Total Joint Arthroplasty Acute Care Rehabilitation Starts in the Home

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- [Calista] Well, it is my pleasure to introduce John Gose today. John is the former director of rehabilitation with Penn Medicine at the Chester County Hospital in Westchester, Pennsylvania. As an active administrator and clinician he understood the spectrum of concerns that both patients and rehabilitation staff face in the management of peptologies including orthopedics, sports, balance dysfunctions, and trauma of the extremities and spine. He has worked with a broad variety of patient populations, from active aging adults and orthopedic joint programs, scholastic athlete, the industrial worker, and the professional level athlete and amateur to professional tennis players, including Billie Jean King, Serene Williams, Andy Roddick, Michael Chang, and Martina Navratilova. He has instructed as an adjunct faculty at Weimar University, Hahnemann University, and Newman College and guest lectured at the University of Delaware. He has also lectured nationally on orthopedics and sports rehabilitation for over 35 years and presented at the Combined Sections Meeting for the APTA orthopedic section. He was also selected to be on the original steering committee that developed the musculoskeletal practice patterns for the APTA's practice pattern guidelines manual. He has published research on the total knee arthroplasty and the iliotibial band. John has also been politically active in the APTA as president and vice president of the Delaware state chapter. So thank you so much for being with us today, John, and at this time I'm gonna turn the microphone over to you.

- [John] Okay, thank you very much, Calista. Welcome, and welcome from southern Florida, where the weather is wonderful. I hope that it's wonderful where you all are. As Calista said, I have been involved both clinically and from a management standpoint in physical therapy for many years and have taught especially on this topic of joint replacement for over 35 years. From an experiential standpoint I have worked in acute care, skilled nursing, home care, and outpatient services. The joke that someone with that many positions can't hold a job, but what it says about physical therapy for me was that it provided me with many opportunities to enjoy the field of physical therapy to provide care to the continuum of care for patients, and to me this was very

satisfying. I know that many of you online have a variety of years of experience, from a new grad to multiple decades, as well as working through the continuum of hospital, home, skilled, rehab, and outpatient services. The information I'm presenting today has been gleaned by close examination of classic articles that stand the test of time and current literature as recent as July of this year. So your information to be presented will cover the continuum of care and will give you the opportunity to use some of this information as you move through your continuum of care in your careers, whether you're with a hospital base now or whether you're moving on to home care or skilled or outpatients, et cetera. Now today's lecture and course will have basically four learning outcomes.

Certainly we're going to discuss the current literature and we want you to be able to list and identify three interventions for home care for patients that underwent total joint replacement. Additionally we want you to be able to understand, remember, and be aware of acute and emergency signs post op complications that you might see out in the field. We want you to be able to put together a 30 day clinical guideline because that takes the patient from soup to nuts, from day zero through the most critical timeframe of their care, which is the 30 day cycle of healing. And lastly, we want you to be able to at least list and identify four clinical outcomes for patients with joint arthroplasty of the knee.

I start out with this slide. This is an old farmer that I met and worked on, Samuel. Very funny fellow, hard working, into his 80s on the farm, and he always told me he couldn't stop a fat pig in a narrow alley. And obviously from the X-rays and the visual you can see that. Additionally, he has an infection in his lower leg from falling in the barnyard, which also provided some issues for management, both pre-operatively and post-operatively. But more about Samuel when we get to that. A little bit of background on demographics of this patient population. Average age is 70 and mostly are women. From an obesity standpoint, anybody over the BMI of 30 has an issue with some

rehabilitation and tends to prolong some of the things that we do. 90% of patients reported have osteoarthritis, and there are outcomes studies and scores that are used commonly in the literature and the four listed, the KSS, HSS, the WOMAC, and the short form 36 are very commonly listed in the current literature. The National Institutes of Health hold a consensus on knee replacement, hip replacement, bilateral knee replacement every several years, and they bring together experts from across the continuum of clinical care as well as educational and research. They put together some of the data that we tend to need to look at, especially from an insurance standpoint, and the data that you see here, the numbers stand out. Obviously more females than males are getting total knee replacements, whether it be for white, Hispanic, or African American women. This also tells me something that one, females are living longer, and that's supported by the literature and data. Additionally, the females are the more assertive and more aggressive person to take care of their medical needs, maybe men being a little bit more stubborn and delayed. But that pushes the numbers towards the female side of the statistics.

From a reason why things are, why people do come, the two main, pain and function. The pain gets to a moderate to severe level, and as you know, the surgeons say when it gets bad enough you'll come see me for surgery. At that point the X-rays are done, the mechanical dysfunctions are delineated, the patient probably has failed conservative measures, which are the pain medications, the rest, the ice, and physical rehabilitation on an outpatient basis. They have possibly had a prior surgery, whether it be a balancing of the collateral ligaments or the lateral capsule on a knee. Maybe they've done a valgus osteotomy of the tibia to balance the tibia underneath the femur. But in any case they move on to the next level of care. They may have controlled or uncontrolled inflammatory disease, which is the rheumatoid arthritis, which is a total joint destroyer. From a low risk standpoint, they need to have low risk, especially for today's world of same day surgery or next day discharge. And the national Consensus Conference on total knees delineates most of these indications. Other risk factors for a

long length of stay are certainly advanced aging, especially over the age of 80, the higher BMI. The Charlson Comorbidity Index is an orthopedic index or medical index that gives scores for various comorbidities that put the patient at risk. That is a laundry list of things that are added together. Additionally, the Mental Capacity Score delineates some forms of dementia that, as we know, patients advance dementia after surgery and especially in the female population so that is of concern for a pre-op decision.

