

[MUSIC PLAYING]

KRISHNA

Hi. I'm Krishna Tummalapalli, interventional cardiologist at UPMC Shadyside Hospital. And today's presentation

TUMMALAPALLI:

is what is the role of percutaneous coronary intervention in octogenarians and nonagenarians. And I do not have any conflicts of interest for this presentation. And my goal is, during this presentation, with the help of about four clinical cases that I have performed at Shadyside Hospital, and also with the help of several articles in the literature, to emphasize the point that just because somebody is in their 80s and 90s, we do not want to withhold percutaneous coronary intervention for this group of patients. And at the same time, we need to be aware that the more elderly you are, higher chance of complication rate. So we have to balance the risk-benefit ratio particularly in this age group.

So let's begin. So this always is a good question-- who is elderly? There is always a big debate on this aspect. And I'm going to use, for the purpose of this presentation, the American College of Cardiology definition. So if one is more than 65 years of age and less than 79 years of age, they are called elderly. And if somebody is over the age of 80 years old, they are called very elderly. So I tried to focus my talk today on People. Who are 80 and above-- octogenarians and nonagenarian.

And I should also mention that 80 now is the new 60. In other words, the 80-year-old-plus individuals now are very active. And they like to do things. They like to go to places. And I have had patients who are skiers and things of that nature. So we need to make sure that they are able to maintain their functional capacity, even though they may have coronary artery disease.

So we all know that even in elderly patients, the coronary artery disease is still the most common cause of death. Not cancer. Not any other disease. Still, the coronary artery disease poses a greater risk for the life of this group.

So also a clear knowledge gap exists among this group of people. Meaning that among the studies that we go through in the literature, most of the studies have eliminated people over the age of 75 in their prospective randomized clinical trials. So another way of looking at this is that this gives an opportunity for us to gain knowledge in this group of patients.

The elderly present in three different ways, either STEMI, acute myocardial infarction, which may proceed to cardiogenic shock, or non-STEMI, which may also deteriorate into cardiogenic shock or stable ischemic heart disease. We also know from the Swiss STEMI registry, the older patients are typically given less chance of percutaneous coronary intervention by the invasive cardiologists, thinking that if they embark on this group of patients, their complication rates would be higher. So there's an opportunity for us to learn, in this group of people, is it OK to treat them only conservative medical therapy, or should we be offering the percutaneous coronary interventions in this group. So let's examine that.

So why are we concerned about this group, 80s and 90s? Because the population is growing in age. If you look at this, particularly people over the age of 75 years old, by 2050, we're going to have 46 million people, which is a large number. And these people do have coronary artery disease, and they will need help with interventional cardiology. And the data clearly shows that acute coronary syndrome accounts for 30% of mortality in this age group.

So interestingly, the elderly patients present in two different ways. Some of them have increased bleeding due to high TPA and low platelet activity, and some of these patients have increased thrombosis because of the increase in the plasminogen activity inhibitor, and also blood having higher viscosity. So this has to be taken into account when we treat these patients with medical therapy.

In addition, they do have diffused coronary artery disease, and hence most endothelial dysfunction is noted in this group of patients. And majority of the times the coronary circulation depends on the ability for the coronary arteries to dilate to meet the increased demands. But elderly patients, because of the endothelial dysfunction, they have reduced margin of safety. So all these factors play into what we can do for these patients and how best we can help.

First thing I would like to also emphasize is that today's discussion, we are only going to focus on the role of the interventional cardiology percutaneous coronary intervention, and we're not going to discuss much about the medical therapy. Except, I will say that all of these patients, regardless of their presentation, must require guideline directed medical therapy. And then we can talk about which patient will fit the criteria for interventional therapy and which patient does not.

The other aspect that we have to understand in the 80 and 90-year-old patients is that the propensity or prevalence of coronary artery disease is very high. And this has been shown in Framingham Heart Study and Cardiovascular Health Study, that over the age of 75, 55% had already triple vessel coronary artery disease. They have high prevalence of left main coronary artery disease. And not only that, the coronary regions are very advanced usually.

They have heavy calcification. The coronary vessels are very tortuous. There is diffused nature of the disease, long lesions, and multiple vessels are involved. And we call this in interventional cardiology as class C lesions. We rarely see in 80 or 90-year-old patients a single vessel, single lesion, type A or type B lesion. So this causes challenge when we offer invasive therapy for this group of people.

