension is probably one of the more common conditions that you may be seeing in women of childbearing age. It's not uncommon. About 20% of women of childbearing age now have chronic hypertension and it complicates at least probably 5% to 10% of pregnancies. Risk factors for that are older age, obesity, diabetes, African-American race, and we know that women who have chronic hypertension are at an increased risk for developing pregnancy-related complications.

So they're at higher risk of developing superimposed preeclampsia, they're at higher risk for preterm birth, growth restriction, gestational diabetes, and these risks are much more pronounced in women with severe hypertension. If they have severe uncontrolled hypertension, it can even lead to severe complications, such as intracranial hemorrhage or abruption or fetal demise.

So if you're managing a woman with hypertension and she's contemplating pregnancy, one thing that I would consider is transitioning to her medicine that you know is going to be safe during pregnancy. We use very commonly at Barnes nifedipine. It has a very good safety record and the other great thing about it is it's a once-a-day medication. So I think the compliance is very good with it.

Labetalol and hydralazine are both safe and effective, but they're three-times-a-day medicines. And I personally have a hard time remembering to take a vitamin once a day and so I think it's unlikely that most women are routinely remembering to take a three-times-a-day medicine while they're also trying to corral their other children at home and go to their job. So I try to avoid the TID medicines.

Hydrochlorothiazide-- a lot of people have fear about using it. It's actually pregnancy class B. It's pretty safe. The biggest risk is you want to make sure you're overdiuresing the woman. The kind of classic teaching is to use methyldopa in these patients, but I essentially never use it for a couple reasons. Number one, I don't really feel like it works very well and number two, it does increase the risk of maternal depression. And so that combination of things makes me sort of shy away from using it frequently.

In women with milder hypertension, you can actually consider stopping the medicine when they become pregnant if they have reasonably controlled blood pressures and no signs end-organ damage, because as we talked about earlier, the systemic vascular resistance drops early in pregnancy. And so often, you can get through the first and second trimester with no antihypertensive therapies at all. And then, if the blood pressure is going up above 150, which you may see as they get sort of into their third trimester and the volume load's really going up, you can always add back medications.

And then, the other important point here is that women who are on potentially teratogenic medication, such as ACE inhibitors or ARBs or aldosterone antagonists, need to be on effective methods of contraception, because we would prefer to avoid them getting pregnant while taking those medications. So once a woman with heart disease becomes pregnant, how do we manage them? Well, I could give a whole other talk on that, but I'm not sure how relevant it would be to everyone in the room.

But I think the most important thing is that they have a good multi-disciplinary approach. It's important to have an obstetrician and a cardiologist who are familiar with heart disease and the changes that occur during pregnancy to be working together to manage the patient. And then, as they get closer to delivery, having anesthesiologists who are comfortable and confident in managing these women through delivery is also very important.

I really think that management of a woman's pregnancy begins well before she becomes pregnant and so that's where this pre-conceptual counseling really comes in. She should know what are her risks. What are the likely complications she may have? What are the risks to the baby? What medications does she need to be changed to, if any? And then, management of cardiac complications obviously is a big one, knowing kind of what to expect, when to expect it, and how to manage those. I think they're important in treating the complications they may develop early on before they become very ill. And then, contraception counseling we'll talk a little bit more about in a minute.

All right. So the next group of women who are those who went into pregnancy perfectly healthy, or at least perfectly healthy from a heart standpoint, who then develop pregnancy-related heart complications. So there are certain conditions that tend to occur more frequently in pregnant women. So myocardial infarction, cardiomyopathy, particularly peripartum cardiomyopathy, and dissections are all more common when women are pregnant. And this is because pregnancy is a thrombophilic state. So they're at high risk of developing blood clots. And secondly, the hormonal changes of pregnancy actually cause significant changes in the arterial wall of the coronaries and the aorta. So they're at higher risk of developing tears in those arteries.