Contraindications for surgery, local infections like Samuel has on his left tibia from a fall. The surgery had to be delayed. Relative contraindications with the peripheral vascular disease, that might be associated with uncontrolled diabetes. Along with that, other neurological pathologies including multiple sclerosis, Lou Gehrig's Disease, certainly Parkinson's disease and CVA or strokes. Cardiopulmonary decreased function, whether it be from smoking or whether it be from cardiac conditions relative to diabetes are of concern, but again, they are relative contraindication. The National Institutes of Health says if someone is a smoker they should stop smoking two months prior to surgery in order for the system to flush out the bad ingredients in their systems that smoking deposits.

Other contraindications, or more importantly, patient selection concepts, the WOMAC, KSS, HSS scores give a pre-operative score. For instance, if the score of a perfect knee is 100, and the person's function is 100, that's wonderful. As the score gets closer to 50 the surgeon takes heed and says well, it might be time for surgery. Most patients end up having surgery when their WOMAC, KSS, or HSS is closer to the 50 point score. The New Zealand Priority Criteria for major joint replacement also includes a different score that the southern hemisphere medical departments use and give them functional scoring as well. The Mini Mental Status Exam, again, looks for delirium and whether there's a chance for an increased delirium afterwards, especially with pain modification drugs. Now, if you're going for same day versus a staged bilateral knee

replacement, the bilateral total knee replacement consensus from NIH says there are concerns for patients over the age of 75. If the anesthesiology class score, as scored by the anesthesiologist is a class three then that's of concern. And the other laundry list, as you see, for ischemic heart disease, left ventricular function, pulmonary disease, the dyspnea, shortness of breath, can follow with all of those. Certainly a BMI of greater than 40 would put the patient at a poor chance for functional movement into a same day or next day type of discharge. If they have poor controlled diabetes, again, doing bilateral knees on the same day is setting the patient up for possible future infection and problems for readmissions later. If they are staging the literature now says it should be no sooner than three months to give the current knee time to recover and function. From a pre-op preparation standpoint, I can't say enough the importance of what prehab can do for a patient. The literature recently says that it reduced post-op care time and costs by 29%.

And insurance carriers and certainly Medicare are looking at the cost of rehabilitation as one item that could and/or should be better controlled. So if you are providing prehab, you need a minimum of three weeks prior to surgery to make mechanical changes in the bodies of the patients. In other words, to make them stronger, to get more flexibility in the knee pre-operatively, especially flexion. For this prehab, they can get their referral from the PCP and ortho, the surgeon, the rheumatologist, or a pulmonary doctor. And that is good enough for insurance coverage as it is standard therapy for osteoarthritis. Certainly the things that you want to work on are range of motion, strength, power, balance, gait, as the gait has changed probably, and if they are going to use assistive devices for any length of time afterwards they should have practice prior to hospitalization. Additionally in prehab, the surgeon's office should be doing the risk assessment prediction tool, the RAPT Tool, which is that 12 point tool that scores a patient, whether they should be discharged or could be discharged fairly immediately or whether they are going to have a disposition that might be skilled nursing versus home care. From an education standpoint pre-operatively, general

education with a class, the booklets, online videos, all could or should be tried. Interdisciplinary people should be involved from all the departments that help this patient get through the next 12 to 14 weeks of post-surgery. Now, if you're doing an education class it should be within the two to four weeks prior to surgery so that the information is current within the patient and any things needed in the home care setting can be addressed quickly but prior to surgery. We do know from a literature standpoint that education classes do relieve anxiety and improve patient satisfaction, let alone reduce the use of pain medications, which therefore help the patient in interactive rehabilitation activities with the staff in a hospital and home care setting. From a prosthesis selection standpoint, the surgeon has multiple things that they need to choose and that we might need to be aware of.

Certainly the patient who is over the age of 80 is of concern from an osteoporosis standpoint and how far the tibial pin, if there is a long tibial pin that needs to be. Looking on the left hand knee, the right hand picture, you'll see the tibial shaft pin on this tibial plateau is much further down than the opposite knee. That certainly was chosen that way due to the osteoporotic issue on the knee with the shorter stem. A level of post-op function, whether it's predictive or based on pre-operative is of importance. Certainly weight and obesity are of concern. The level of cartilage construction, bone destruction, and integrity of ligaments and capsule will lead the surgeon to pick certain types of prostheses.