Not only that, the elderly, they have more association with comorbid conditions, such as congestive heart failure. They may have previous myocardial infarction, atrial fibrillation, diabetes, stroke, COPD, and renal failure. So when you have this many comorbid conditions, again, their margin of safety is very small.

But I also want to point out the issue of calcium score in this age group. And we all know that, clinically, the majority of the 80-plus-year-old patients, they are asymptomatic most of the time but still have underlying severe coronary artery disease. And one way to assess that is by checking their calcium score. If the calcium score is more than 400, those patients are more likely to have a higher disease burden.

In addition to that, this group has more challenges. So a very important aspect is their atypical presentation. The older you are, they do not come with classic chest pains. They have very vague symptoms. They come in with nausea, vomiting. Sometimes they may just say, "I'm not feeling well. I just feel weak. I feel tired."

And a lot of times this can explain why when they come to the emergency room with these symptoms, even though they may be having STEMI or non-STEMI, there is a delayed recognition and a delayed therapy in this group of patients. So we have to be aware of that. A majority of these people have LV dysfunction. They also have valvular heart disease. Particularly the elderly people have calcific aortic stenosis, and majority of them also have mitral incompetence of a variety of degrees.

They also have musculoskeletal and cognitive dysfunction. They have poor functional status. And when we offer invasive procedures, they have higher chance of vascular, renal, and cerebrovascular complications. Stroke risk is high with invasive procedures. In this group. And, for example, the more elderly you are, you may have protruding atheroma in the aorta. And when we do cardiac catheterizations in and out with the catheters, we may dislodge some of the trauma and a thrombolism is common-- more common than in younger people.

And we also know that the older people, when they present with STEMI or non-STEMI, they have a higher mortality rate than the younger population. So this actually gives us an opportunity that the older you are, if we help them with invasive procedures when they present with acute coronary syndrome, we may be actually saving higher number of people. The absolute benefit, absolute mortality benefit with invasive procedures, is actually higher in older.

The other important aspect I like to point is the Activity of Daily Living-- ADL. So in other words, the functional status and frailty of the patients is very important. The higher the functional status, this group of patients do well with invasive procedures. And the more frail you are, their mortality is high in people who are 85 years or older. So that has to be taken into account when we offer invasive procedures.

So let us now discuss these three groups-- STEMI, non-STEMI, and stable ischemic heart disease. So when a patient presents with this EKG, with chest pains, the decision making is very easy. So we have a clear cut STEMI. ST-elevation myocardial infarction with ST-elevation significant in II, III, aVF, and also V4-V6, as well as significant ST-depression in I and aVL, clear inferior lateral myocardial infarction. So the decision-making is very easy.

The principles are that if a patient presents with STEMI, the goal is the earlier we open the infarct-related vessel and TIMI 3 flow is maintained very quickly, the higher the benefit or lower the mortality for this patient. Is that true in elderly? So that is the question. We are really focusing on the elderly, 80s and 90s, patients.

So the landmark trials we are all familiar with, the PAMI and DANAMI trials, they showed that the PCI is clearly superior to fibrinolysis. And when they looked at the subgroup analysis, that's also true in people over the age of 70 years old. And if we look at the GRACE registry, and we're also familiar with the GRACE score, any time patient comes to the emergency room with chest pain, we assess their risk by looking at the GRACE score.

So in that GRACE registry, if we look at it, there are 2,975 older patients were analyzed PCI compared to fibrinolytic therapy, and the PCI was clearly associated with reduced death and reinfarction. So guidelines would say that there is actually no age limit if a patient comes with STEMI or primary PCI. We should always consider primary PCI.

Obviously, there's a strong contraindication for CAP, such as renal failure, terminal disease, malignancy, et cetera. We won't offer. But age itself is not a contraindication for primary PCI, even in people who are in their 80s and 90s.

So let's just draw some really clinical important factors when we offer therapy for the STEMI patients. So if we're in a PCI capable center, PCI should be performed for STEMI if they have symptoms less than 12-hour duration. And our goal is door to balloon time would be 90 minutes. So if you are in PCI center, patient comes with STEMI, we have to open the artery within 90 minutes.