So I want to spend a few minutes talking about peripartum cardiomyopathy. It's not common but it's not uncommon. It occurs in about one in 2,500 women in the United States. And one thing that can be tough about it is the symptoms are often difficult to distinguish from normal pregnancy. Most pregnant women are short of breath and a lot of them have edema and many of them have PND or orthopnea just from the baby pushing up and they feel like they can't breathe when they lie flat.

One thing that I have actually found to be a somewhat helpful symptom is development of cough. If they begin to develop some pulmonary edema, they'll complain of this dry cough or bring up just a little clear sputum. And that shouldn't occur in normal pregnancy so that always kind of tunes me in to the fact that they may be developing some pulmonary edema.

So peripartum cardiomyopathy must develop within the last month of pregnancy or within five months after delivery. And it's defined by significantly reduced LV systolic function. So an ejection fraction of less than 45% is usually what we use. And then, often, the LV cavity will also be dilated. This must occur without preexisting heart disease or other identifiable causes of heart failure. So if they also have a severe viral syndrome that may have myocarditis, they would not be included in this definition, et cetera.

So there's actually quite a bit of variation in how often peripartum cardiomyopathy occurs throughout the world. If you sort of sum all these together, in the United States, it comes out to be about one in 2,500. Other places, such as Africa, it occurs much more frequently, about one in 1,000. And then, actually-- we don't totally understand why-- but in Haiti, it occurs in about one in 300 women. So we don't know if this is related to genetic factors or cultural or behavior or environmental factors or maybe a combination of both. If anyone knows someone in Miami who's interested in this, I think it's a-- take those Haitian women who are now in Miami and they have a different environment. We can see. I don't know anyone down there doing this, though.

It's not very well understood. There are a lot of things that may contribute to it. Twin pregnancies, women who've had a lot of babies, very old or very young women, or women who've had a lot of tocolysis all seem to be at higher risk of developing peripartum cardiomyopathy. Some of the typical cardiac risk factors are probably related, as well. And something I'm kind of interested in, there are some emerging risk factors, particularly including preeclampsia, that seem to have some pathophysiologic overlap with the disease and I think there's going to be some interesting research done in this over the next few years.

So as you can see by this list, it basically is a good way of saying, we don't know what causes it. There are a lot of different things that have been proposed as far as mechanisms, but I think the thing that is most promising at this point is that there's a sort of two-hit hypothesis. And so every woman is exposed to some anti-angiogenic factors late in pregnancy. The placenta produces this and they're overproduced in women with preeclampsia. And because of all these excessive ROS, there's abnormal cleavage of the prolactin protein to cardiotoxic metabolite. And so it's thought that all of this sort of anti-angiogenic onslaught may contribute to some maybe global ischemia of the heart and leading to the problem.

However, not every woman with preeclampsia develops peripartum cardiomyopathy so it can't be that alone. So there must also be some host susceptibility, probably some sort of genetic factor, that renders these women's hearts unable to handle this anti-angiogenic onslaught and then they go on to truly develop disease. So as you can see here, the vast majority of women develop this within a month after delivery. And in fact, I usually see it within about one to two weeks after delivery. After they deliver, their LV function worsens, they have a huge shift in their hemodynamics as all of this fluid is being reabsorbed into their vascular system, and that's when they tend to come in in pulmonary edema.

All right. So just a few-- I'm a cardiologist so I have to show you a few echoes, just a few echoes here for-- this is a patient who got an echo for other reasons at end of third trimester, right after delivery. You can see her LV cavity is normal size and squeezing well. This woman, on the other hand, has peripartum cardiomyopathy and you can see that the left ventricular cavity is very dilated and the systolic function is significantly reduced. And this is just showing you here that-- so her end diastolic diameter is 4.6 centimeters and this patient's is 6.3-- so big difference in the size of the ventricle.