Now, the variations today with the plastic spacer in between the two surfaces of the tibia and femur are made of the different materials, the cobalt chrome, titanium, ceramic, and oxcynium, all with different levels of durability or anti-compression. The ceramic post-operatively with ambulation does have a squeak with ambulation, and the titanium does not. Neither does the cobalt chrome. So the surgeon has a choice of which to pick. Now, if they say that this patient's knee can get by with a unicompartment because only one side is more deteriorated than the other, then the

unicompartment is basically an easy in and easy out. In other words, they can take that prosthesis off if they want to and put in a total knee. Unfortunately, the literature shows that if a patient has a unilateral knee replacement the majority of them do go on to a total knee replacement within five years. So the uni necessarily may not be the best answer for the long term results. Now, what you see here are three different types of prostheses. On the right you see the total knee replacement, which requires the ACL and the PCL to be sacrificed but the patient must have good medial and collateral, medial and lateral collateral ligaments and stability that way. Additionally, they might be the younger patient with good quad and hamstring strength starting out. The middle prosthesis is a PCL sparing or retaining prosthesis that has the cut out in the plastic area and the PCL is spared but the ACL is sacrificed. On the left, the modular or posterior stabilizing has taken out, the surgeon has taken out the posterior cruciate ligament and now has a device in the prosthesis that has a plastic, let me pull this arrow in. It's not working. That's okay. It has a, a plastic spacer in the metal tibial, femoral component that gives the posterior/anterior stabilization. There are other names, medial pivot, rotating platform, mobile-bearing, those are all for patients who are likely to be more active and need rotational capabilities similar to what the natural knee does.

The last line, it says the patient should have information card about the prosthesis design and the date of the manufacture. This is important. They should keep that next to their driver's license wherever they go so that if for any reason they do have a trauma and they do go to an emergency room, if they have a lower trauma, a lot of times patients are sent for an MRI, but if they have a card, they have information, they know what the issues are with the knee area and the MRI might be avoided, especially if the material is something that should not go into that booth. Now, the interface where the prosthesis is connected to the bone is either cemented or uncemented. The cemented use of methylmethacrylate, that will harden in 13 to 15 minutes, depending on the mix of it, and it will be hard and the patient would be able to bear weight

immediately in the recovery room as necessary. The uncemented knee, obviously, requires a beaded, coded prosthesis that bone will grow into over a period of time, and usually that is rock solid between the sixth and the twelfth week when the osteogenic activity has maximized. From an incision standpoint, the surgeon typically has a medial incision. And that medial incision has the patella lateral, there we go, and the patella is slipped lateral. The femur is exposed, and you'll see the line that the surgeon used as well as little hash marks across perpendicular to that vertical line. And that's for his future putting together the skin to skin so that it is lined up and they don't have a myofascial restriction. Other types of surgical interventions include the sub-vastus, which is good for earlier range of motion and quad function, the mid-vastus where they do cut into the muscle, which is not a very good option for muscle reaction, and a valgus approach where they cut laterally and slip the patella medially.

That is for a patient that is a valgus knee, therefore the lateral side of the knee is tighter and the medial side of the knee, both capsule and medial collateral ligament are stretched out. So they don't want to flip the patella lateral because that will weaken these structures even more. So here you have the standard medial incision with the patella flipped and peeled lateral. With the patella exposed they can drill holes in the bottom of the patella after they removed the osteoarthritic bone. Then they will use two different jigs attached to the patient's leg. The first jig is so that they can cut off the femoral condyles.

The second jig is attached to the tibia via various straps, and it is perpendicular to the line of gravity, of compression gravity, and the surgeon will say it is the most critical cut because you need a very level platform of tibia for the new femur components to sit down on and the plastic to space in between. So the positioning of this jig and the cut through these black lines here, which we'll see in the video, are critical for the success of a very level knee. Here you see the knee with the femoral component attached, the plastic polypropylene spacer, and the patella button as they call it ready to be

repositioned and flipped back over and the suture site closed. That pretty much is the minimally invasive. Now there are a couple of other approaches, depending on what the surgeon feels necessary in order to expose the bones and/or move around a knee that may have had previous surgery. You may do something that you see in the operating report, the surgical report called a quadricep snip, a V-Y quad advancement to lengthen the quad, or a femoral peel, all different terms and the surgeon would clarify exactly what he did with each one of those. Now we're gonna see a video of a standard minimally invasive total knee replacement. The surgeon will walk us through, this is a very good standard approach and a quality classic knee management. You will see the surgeon do several different stability tests after he puts in the prosthesis, and with that it tells him whether he has put in the right spacer, the plastic spacer, so that the knee has terminal extension and has no lock out prior to zero degrees of extension and it has adequate flexion. So we can go to the video at this time.