So if somebody has contraindications to fibrinolytic therapy, then we have to offer PCI regardless of the time delay. What about if the patient has STEMI and then they come in with cardiogenic shock? So PCI should be offered irrespective of the time delay from the onset of the myocardial infarction. Sometimes patients do present to the hospital two or three days after a clinical MI, and when they come to the hospital they may be already cardiogenic shock, and they need PCI at that time.

So what about PCI if the patient comes to you with between 12 and 24 hours? So PCI is reasonable if they're still having ongoing chest pain and ongoing ST segment elevations. So yes, we should consider PCI.

So what about then if you are not in a PCI center, but you're in a non-PCI center away from a PCI center by several miles? So the key is that we need to make a clinical judgment. If I send this patient right away to a PCI center that is close by, can that interventional cardiologist perform PCI and open the vessel from the local hospital to the PCI center within two hours. Two hours is the key.

So if we assess-- if I'm in a non-PCI center and if I assess my PCI hospital is far away-- my patient cannot get the PCI within two hours-- then we fibrinolyse. So fibrinolysis can be given in those kinds of situations. And what data do we have? We have the STREAM trial.

So the STREAM trial is the strategic reperfusion in elderly patients, early after myocardial infarctions. So what they have done was they have given tenecteplase, followed by transfer to the PCI hospital. The reason for that is, once you get done with fibrinolytic therapy using tenecteplase, you send the patient to the PCI center. So the patient reaches the PCI center-- an assessment will be done. Is there a reperfusion or is there no reperfusion?

If there is no reperfusion, then those patients will get a cath and rescue PCI. So by using this strategy, the STREAM trial has shown us that comparable efficacy was noted among patients who are less than 75 and who are more than 75. So again, making a point that patients who are elderly should not be withheld this lifesaving help. The composite endpoints of death, shock, congestive heart failure, reinfarction are similar to primary PCI. So I think this is a good strategy if you are in a non-PCI center.

OK, let's recap what you're learning here. That if you are in a non-PCI-capable hospital, you give fibrinolytic therapy and send the patients for possible rescue PCI.

But we have to be aware of the contraindications. Because the more elderly patients will get more chance of complications if we give fibrinolytic therapy. So these are the list of complications. These are risks of contraindications I would like you to be aware-- any prior intracranial bleeding, any malformation, known intracranial neoplasm, suspected aortic dissection, to name a few. These are the contraindications, and we do not want to give fibrinolytic therapy.

And also, whenever we are contemplating fibrinolytic therapy, we have to get a good, informed consent from the patients. Because the more elderly you are, the more chance of intracranial bleeding. And that has to be spelled out in the informed consent. And sometimes if the patient is very elderly, another strategy also has been used, where only half the dose of fibrinolytic therapy is given, and the patients are sent for possible rescue PCI.

Now, let's turn our attention to non-STEMI. And non-STEMI is really-- figuratively we could clearly use the term-- the tip of the iceberg. So the elderly people in their 80s and 90s, they are more often likely to present with non-STEMI. They do not typically present with severe chest pain instead. So majority of these patients with acute coronary syndrome are non-STEMI patients. And in fact, the mortality in non-STEMI is very high, and some of these patients can go on to develop complications, such as arrhythmias, ventricular septal defect, mitral incompetence, and some of them go into cardiogenic shock. And even though they may look good initially in the emergency room, they are very much associated with high chance of mortality and morbidity.

So let's take an example of a patient I had recently, an 89-year-old retired physician. So he has a history of hypertension, dyslipidemia, chronic renal failure, and was admitted with chest tightness and shortness of breath. EKG showed normal sinus rhythm, right bundle branch block, nonspecific ST-T abnormalities, and PVCs. We will look at the EKG in a minute.

Important to note here is that he had an echocardiogram done three months earlier which showed normal LV function. So this patient never had myocardial infarction or any previous coronary procedures. So when he came in non-STEMI was diagnosed because troponin was 6. And it so happened that this retired physician presented on a Friday late evening, and his renal function was assessed to be 1.8. He has chronic renal failure.

So we thought it was Friday evening, he was relatively pain free at the time. We thought, we'll stabilize, give him IV hydration, get him ready for cardiac cath on Monday morning. So here is the EKG. As you can see, it does have normal sinus rhythm with frequent PVCs and couplets and right bundle branch block type pattern and non-specific ST-T abnormalities.