And then, this is just on a short axis view here. Again, here's a normal woman's heart, normal size, squeezing well. And you can see there's just global hypokinesis of this woman, significantly reduced systolic function. Sometimes, imaging a pregnant woman can be difficult because they're breathing fast. We can't give them contrast because it's contraindicated. Their baby's pushing their heart in a funny position so it can be hard to get good images. So sometimes, I find it really helpful to use some ancillary measures of heart function to help me determine if I think this is really truly peripartum cardiomyopathy, because it can be difficult to really see the endocardial border.

So the LVOT VTI is actually sort of a marker of stroke volume. And in a normal woman, it actually should be elevated, supernormal, at the end of pregnancy, because they're really in a hyperdynamic state. So normal is 18 to 22 and in this normal woman, you can see hers is nearly 26, which is exactly what I'd expect for a healthy woman at the end of pregnancy. On the other hand, this woman with peripartum cardiomyopathy, hers is 9.7. So it's half of what it should be. Her stroke volume is very low. And another sort of just interesting thing-- this is an echocardiographic equivalent of a pulse alternans. So you can see her heart function's so bad, every other heartbeat is sort of significantly reduced.

And then, another thing we're using a lot more these days is something called myocardial strain and it sort of looks at how much the actual muscle fibers are moving during each heartbeat. And again here, normal's about 18 to 22. And so in this normal woman, hers is about negative 21 and 1/2. And this is what you want to see is a nice bright, red picture. In this one with peripartum cardiomyopathy, hers is negative 6.7. So again, even if you couldn't clearly see the endocardium very well, you get an idea from this that heart function is significantly reduced based on these other parameters. And then, this is just a picture of a woman's IVC. So it is just a good marker of significant volume overload. You can see how dilated this is. Normally, it should be nice and small and skinny.

So how do we treat these women? Well, a standard heart failure regimen, really, beta blockers, afterload reduction, diuretics-- if they're still pregnant, I usually use hydralazine and Isordil for afterload reduction. For women who've delivered, I unabashedly use ACE inhibitors in them. People get very nervous about using them in breastfeeding women, but there's really no good data that it actually causes any harm to the baby and the American Academy of Pediatrics are also comfortable using them. I don't use them first-line for hypertension, but for a woman with severe LV dysfunction who's clearly going to benefit from an ACE inhibitor, I feel very comfortable using them. I figure it's more beneficial for that baby to have a mom recover her heart and be around to take care of them rather than withhold a potentially lifesaving medication.

Anticoagulation is also important to these women. They're still hypercoagulable, they have a big, baggy heart, and they're at very high risk of developing LV thrombus. So if women have very severely reduced EFs, I will actually recommend and most people recommend putting them on full anticoagulation. For people with more moderate LV dysfunction, usually a full-dose aspirin would suffice. And then, they need follow-up imaging to evaluate their progression and recovery and contraception is extraordinarily important in these women. I tell them, absolutely becoming pregnant in the next year is out of the question, cannot do it. And after a year, we'll talk. We'll discuss.

So what is their likely course? Kind of a good rule of thumb is 1/3 of women will completely recover, 1/3 of women will partially recover, and 1/3 of women will have no significant recovery. Usually, if they're going to recover, you'll see a pretty significant improvement within about three months after delivery. Now, what happens with the next pregnancy and how do I counsel them? Well, if they have persistent LV dysfunction, any degree of consistent LV dysfunction, I say pregnancy's absolutely off the table.

And why is that? Because about 1/2 of them will develop recurrent peripartum cardiomyopathy and even more concerning, about 20% of them will die, which is absolutely not an acceptable risk in my book. On the other hand, women who have complete recovery of their LV function, I discuss with them the risks and benefits and sort of let them decide. And then, I'll help them through their decision and support them.

Now, why am I more relaxed on them? Well, only about 20% will develop recurrent heart failure symptoms. It's a significant minority. But the good news is they're not very likely to die from it. So I tell them, you're taking a risk if you choose to do this again. You might develop recurrent heart failure, but it's not likely to be a life-threatening problem. So many women will still then decide, yeah, I don't think it's for me. I want to just stay away from it. But it's different than the women who have persistent LV dysfunction, for whom I really do believe it's a life-threatening problem.