- [Surgeon] The first thing I would mention is that we are meticulous about preventing infection. We do everything such as space suits, antibiotics, antibiotic irrigation, and even seal the skin with this plastic that we put on. Here we are making the incision. The patella's in the center of your screen now. As we make meticulous adjustments so that we can get exposure, now we're seeing into the femur. We take off the spurs on one side, and then of course once that's done you wanna take the spurs off on the other side as well. There are also some spurs on the underside of the kneecap, the patella, which we also remove. This allows to more adequately and accurately size the different bones for the prosthetic implant. We make a hole, a tunnel in the center of the femur here, and then we slide a rod down the inside of the femur. Using this as a guide, this allows us to cut a specific angle relative to the femur, usually five or seven degrees. We can then cut very accurately eight or 10 millimeters off the distal femur. We have a capture device here that makes it a slot that we slip our saw blade into to make our cuts extremely accurate. Here we are taking a thin cut off the end of the thigh bone into the femur. Now this is typical. Most people think we are taking huge cuts of bone.

That's just not the case. As you see here, we're taking very small, thin cuts of bone, just enough to make the angles right and to make the prosthesis have enough room to fit with your knee aligned near perfectly. This is a jig that has four different slots, and we cut in that jig once we set it up right. But here's an example of the posterior part of the femur. Look how much we're taking off. Not a whole lot, just the right amount. This is another jig that for a certain type of prosthesis we take out the center here so that a slightly larger prosthetic implant on the femoral side can fit. You will notice a lot of squirting water. This is antibiotic saline that's pumped in a pulsatile lavage system. This really squirts, keeps all the soft tissue, bony tissue nice, clean, moist, further decreasing the risk of infection. We're going to remove this bone now, and then we'll focus on the tibia.

- [John] So now they're taking out the ACL and the PCL.

- [Surgeon] Here we have the tibial guide lining up longitudinally from the front and the side with the shin bone, the tibia. This guide goes from front to back, and we're very meticulous about how we orient this. It's maybe the most important cut of the entire operation. We also match the slope of the top of the shin, the top of the tibia. And we are meticulously making sure everything's lined up nicely. At the top of this guide we're going to insert a device that allows us to take approximately two millimeters below the lowest point on the tibia if it's not too deficient. Now once we adjust that down, notice we have a nice slot. We're looking straight down. That's where the saw blade is gonna go and take that cut right below the tip of that little guide. Looking straight down this slot, now the Saw is coming in. What a great view, showing you how we make this cut to take off just the right amount of tibia. Now, as we pry this up you'll note it's very thin. You can even see the light through the thinness of that bony cut. And as we remove this you'll see we're really not removing a lot. Again, the myth of the huge bony cut. We have a tibial trial that allows us to match the size of the tibia so that we know what size implant to use. On the femur we have five cuts we've made plus that central cut. Now,

we fit this on the end of the femur, and we're going to try to make sure we're nice and balanced. It needs to be lined up perfectly. Once we do this we take the plastic insert between the femur and the tibia and insert this. This allows us to check the balance of the ligament. Here's the insert right here. As we insert this, we then aggressively check the knee, make sure it comes out straight without any difficulty but not too loose. We bend and twist and torque the knee to make sure everything balances nicely. We then irrigate again, of course. This is something we do every three to five minutes throughout the case. Here is the patella. We, in this specific case, want to take about eight millimeters off of the bone. This is a device that allows us to be very accurate in doing so. We bring in our saw yet again, take off exactly eight millimeters. Once this is done, as you will see, we've actually taken off a very thin piece of bone. We're again trying to take off what we're willing to replace with prosthesis. Very thin cut. Once we size this and drill the peg holes we bring in the prosthesis, the trial prosthesis with the peg holes, and we make sure that it tracks normally. We sometimes have to adjust the ligaments that balance that. Again, irrigating copiously, keeping those soft tissues and bony tissues moist. Now we instrument for the bottom tibial prosthesis. This is a key hole of sort that fits into the tibial bone. It further stabilizes the tibial base plate. We pound that in, make sure it's just right.

We size usually from a smaller size up to a larger size so we do not have a fracture. And once we've done that, this is what we've taken off on the left here on the femur. Small pieces of bone, very specific, meticulous cuts. We look at the tibia. This is what we've taken off, and this is what we're gonna replace it with. And then finally, of course, the patella is the small green button. And we take a small piece there. Notice it's pretty identical, and that's what we're after. We wanna match it. Here's another step we often take many times throughout the case but certainly before we put the actual implants in. We change gloves. This is another step towards antisepsis, prevention of infection. Here are the actual prosthetic implants, the femur, the tibia, and then, of course, the base plate fits on top of the tibial prosthesis. And then, of course, we have the patella.

Notice the little pegs on the bottom that fit into those holes we've already prepared in the patella. We mix the cement with Tobramycin. It's an antibiotic that most surgeons use to decrease the risk of infection even more. This is mixed under vacuum to decrease the porosity. Notice how porous that bone is. We're gonna squish the cement right in there and make it bond like crazy. In fact it's pretty difficult once you've cemented this in to get it out. Here we are putting cement on the bottom of the tibial base plate, and we will get that just in the right place and then we'll put some glue on top of the tibia itself. Sometimes we call it glue. Sometimes we call it cement. Same thing.