No ST-elevation. So if there are ST-elevations, clearly he would go for cath right away. But we thought, we'll stabilize. So what happened to this gentlemen? So that evening and night, he deteriorated. He had recurrent chest pains. He went into atrial fibrillation with rapid ventricular rate and progressively became hypotensive.

His blood pressure went as low as 78 or 60 millimeters of mercury. And we did a STAT bedside echo at that time. The LV ejection fraction was 35%. As you can see, he deteriorated from 65% earlier, and he was going into worsening heart failure, requiring increased oxygen requirements. He did not need intubation, but however he was getting more and more short of breath and he was going to cardiogenic shock. He was becoming cold and clammy.

So now, here we have a very, very elderly patient with this clinical scenario, non-STEMI cardiogenic shock, poor LV. What should we do? Should we treat him only conservatively because he's quite elderly, complication are high, or should we do emergency cath? Do we need to consider his age when we offer invasive therapy for cardiogenic shock?

So these are all the questions. And then, what data do we have? What literature do we have that can guide us in these types of situations? So we don't have any specific non-STEMI cardiogenic shock prospective randomized trial. However, we do have SHOCK trial in STEMI patients. This was published in the *Journal of American College of Cardiology* in March 2003.

So at that time the hypothesis was that patients who present with STEMI and go into cardiogenic shock, is there any benefit of early revascularization in these people? Early revascularization meaning within 36 hours of onset of the myocardial infarction or within 12 hours of onset of the shock. You take the patient to the cath lab, you do the revascularization, compared to late revascularization group if indicated medically. And then they're not getting better-- then only, you do invasive work deferred for 54 hours in this scenario.

So this is a very important trial, because this trial can never be repeated because of ethical issues nowadays. So this is the trial we have in STEMI and SHOCK patients. So I'd like to walk you through this one.

So here, they actually screened 2,000 patients with ST segment elevation and cardiogenic shock. And as you see, only 302 patients were randomized. And they looked at the early revascularization was as late revascularization. And if you have a patient with cardiogenic shock and STEMI, if we do not revascularize, their mortality is 80%. So the question really is, by taking this approach, are we able to change this mortality?

So let's look at the data. So in this, as we said, screen, 2,000 patients-- the randomized 302 patients. But if we look at the patients over the age of 75, there are only 56 patients. When they analyzed the results on this group, they actually had worse outcomes compared to the younger people. So people who are less than 75 years of age, they got benefit with early revascularization, and people who are older than 75, they did not get benefit. They actually had worse outcomes.

So this study suggested that maybe we don't want to do interventions on people over the age of 75, that are in cardiogenic shock. But at the same time, when those people who were not randomized, those people were put in SHOCK registry. And when they looked at the SHOCK registry patients, the people over the age of 75 turned out to be 232 patients. And those patients who underwent early revascularization, they actually have survival advantage.

So their mortality was reduced from 79% to 48%. Although 48% is a high mortality, by doing invasive procedure and early revascularization, most of them got survival benefit. So based on this, actually, if we look at the 2013 STEMI guidelines, they actually did not exclude any older patients for early revascularization in cardiogenic shock.

So based on that, what we did, coming back to our patient, we took our 89-year-old retired physician with cardiogenic shock to the cath lab right away on that Friday night. And as you can see, the angiogram reveals the left is patent, very critical left anterior descending artery stenosis right here with a little sluggish flow. The circumflex is patent. And then other look at the LAV, very, very critical one spot stenosis 99%.

And then we look at the right coronary. Right coronary artery is widely patent and stable. And so, we did intervene. They did the predilatation, standard to PCI. We did the stent placement. We did post dilatation. and we have a nice, good opening of the LAD right here, as you can see, in a very nice opening and good flow.

So then the question is, what happened to this patient? So the clinical course was good. Next day, the patient's hemodynamics have improved. Intra-aortic balloon pump was removed. Patient was converted to sinus rhythm with IV amiodarone. He was in congestive heart failure actually. His renal failure has deteriorated initially. And after a few days, it got stabilized at 2.1.