All right. The last group of women-- you probably see a lot of these women-- are women who develop heart disease years after they become pregnant. And what disease am I talking about? Hypertension, heart failure, ischemia, strokes-- well, what does this have to do with pregnancies? Well, most people in my world, cardiology and internal medicine, their sort of pregnancy history is something about the G's and the P's and I can't quite remember what they stand for. But I think we should be doing a much better job of taking pregnancy histories, because I think it's important for their future health.

So all of these conditions-- recurrent miscarriages, stillbirth, preeclampsia, abruption, pregnancy-induced hypertension, gestational diabetes-- they're all associated with elevated risk of future heart disease. And so this is free information and I find that most women remember if they've had any of these complications. And so you can use that to sort of factor into your assessment of how high at risk are they of developing problems down the line.

So pregnancy is sort of, again, a free stress test for women. So it's a metabolic state. Everyone's sugar goes up a little bit. Everyone's lipids go up a little bit. And for most normal women, these things go up a little bit, but they don't break through into a true disease. This dotted line is sort of the line for "disease," developing some sort of metabolic disease. And then, they go on and then finally develop coronary disease when they're 80 years old.

Now, other women, on the other hand, will have severe derangements in these metabolic changes during pregnancy and they'll develop preeclampsia or gestational diabetes or gestational hypertension. And then, what we know is that they go on to develop cardiovascular disease much earlier in life, in their 40s and 50s. So I think this is kind of a chicken or egg question. Is it that pregnancy is just a stress test and it's identifying women who are already at risk of developing heart problems down the line, because we already know that women with preeclampsia are more likely to have underlying hypertension and obesity and insulin resistance and all these other heart risk factors? That certainly might be true.

On the other hand, we know that preeclampsia is really a disorder of endothelial function. And there are studies that show that endothelial dysfunction and diastolic dysfunction can persist for years after pregnancy. So it's also possible that this period of their life and metabolic abnormality is actually accelerating their vascular disease and that may persist. No one knows the answer to that right now. But either way, it's clearly associated.

So how much is this risk? Well, women who have had preeclampsia are at about four times a risk of developing hypertension over the years following pregnancy. They're at twice the risk of developing myocardial infarction or heart failure and also at a little bit increased risk of stroke, as well. Women who've had pregnancy losses-- so stillbirths, higher risk of heart conditions. For each miscarriage, the risks of these conditions go up.

Now, these are situations where I don't think that a miscarriage is causing cardiovascular disease but probably rather they have underlying vascular disease that led to their miscarriage or led to their stillbirth. But I think it's still, again, free and useful information that we can use in assessing a woman's risk-- same with recurrent miscarriages here.

So this is actually have a problem that I feel relatively passionate about. I feel like most young women come into contact with the health care system because many women become pregnant. So they see their OB/GYN and they might develop pregnancy complications, like preeclampsia or gestational diabetes. But then, often I feel like they kind of tend to fall out of the health care system. They're young, they're healthy, they're not seeing a doctor, they're busy, and over the years, they develop obesity and hypertension and dyslipidemia. And then, they come see me or all of my male colleagues and they're coming in with premature MIs or heart failures or strokes.

And I feel like this is where the role of primary care is so important at bridging that gap. And I think it's so important that women are transitioned from their obstetric care into good primary care so that we can potentially theoretically put me out of business by screening these women for hypertension and dyslipidemia, treating those conditions when they arise, counseling them on smoking cessation and weight loss, and so that we can really aggressively treat their risk factors and prevent them from developing premature disease down the line.

And even just educating them that they're at risk-- a 45-year-old woman with chest pain probably doesn't think she's likely to be having an MI and most of the time, she's probably right. But woman with a lot of these other risk factors, that might be the case for them.