We push this down into that spongy bone to give us a much better bond. Once we do this we cement our tibial base plate in place. Notice that we squish the glue out because we have more than enough. We want too much not too little. And so once this squishes out we get rid of the excess cement by just trimming it off right here. After doing this we want, of course, a line to line fit. We've already made sure that's the case. We put cement on the back of the femur, make sure it's in the right place, molded just right. Then we put cement on the femur itself, push it in that spongy bone to make sure we get a great bond, and then we impact the femoral prosthesis in place, bonding it to the femoral bone.

And notice the cement squishing out again. We take the inserter off, remove excess cement at this point. After we remove the cement, of course we have to remove that central cement as well. We take the trial plastic between the femur and the tibia and insert that and then straighten the knee. This makes sure we can maintain full extension or a fully straight knee. That's imperative, have to have that. Finally, of course, we put cement into the bone on the patella, place the patellar prosthesis in place. Those pegs fit the holes. We have a device to compress this and hold this while it hardens made specifically for this purpose. We remove the extra cement and hold it until it's nice and hard. From the time we start mixing cement that's about 15 minutes.

This is the actual implant, a base plate poly. We tap it in place, and it's firmly fitting then we aggressively check that knee and make sure it comes out straight, torque it, stress it, and give it a stress, rotational stresses. And once that's perfect we know we can close. Here's the deep layer. We do the superficial layer. And then we go, finally, to the skin. Notice how those lines line up. This gives us a good guide to match skin to skin. That's how we put in the staples. Of course they go all the way down. You'll note there's a little drain tube. It does not allow blood to collect inside your knee.

- [John] Okay, as one thing that you heard him say near the end of his procedure was that it was extremely critical to make sure that the knee did get terminal knee extension. He did that with that drop test where he held the ankle and had a hand under the knee, and he just took the hand under the knee out and let the knee drop and it reaches terminal extension. If it did not then he would have to have replaced that plastic spacer with something a little smaller. So, what are the complications that could occur? His alignment of the different cutting devices and jigs is important. As he said, alignment was critical so that the tibial plateau creates a good base and the femur at seven to eight degrees retroversion fits very nicely. Certainly with an osteoporotic patient fracture is an issue if tapping in too large a tibial shaft pin. Bleeding can be an issue but typically is not unless they were on some type of pre-operative medication. Infection certainly, PE, stroke, and lastly, death. We'll go over some of these post-op issues in later slides. One thing the literature does allude to is that from a surgical complication standpoint, there are more complications with surgeons who do less than 12 knee replacements a year or hospitals that do less than 25 knee replacements a year. And if it is a surgeon who does less than 12 in a hospital that does less than 25 your odds are significantly increased for complications. And it might be better to find a different location. So, post-operatively. Well, they're all gonna have effusion, and they're all gonna have pain. After that the different complications are much lower in percentage but certainly more serious in their nature. We'll go over each one of these individually. Infection, well the warning signs of a peri-prosthetic infection, a PPI,

whether it be from MRSA, strep, or staph. The keyword would be increasing on anything. Increasing redness, tenderness or swelling. Increasing drainage. Increasing chills. Increasing knee pain, both with activity and with rest. Lastly for an infection the persistent fever of higher than 100 degrees. So that is something that, from a hospital standpoint they need to keep track of, but certainly with such a quick turnaround and patients leaving the hospitals at 24 hours or 36 hours and getting into either skilled or home care, hopefully more home care, those signs and symptoms are things that any interventionalist, whether it be physical or occupational therapy or nursing, need to be aware of for infection. DVTs, again, the keyword is increasing. So the warning signs would be the increasing pain in your calf, the tenderness or swelling increasing above or below the knee, and the increase in swelling in your calf, ankle, and foot, below the knee.

So that increased tergar that you see in the right hand picture, although that effusion may be typical, if it starts to travel south that's something to take serious control of. Additionally, for PEs, the warning signs for that blood clot traveling to the lung, the key word is sudden. A sudden increase in shortness of breath, that sudden increase of chest pain, and a localized chest pain with coughing. So they cough and they point to a certain location, whether it be a lower lobe, an upper lobe, front, back, those are the things that the patient will complain of that we have to keep a keen ear out for. Some other shorter term i.e. after 30 days out to long term complications, prosthetic loosening can be an issue, especially if it is a non-cemented knee and they have trouble weight bearing and upon follow up radiology exams they see some malalignment developing. With an older population the thin skin, possibly a smoker, maybe diabetic, a heel decubitus on somebody who's not very mobile is something to be aware of. And certainly the cardiac and pulmonary issues that can occur in the older population and people who already have issues prior to surgery but have been cleared for surgery. Now, for the hospital stay, when I started in this field patients were in the hospital for 30 days in acute care. They were in bed for seven days. Then they were