The Oxygenation status improved. He never required intubation. And he was discharged home with the LifeVest. So he did very well. After three months, we repeated the echo, which showed LV ejection fraction back to almost 50% to 55%. Lower than normal, but still much better than 35% in the hospital.

And now he is doing very well. Over two-year follow-up he is very stable. No angina. LV function has improved. He enjoys gardening, and then he brings me fresh tomatoes every year.

So then the question comes, specifically in non-STEMI, are there any other important trials which show that people over the age of 75-- is there any benefit for us to offer invasive procedures? So I would like to bring our attention to a few studies here. This is specifically looking at non-STEMI patients. TACTICS-TIMI-18 is an important trial. So they're focused on people over the age of 75. The benefits of PCI are better with early invasive therapy. There's a 56% reduction of death and MI compared to conservative therapy. So a very important trial.

And then, there's specifically a randomized prospective trial including only 80-year-old patients. This is published in *Lancet* 2016. So they actually had a good number of patients, 457. The median follow-up was for 1 and 1/2 years. So if you look at the data, death, myocardial infarction, stroke, and urgent revascularization all were lower in invasive arm.

So we also have the GRACE registry we alluded to a few minutes earlier. So out of the 18,466 patients in the registry, 16%-- a good number of them-- were octogenarians. And they showed improved outcomes in all age groups, also in octogenarians, with the coronary intervention compared to conservative therapy. And then we also have CRUSADE registry. What they showed was the coronary intervention is better in ages 75 to 89, and also over the age of 90 years of age.

So as you can see, we are now pushing the envelope. We are not only offering PCI among 80-plus, but we are also showing benefits of PCI in 90-plus years of age. And I'd also would like you to refer to your Denmark study, which showed five-year survival in nonagenarians is same as in octogenarians. So we should not withhold PCI just because somebody is 90-plus years of age.

So that brings to my next patient i had the pleasure of taking care of. A 94-year-old female-- she came in with non-STEMI. So she's a very independent lady, she has a history of hypertension, hyperlipidemia. Her symptoms were dyspnea on exertion. She was admitted with that. She lives by herself. She swims almost every day. There's no previous history of myocardial infarction.

Her clinical examination is really unremarkable. EKG show lateral wall T-wave inversions. And the troponin was 1.45. And she also has a written DNR/DNI wish from the patient. So we did the echocardiogram, which showed the dilatation of the left ventricle. As you can see, these are still images without and with contrast. The anterior septum, apex, anterior lateral wall, and the anterior wall, they're all hypokinetic and LV ejection fraction was 25%.

She was very much involved with her care. She wanted to know what was going on-- what is her best chance of becoming independent again? So we did the cardiac cath. As you can see, the right coronary artery is 100% occluded. The left anterior descending artery here showed long, segmental, 99% stenosis. This is also calcified. The circumflex coronary artery showed moderate coronary artery disease.

Here are the videograms. As you can see, there's a long segment. Even without contrasts, there's evidence of calcium in this artery. So we did radial arterial approach. The reason I am mentioning this is that we prefer radial arterial approach for angiograms and PCI, because the radiological approach has less chance of bleeding complications, and the bleeding complications actually go up when the clinical complexity of the patient increases from stable angina to non-STEMI to STEMI.

And the reason this is important is anytime you have any bleeding complication, after a PCI the mortality rate goes up. Particularly if we go with femoral arterial approach, one of the dreaded complications is the retroperitoneal bleeding. As you can see here, reconstructed CT angiogram, there's retroperitoneal bleeding. And sometimes if it is not contained, it can cause fatal bleeding.

Although, over the years, the complication rates with femoral as well as radial approach, both are decreasing, because we are following safe vascular access approach using ultrasound. We use ultrasound routinely for femoral arterial puncture and also for the radial arterial punctures. And using several landmarks and proper care, these complication rates are coming. But the point to illustrate here is if there is a bleeding after any PCI, it raises your mortality.

I would like you to refer to the three studies represented here REPLACE-2, ACUITY, and HORIZONS AMI. So this published almost 12 years ago. It showed any bleeding-- it doesn't matter whether it's access site bleeding or non-access site bleeding-- after a PCI is associated with higher risk of one-year mortality. So we try to do radial arterial approach as much as we can.