All right. So I'd like to spend the last part of the talk talking about contraception in women with heart disease. This is also a really important topic to me. I struggled in medical school with deciding to go with OB or internal medicine. I found this weird, unique mixture of the two. But I think we really undercounsel our women on contraception. At least, cardiologists do. I can't speak for the rest of the group. But I think it's an important thing.

It is recommended by the ACC and AHA that women receive counseling on contraception if they have underlying heart disease and that can be for one of two reasons. For women who are at lower risk for cardiac complications for whom pregnancy is not absolutely contraindicated, we want to help them plan their pregnancies. We want to get their blood pressure controlled. We want to get them off of teratogenic medications. We want any pre-conceptual imaging that needs to be done to be done and help them plan a pregnancy so that they're less likely to develop complications.

On the other hand, for women with those very high-risk problems, like pulmonary hypertension, we want to help them prevent pregnancy altogether. We don't like to meet them for the first time when they're 33 weeks pregnant in heart failure. We want to help them plan ahead.

There are several settings that show that most women do not recall ever discussing contraception with their cardiologist. Most people remember talking to their OB about it and a lot of them remember talking to a primary care doctor about it, but very few remember talking to their cardiologist about it. And many women recall inaccurate information. So either we gave them inaccurate information or they didn't remember the correct information. We don't know why that is.

And the most common reason is actually, people counsel them overly conservatively. If you don't know, just tell them, I don't think that medicine is safe for you and I don't think you should get pregnant, which I think is still a disservice to women with low-risk lesions. So there's two main issues to think about when talking to a woman about contraception. Is the method safe for her and will it keep her from getting pregnant? And there's a big difference between how effective a contraceptive method can be and how effective it truly is out in the real world.

So there's kind of two big groups of contraception, the hormonal and non-hormonal groups. And I kind of like to think about the effective and not as effective methods. So amongst hormonal contraception, the methods with very low failure rates, less than 1%, there's the Mirena ID and the subdermal implant, which what we're using now is the Nexplanon. And then, the other options all have failure rates more than 5%. So that includes Depo-Provera, oral contraceptives, the patch, and the ring.

Now, for a woman who is low-risk for pregnancy complications and in a stable social situation, I'm perfectly satisfied with them using any of these methods of contraception. On the other hand, a woman who has a high risk of death with pregnancy, I think you need to go with something that's going to have a very low failure rate, because the consequences are very different.

We've also got our non-hormonal methods. So those are, with failure rates less than 1% are the copper IUD and then male or female sterilization. And then, those with higher failure rates-- actually higher than 15% out in the real world-- are the barrier methods or natural family planning. Again, if it's not a huge consequence if they become pregnant, I don't have a problem with these issues, but for women for whom it's life-threatening, I don't recommend.

So I actually did a study which will soon be published but not yet published looking at the women in our congenital heart disease clinic. And we talked to them about what types of contraception they use, what their knowledge was of contraception, and who had unplanned pregnancies. Well, I was actually surprised to find that a full third of women had had an unplanned pregnancy. This is women with known congenital heart disease. And actually, the risk was highest in people with absolute contraindications to pregnancy. So a full half of those women had had an unplanned pregnancy.

So we asked the women who'd had unplanned pregnancies, what method of contraception were you using when you got pregnant? Well, almost 1/2 of them were using no contraception at the time of the pregnancy and actually, the next most common thing was combined oral contraceptives. Only one woman reported having a copper IUD in place when she became pregnant.

So then, we took all of the women who were currently sexually active and said, well, what type of contraception are you using right now? Well, the most common method was none. So it's not surprising that we've had so many unplanned pregnancies. Only about 10% of women were using the highly effective reversible contraceptives and the combined hormonals were kind of the next most common and about a quarter of women had had permanent sterilization. Those were primarily women who were kind of getting towards the end of their childbearing years, who'd had their kids and were sort of done having children.