allowed to non-weight bear for two weeks. Then they would go to rehab for a month. Then they would go to home care for a month. That obviously has changed dramatically. Now the length of stay is getting to be 24 to 36 hours, depending on your program, depending on the patient selection. Pain levels are targeted to be under control with a variety of pain medicines, but certainly getting the patient's pain level on a visual analog scale of 10 to four or below is paramount. Outcomes of active and passive range of motion, in a hospital setting we certainly want to move them through so that they have functional capabilities for sitting, toileting, and stair management. Now the number of PT and OT sessions obviously has decreased over time, and at this point if they're getting three PT sessions and one OT session in the hospital, maybe two OT sessions, to finish off what they are doing as far as ADL preparation for the next level of care, that is calculated and maintained. Ambulation distance, certainly if they're going home patients are shooting for 150 feet which is basically living room, dining rime, and kitchen distances in a home setting. They should have success with stairs, and if it's a two story house certainly 13 stairs. And also following what ADLs they are capable of doing and need to be able to do at home, especially if they do not have a caregiver.

Cost analysis is critical for the business office in a hospital setting and also as they move through the continuum in skilled and home care because decreasing a cost, as I said at the outset of this presentation, is under scrutiny by Medicare especially and certainly followed by other insurance carriers as rehab being a targeted activity that they can improve on. So let's go over some of the phased rehab. And this slide has a lot of information on it, but I just wanted to say that wound healing dictates the phases of recovery, not where they are. So when I use the word acute care I'm not referring to the hospital based service. I'm referring to the first 30 days, which is Mother Nature's healing time to seal the wound and begin the neocapillarization of the tissues that have been cut and prepare the patient for better mobility and functional capabilities later. So it's not whether they're in acute skilled home care or outpatient. It's that 30 day

window initially. Now, from an outcomes studies, they're show that they're not much differences in the WOMAC or the KOOS pain levels, ADLs, depression, safety, quality, or life scores, whether they're in home or whether they're in outpatient therapies or whether they're supervised versus limited supervised programs. And this is something that the literature over the last few years have been looking at with follow ups of one to five years, one being short term follow up, five year being intermediate, and five to 10 years being long term follow up for patients with knee and/or hip replacements. So the, as I say in the fourth major point there, the scrutiny of cost is increasing with rehab in the crosshairs and do we need one on one care? Can we get away with group care?

Can the patients thrive, not just survive, home care and on to outpatient? Or can they do telerehabilitation, which is the obviously distant supervised programming that is gaining momentum throughout the country. So at this point therapists and the therapy departments must show their worth by tracking much of their outcomes with their patient populations and having that readily available for either publication or the answers to insurances that are asking or requesting or demanding to decrease reimbursements to the various facilities, hospital, skilled nursing, home care or outpatient. So, when does acute care end and start? The first 30 days are critical, but maximum protection is the first two weeks because that's when that surgical wound is healing and neocapillarization has started so we have new blood supply growing to the area and fibrinogenesis and the capabilities of the area to scar in the proper manner to move forward with function in that second week to sixth week subacute phase. So those of you who are in hospital, subacute and acute, you're in those first two categories typically. And the home care, especially in the one week to four week window. Certainly minimal protection to independence greater than six weeks when the wound is fairly mature, range of motion has been stabilized, and function is what we're working towards. From an examination standpoint, I would love to say that everyone gets to see the surgical report, what approach was done, what prosthesis was used, if there were any complications in the operating room, was there any range of motion

recorded in the operating room? Unfortunately most people don't get the surgical report. The surgical report in the hospital is not dictated on time for the acute care therapists to see so they must, if they have a question, contact the surgeon or the surgeon's assistant to find out that status. Certainly in skilled and home care, you would hope that the surgical report is included in the post op notes and that would be something to really press for in your system to get that surgical report available to you. Certainly weight bearing status, if it is an uncemented prosthesis, what medications might be needed, certainly what prior level of function they had and where they were going back to, whether it be one story, two story, whether they had someone at home with them, whether they had stairs, ramps, railings, et cetera. From a test and measuring standpoint, there are any number of things that we do look at, the first from a hospital based standpoint is walking in the room and finding if the patient has good arousal, attention, and cognition, the first three things that would tell you this is gonna be a good morning or this is not gonna be a good morning. Immediately thereafter what type of mobility they have in the bed, can they take weight bearing, can they locomotor within the room and move forward with muscle performance activities within a pain tolerance to achieve their range of motion and then work towards self-care and home management with the expert guidance of occupational therapists.

So this inpatient acute care hospital-based outcome or goal is to achieve this independence that they can return home for the function that they need, that we start the patient to understand the importance of pain management, inflammation management, and controlling of bleeding, with the middle item, inflammation control, being one of the most critical ones in the first 30 days. Also, can they do functional straight leg raising? Physicians love straight leg raising as a proof that the extension mechanism is working. Well, when the vastus medialis is not working the rest of the muscles are able to keep the leg straight. So it's total quad strength that can create a straight leg raise and you don't need the VMO. But that tends to lead to quad weakness that inhibits function down the road and we need to be aware of that VMO

capabilities ultimately. And lastly, what is their range of motion, getting them five degrees to 90 degrees by the time they leave because on the operating table they're probably zero to 120 or 125, whatever the prosthesis allows. Inflammation will inhibit that range of motion. Now, are you using CPM in your hospital setting? Well, at this point, if you are you're probably using a flexion protocol which you're starting the patient at zero to 30 degrees and increasing at 10 degrees per day so by day two, if they are there day two, they're at zero to 40 degrees. If you're using an extension protocol, you're putting the patient in flexion, beginning at 60 to 90 degrees and increasing their range of motion per day. But less swelling leads to better ranges of motion. But this range of motion should be eliminated pretty much by the sixth week and certainly by the sixth month.