And also reflected here these are the latest guidelines from ACC/AHA coronary revascularization guidelines, published just recently, 2021. And of the top 10 take-home messages here, as you can see, radial artery access is recommended in patients both for ACS and stable ischemic heart disease when we are doing PCI procedures. So coming back to our 94-year-old lady, we know that she has a long segmental, 99% stenosis in this LAD, which is calcified.

Well, the questions are she also has occluded right coronary and also had moderate disease in the proximal circumflex. So what should we do? Should we offer CABG because the patient has [INAUDIBLE] disease? Or should we do multivessel PCI? Should we only stent the LAD and whatever this DNR/DNI status?

So interestingly, this patient, on her bedside, has this book very well displayed for everybody to see. The title of this book is, *The Older You Get, the Trickier It Is to Navigate the Health-Care System*. And it also says, clearly, "Treat me, not my age."

So she's also very intelligent and involved with her care. We had a long discussion with the patient and her daughter, and she wanted to have a good quality of life. Also, she said, at any cost, I can go for PCI, but I do not want coronary artery bypass graft surgery at any cost. So again, the reason for discussing and sharing this case is that the older we are, we are also going to get into social and ethical issues when somebody says, I don't want a bypass at any cost.

Is it ethically OK to offer PCI? What if there is a perforation of the LAD? What if there's a complication? What if there's an acute occlusion of the left anterior descending artery during the procedure? Should we just let her die on the table, and is it ethical? And also, what to do the DNR and DNI?

A lot of times, I have noticed, in my clinical practice that the older patients, and sometimes younger patients too, do not distinguish between a critically ill health condition and a terminally ill health condition. So that's sometimes commingled, these two. And then say, I'm too sick. I don't want anything done.

But unlike terminal cancer, this non-STEMI cardiogenic shock is potentially a reversible condition. So we explained that to her, and then she actually reversed her DNR/DNI status in preparation for the PCI next day. So the very next day, we were getting ready for her PCI of the LAD. So she deteriorated with increasing shortness of breath, and her blood pressure started to drop. She was requiring high oxygen requirements again-- required Lasix.

And then we just got further, and she said, I want to live. I want to live a good life. So let's proceed with the PCI. So here, we did support her with interactive balloon. We put a temporary pacemaker, and then we did the atherectomy initially to debulk some of this calcium so we can easily put a stent. So if we put a nice, long stent in the LAD, it would have a nice, good result.

So what was the clinical course in this patient? So this patient had a two-month echo that showed LVD of 45%. She was going to rehab three times a week. No angina. No shortness of breath. Her blood pressure was high, but we adjusted the medicine. So now it's more than three years follow-up, and she's still doing well, and she's still here.

So then you might say, hey, Dr. Tummalapalli, this is a nice case here. A 94-year-old lady-- you are showing a success story. But should we be doing these procedures just because we have the technology available in 90-plus-year-old patients? Do we have any literature to support that this is beneficial?

So that brings me to this paper, PCI in Nonagenarian-- Is It Appropriate, and When Is It Appropriate? So this paper is very important paper. This is a National Inpatient Sample that is collected during the years from 2003 to 2014. This was published in *JACC* September 2018.

So basically, what they have done is, based on the discharge diagnosis, during these years, they had nearly 70,000 nonagenarians who already had PCI. So these 70,000 patients were analyzed in this paper. Yes, it's not a randomized prospective trial. Yes, there are inherent problems. But because of the number of patients are very high, I believe that we can still carry out some of the conclusions which are valid.

So what did they find? They looked at all these patients-- 70,000 patients. They have categorized them into STEMI, non-STEMI, and stable ischemic heart disease patients, also cardiogenic shock patients. So their observations are very important for us to analyze. The proportion of cardiogenic patients have increased who underwent PCI, and people over the age of 75, also 90 patients, they have reduced hospital mortality.

And if you look at only STEMI patients, the baseline risk profile has increased, which we alluded to in the beginning of my talk, that the older you are you have more comorbid conditions. The in-hospital stroke rate slightly increased. The bleeding and vascular complications have decreased over time from 2003 to 2014. Because, during this time, the interventional cardiologists, we are also learning how to decrease bleeding complications.