So one big question to think about is, for who is it safe to use any sort of estrogen-containing method? The most common one we use is the pill. I think the most important thing is to think, for who is it not safe? And for everyone else, it's probably safe. And most of these, if you think about it, kind of make sense. So estrogen-containing methods of contraception can cause hypertension and hypercoagulability.

So anyone who you don't want to have high blood pressure or to develop blood clots-- we don't want anyone to develop those problems, but for whom would it be very dangerous to develop those problems? Those people shouldn't take it. So people with pulmonary hypertension, if they develop a DVT and PE, they're likely to die. So Fontans are at a very high risk of developing a thrombus in the Fontan circuit. So for those people, it's contraindicated.

Women with afib-- obviously, that puts them at increased risk of stroke-- women with mechanical valves, people with residual right to left shunts because of the risk of paradoxical embolism, people with coronary or aortic diseases-- so Kawasaki disease, aortic dissection, coronary disease-- women who've had a previous thromboembolism-- so those are the women who really should stay-- and then, of course, if they have underlying hypertension, as well. So those are the people who we should avoid estrogen-containing methods. And for everyone else, they're pretty much safe to use-- oh and in significant LV dysfunction because of the risk of LV thrombus.

The next thing is a very good option for these women. It's the long-acting reversible contraception. So that includes the progesterone-implanted IUD-- so the Mirena-- the copper IUD, and the progesterone-implanted rod, which would be the Nexplanon. These actually-- all three of these methods have a class one or two indication for all women with heart conditions. Even if they have valvular disease, mechanical valves, prior endocarditis, the risk of infection with these in the modern day is so extraordinarily low.

On the other hand, for the women usually that you would be most worried about using these in, they're the women at highest risk of major complications of pregnancy. So I think if you weigh the risks and benefits of putting in a highly effective method of contraception versus their potential bad complications of pregnancy, it's a hands-down win for using a highly effective method of contraception. We know that all three of these methods are as effective or more effective than tubal ligation. The copper IUD is slightly less effective, but still less than 1%.

They're all free of estrogen so you don't have to worry about any of those contraindications. They're all completely reversible. So when they decide they want to become pregnant, you can take it out and they can become pregnant. And they're FDA approved for 3 to 10 years. So they don't have to think about taking a pill every day, doing something once a month or even once every three months, which makes their real-world efficacy so much higher than many of the other methods.

So what we have employed at our clinics is that all women of childbearing age with heart conditions should be assessed annually for their method of contraception and documented. And we recommend the long-acting reversible options for anyone who is either WHO class three or four so meaning absolute or relative contraindications to pregnancy and then anyone taking teratogenic medications. For the other people who are on safe medicines and are at lower risk for complications, I have no issues if they want to take other methods. But I think that this really is an important safety thing for these women.

All right. So to kind of sum things up, counsel your patients with heart disease on their contraception and pregnancy risks. I think it's a really important part of their care to be counseled on this and to really start their pregnancy management long before they ever become pregnant. Second thing's pregnancy risk is very heterogeneous. So as we talked about, some women have extremely low risk of complications with pregnancy. In other women, it's life-threatening and really not a good idea.

Fortunately, though, most women can do well with pregnancy. There's a very small group of women for whom their risk is very high and everyone else either does well or we know what complications we can be expecting and head them off early and they can really get through it without major complications. Peripartum is really the highest risk time. I think most people expect that they're going to see problems in third trimester, but it's usually that week after they deliver that they develop heart failure or other major complications. And so I'm always very alert to doing a good exam, taking a very careful history in that first few days after they deliver, because that's when they're likely to have problems.

And then, lastly, pregnancy does help us predict long-term cardiovascular complications. These are not folded into the current ACC/AHA Guidelines for statin initiation, but if I have a woman who has rheumatoid arthritis and had preeclampsia during pregnancy and her mother had early heart disease, those are all sort of nontraditional risk factors that I would weigh into my decision, in terms of what's my threshold for initiating therapy or certainly for counseling her heavily for lifestyle modifications.

That's all I have for today.