From a literature standpoint, no, there is not enough evidence to support the short term use of CPMs unless, and here's the caveat, unless the patient has a fibrogenetic system that lays down scar tissues excessively fast and the patient would be compliant with a CTM in the home setting. So that does require multiple hours in the day, upwards as high from the literature standpoint as 20 hours a day and as little as three hours a day. The more the better, however from an acute care standpoint our hospital did away with CPMs 15 years ago, 10 years ago, and haven't looked back because of the speed of rehabilitation and disposition discharge. Now, let's talk about that all important pain control, inflammation, and bleeding. Well pain management is critical, and if they, patients are above a four out of 10 they might be getting opioid types of medications, which would dull their capabilities to work with us in rehabilitation. But swelling is the problem with range of motion so the RICE program, rest, ice, compression, elevation is important to start in the hospital setting and continue for the first three to four weeks, whether your using external compression devices, whether they're mobile or static while they're in bed, elevating them, whether it be on ledges or bolsters or pillows, cryotherapy, get them in cold and if the cold therapy can be included with the compression devices that would be wonderful. Active range of

motion with ankle pumps, range of motion, the motion at the bottom, neuromodulates pain and provides a mechanical stimulus to collagen synthesis so motion is critical because it does modulate how the collagen is laid down, the extracellular matrix and the fibrin matrix are aligned to allow for good flexion and extension. There is a device out there. Scott Johnson developed this. It's called the LRU pillow wedge, leg raising unit. They didn't have another fancy name for that, but it is a wedge of foam that is cut to hold the leg in neutral with the heel off the edge of the wedge, and the knee is perfectly straight.

You can add to it your ice, cryo, and compression device, and you get your RICE program. It does very well. Dramatic improvements in effusion control, range of motion leaving the hospital within 36 hours with the zero to 110 degrees is not uncommon, and their ability to walk distances, inclined stairs, is dramatically increased. There are other companies that produce wedges that you can use. This is a foam that would probably go home with the patient so that is somewhere around a $90 per pillow cost that is passed on to the patient that they take home with them. However, there are wedges that can be disinfected and reused for other patients in a hospital setting or even in a home care setting. Transfers, gaits, and stairs, all those things that get the patient up and starting towards being in the home. If you're using a stairwell for your stair ambulation and not the wooden set of steps, there are some risk management safety guidelines that you should be following. They are, and I'll put this in reverse. Start with the buddy system.

Always have two people with you taking the patient out to the stairwell. Always tell nursing where you're going. Prop the door open so that in case you have to yell for help. Have your facility place call bells at the bottom, the middle, and the top of a stairwell. Have a mobile phone system available. Additionally, a gait belt should be used on every patient. Certainly they have to be able to use the assisted device on level before they can go to stairs and that they can use their upper extremities with

good elbow flexion and use of the triceps and back muscles to stabilize themselves in an upright position. As far as getting straight leg raising without an extensor lag, the key to restoring quad activity is muscle activation in the early phases. It's not strength gain. Because with swelling, with as little as 10 CCs of fluid you will lose the activity of the VMO. And with 20 cCs, 30 Ccs, and 40 Ccs of fluid within the capsule, the vastus medialis, intermedius, rectus, and lateralus will all be reflexly shut down. So getting the effusion under control early will avoid deactivation of the muscle and will allow for you to activate the muscle through lower repetition, high frequency, quad activity, or hamstring activity. It's not strength gain. Its not strength gain. It is muscle activation in those first three to four days.

Certainly avoid muscle fatigue because then the patient would be put at risk if they were going to weight bearing. As far as using neuromuscular electric stimulation, you can start that as early as day two to bypass the reflex inhibition caused by the effusion. Quad sets, total leg strength using glut sets and hamstring sets are important. Straight leg raising as a test and a test only. Short arc quads leading to full arc quads are important. If you need to start with heel slides to get muscle activation going, that is great.