If you look at the STEMI PCI, the incidence has increased of people who got PCI, from 23% to 30% of the nonagenarians. And if we look at the mortality, mortality went down from 33% to 16% who had PCI. And if you didn't have PCI, mortality was 33%. So there is benefit in performing PCI in STEMI patients, even in the age of 90-plus, based on this National Inpatient Sample.

Now, let's turn to non-STEMI, continuing with the National Inpatient Sample, non-STEMI patients. So most species are actually performed non-STEMI among nonagenarians, which we also alluded to. The older you are, you don't present as STEMI, but you are more likely to present with non-STEMI. So the incidence increase.

So non-STEMI, favorable mortality trend was noted with PCI. Bleeding and stroke unchanged. Vascular complications decreased. So the authors of this paper were concluding that PCI should not be withheld in non-STEMI just because somebody is 90 years old or plus.

So what about stable ischemic heart disease? Stable ischemic heart disease, the PCI incidence actually has decreased, because there's an increased trend in hospital mortality. Part of the reason for this is that the older you are compared to the younger population, you have vascular complication rate, and the mortality can go up based on that. The PCI incidence over these years, 2003-14, has decreased from 27% to 16% because of the higher vascular and procedural complications. And also, actually, there's an increase in mortality in these patients, from 1.2 to 3.9%.

So based on this, what we can conclude is that we can offer PCI in stable ischemic heart disease patients only very, very selectively. We should definitely offer for STEMI and non-STEMI. But for stable ischemic heart disease, better to treat with the medical management. Only if the medical management fails we can offer PCI.

And the obvious question is then which patients that we do not want to offer PCI. But that matters at any age, not only for octogenarians and nonagenarian. So if the patient has very limited life expectancy, if they are having active bleeding, there's an end stage disease process, such as liver disease, bad COPD, malignant disease, metastatic disease, the life expectancy is less than 6 months, we don't want to offer PCI. Or if they're in severe cognitive decline, or patient's preference-- if they do not want it-- if they have an advance directive of not having any invasive procedures. So in other words, at age 80 or 80s or 90s, we don't want to look for coronary artery disease to offer PCI, because the older you are, the higher chance of complications. We don't want to talk somebody into having these procedures if they are not ready and if they are not clinically right candidates for these invasive procedures.

So the next obvious question is then, yes, we are offering these therapies, PCI for people in their 80s and 90s. And is there such a thing as somebody that's too old to have these invasive procedures? How old is too old?

That brings me to my third patient today for discussion. I took care of, about a year ago, a 100-year-old lady, with hypertension, dyslipidemia, arthritis. Came in with chest pain on exertion for three weeks in duration. And then pain at rest requiring admission. She has normal sinus rhythm on her EKG, lateral wall T wave changes, and troponin was 2.63. Her echo showed LVEF 55-60% with slight inferior lateral wall hypokinesis. Medical therapy continued. The chest pain continued in spite of IV heparin and nitroglycerin.

So then the question is, this patient is 100 years old, should we be offering her any PCI? So do we have any literature? No, we don't have any literature in 100 years old. We have anecdotal references and case reports, but we don't have any trials to my knowledge-- any prospective trials-- in centenarians. So then we always have to look at the functional status of this patient.

We touched a little bit, in the beginning of my talk, on the activity of daily living, and frailty score, and things like that. So in this age group, the activity level actually takes a precedence when we decide whether to offer any invasive procedures or not. So in this particular patient, she lives by herself. She's self-sufficient. She cooks and cleans.

She had similar chest pains a few months ago. She was treated conservatively at that time. So meaning that now she has clearly failed medical therapy. And daughter tells me that at age 99 she visited Italy, and she walked everywhere.

So she wants to be independent. So she is functionally a so-called "good" 100-year-old. So for that reason, after informed consent, we offered PCI coronary procedure. So she underwent cardiac cath.

So there's some mild to moderate disease in the LAD, as you can see. The circumflex is the culprit. There's almost a 99% stenosis in the proximal circumflex leading to a big marginal branch with two branches. And then you also have a right coronary artery with a couple of high grade [INAUDIBLE]

So she has mild to moderate LAD stenosis, critical circumflex, two tight ostial stenosis. So then what should we do? So again, we did right radial approach. Yes, we could do radial approach even in 100-year-old patients. So we offered PCI in this patient.

So this brings up another important concept, that the older you are, we already established that they do have multiple coronary lesions and multivessel disease. So we don't need to go after all these coronary lesions in this age group. As long as we take care of the culprit lesion, then they do very well, because they are living with the other lesions for many, many years.

So we did the intervention for the circumflex. And we have a nice result, as shown here. A nice opening of the proximal circumflex in the RA view. Very nice. And she did very well. Following stent, she was symptom free. She was ambulating.

Nitroglycerin drip was weened off. Heparin drip was weened off. She was discharged home on aspirin, Coreg, amlodipine, and Plavix. She was doing very well. Now she's at over one year now. She sees me in the office every six months. She's doing very well-- clinically stable and still independent.

So I hope, based on the studies and some case examples, I have convinced that octogenarians and nonagenarians, we should not be withholding this therapy. PCI is clearly better than STEMI. PCI is definitely better in cardiogenic shock. PCI is better than non-STEMI. Only in stable ischemic heart disease in this age group, if the patient is asymptomatic on medical therapy, I would say, no for PCI. That's when we get complications.

Then the last group I want to discuss very briefly is what about coronary artery bypass graft patients who are very elderly? So again, as we get older in age, many, many patients already have one history of coronary artery bypass and they surgery done. And I had to point out that the bypass graft disease is entirely different than native coronary artery disease. The vein graft disease is more diffuse, complex, thrombotic, very friable, and high risk of distal embolization. So one has to be careful with the PCI in these patients.

So the elderly with the CABG patients, I had one patient, 82-year-old, very functional, multiple risk factors, previous bypass, came in with chest pain for three weeks duration. And he was getting angina while on the treadmill. So EF was normal, near normal, and troponin was negative.

So because he wanted to be exercising, he was not happy with the symptoms, we offered a PCI cardiac cath. As you can see, the right coronary artery has a previous stent, and there's an incident 90% stenosis. This is the wave graph to the right coronary here, and this is the wavegraph to the marginal branch. Again, showing very tight stenosis.

Look how tight the wave graph. There's usually a thrombotic event in these regions too. So we did offer a coronary intervention for him. We have put another stent in the SVG to right coronary artery. It looks like a very nice result. And we also intervened on the coronary lesion on the SVG to circumflex with the very good results as well.

So just focusing on this group of patients, very elderly with a history of coronary artery bypass graph surgery, there's not a whole lot of data on this particular group of patients. There is a knowledge gap. We really don't know whether people who already had one bypass a re-do bypass is better. Percutaneous coronary intervention is better. These are unanswered questions. We don't have a randomized prospective data with a large number of patients in this group.

So always, the first option would be guideline directed medical therapy. PCI only if the medical therapy fails. Because for degenerative graft disease, particularly grafts over three years old, they have high risk of procedural complications like distal embolization, bradycardia, hypotension, no reflow phenomenon. And the procedural MI is much higher if we intervene on a vein graft compared to the native coronary artery disease. And generally redo bypass is associated with higher surgical risk, and also this is not a great option either. So in this group of patients, especially elderly 80s and 90-year-old patients, there is a knowledge gap. And we need some prospectively randomized trials.

So based on all of this data, we can make some statements. And I'm going to borrow these two statements directly from ACC, AHA, and American Geriatric Association scientific statements. So the management decisions for older patients with non-STEMI patients should be patient centered. We have to consider patient preferences, goals, comorbidities, functional and cognitive status, and, very important, life expectancy. And, in fact, the potential benefits of aggressive treatment in older patients are often equal or even greater than those compared to the younger people.

The reason being, the older you are, the higher the mortality with STEMI and non-STEMI. So if we offer these therapies for more older people, potentially we will save even more patients. And some of the other points that I could make also, the older patients are at increased risk of adverse outcomes and vascular complications, so always consider radial approach. And it is emphasized that therapies should not be withheld solely based on age alone. There are many other factors in these patients, and we clearly need more prospectively randomized clinical trials in octogenarians and nonagenarians, because the number of nonagenarians and even centenarians is increasing, not only in this country but also across the world. So these patients, they want to lead a functional life and they do need our help from interventional cardiology.

So with that, I'm going to stop here. And again, I would like to thank all of you for taking time to listen to this presentation. I hope it has been useful and informative. Once again, thank you for your attention.