Once you get to the upright position then you can use something called church pew rocking, something John O'Halloran popularized. It's where the patient is standing with a walker with the back of their leg butted up against a chair or the bed, the bed being lower, therapists on the sides, and now the patient just rocks back and forth, heel, toe, heel, toe and allows the knee to bend. This will create a rhythmic stabilization, which can be done manually as well, but it also creates a reflex reactivity of the muscle, of the quadriceps, to the backward flow of the body and then the posterior structure so gluteus, gastrocs, and the hamstrings when you rock forward. So that's called church pew rocking. Getting your range of motion, the heel slides might be something to get started with obviously. It's common and popular. Going to short arcs, nursing,

published articles that say the dangle protocol, where they sit the patient over the side of the bed and they dangle their tibia down improves knee flexion just as much as supervised physical rehabilitation, physical therapy. But it doesn't address knee extension enough for functional use. So the dangle protocol is something that is used as an adjunct, certainly getting more active motion both for flexion and extension, but be careful of over pressure in flexion. Over pressure, obviously, can lead to wound dehiscence, and as I say in my next slide in the last line here, avoid blanching of the incision because neocapillarization in the incision, whether it be your passive motion or whether it be CPM, that shuts off the blood supply and ultimately could lead to a fragile suture line, dehiscence, and ultimately an infection, something, as in this photograph, we do not want to see.

So avoiding the position in low load prolonged stretch or static flexion is important in the early phase. And one thing to remember, the strongest predictor of post-op flexion is what the patient had in pre-op for their flexion. So that prehab training that we talked about in the early part of this discussion, we talked about getting range of motion for the knee prior to surgery, and this is where it comes into play. And lastly, early control of the pain is helpful so a TENs program is very good in those first three to four weeks and, of course, as we discussed, the inflammation. So for my day to day standpoint, zero to day one, for physical therapy in a hospital setting, you get your eval in, you get your dangling in, you start your weight bearing, and you begin your bed exercises in the first session.

Certainly occupation therapy starts with their eval. They discuss the expectations tha the patient has, especially what they're gonna need for bed mobility. They start with their leg lifter, and then they have a discussion about what kind of DME is gonna be needed, certainly a walker and a three in one commode might be in order and certainly would be supported by insurance carriers. As that progresses, ambulation to that 150 feet with the rolling walker, with the weight bearing is tolerated certainly. Active range of

motion and patellar mobility can be started, especially inferior and superior mobilizing of the knee. And, of course, occupational therapists come in and give the patient a great deal of satisfaction by helping them with toileting, tub, and shower activities, and especially dressing so that they can get clothes on and feel more normal more quickly. So that donning and doffing of clothing and disposition decision making, where they can be safely discharged to, along with the physical capabilities that are pushed in physical therapy. Now, literature says range of motion is averaging for the short stays of minus five to 75 degrees. Control the inflammation with the RICE program and you can improve that to zero to 110. Strength, they should have that independent straight leg raise. You should have them educated about how to control effusion and them understanding what they need to do at home while they're on their own. We talked about ambulation, 150 feet for household distances. Pain control, zero to four, and stairs, 13 steps, which is a standard two story distance. From a mobility standpoint with the occupational therapist everything being independent so that the patient is a happy camper and they are satisfied when leaving home that they are safe to go home. If they are not safe to go home then they made need that extended stay in the skilled nursing facility.

As they are moved out of the hospital after that one to two days then we need to move forward with more aggressive things. Certainly more isometrics for total leg strength, and in that first line I have quads, hams, and glutes. I forgot to put in gastroc muscles, gastroc and soleus. That is a knee extensor, and it does assist in getting knee extension in closed chain, as does the hamstring and glutes. So those are important. Rhythmic stabilization, as I said, with church pew rocking and/or manual work does get reactivity of the muscles so there's no thought process, the muscles just react. Soft tissue mobilization is important, and doing myofascial work around the scar tissue not around the scar tissue in the first two weeks but closer to the third week you can start mobilizing that scar. As you progress out into the weeks, you can be working on seated knee flexion with the foot against the wall. In other words laying on your back in a

seated position with the hips at 90 and the knee at 90 and the foot on the wall and they do heel slide or a foot slide on the wall. And obviously if they have a stationary bicycle, they gotta have a good 90 degrees to get around on that bicycle unless you have a certain device on the bike for improving range without 90. And we'll go over that shortly. Now, both from acute skilled and home care standpoint, knowing what's normal and abnormal in your lab values is important. Here is a list from the American Physical Therapy Association that was published in 2004 and upgraded in 2005 and confirmed what could and couldn't or should and shouldn't be done when out of range.

So, if you have certain issues with DVT, PE, abnormal lab values and infections, those are all things that might set the patient back to readmission to the hospital, and that hospital would then be responsible for the cost of a second admission based on outcomes from the previous surgery. So these red flags we already went over for the DVT, increasing hot, swollen, tender calf and knee. The PE with the sudden, keyword sudden, shortness of breath and localized to the chest when deep breathing and a decrease in spirometry. We'll go over these lab values and a couple others and, of course, what we talked about with infections, with increasing drainage, foul smell of drainage, and core temperature increase. So here is that list from the APTA on mobility and some of the lab values, the hematocrit, platelet, hemoglobin, white blood cell.

No exercise when they're in that top line, that first level of number that puts the patient at risk. As they progress and things stabilize in any of the settings that they are in then light exercises, namely bed and bedroom exercises, are allowed. And then certainly resistive exercises as their systems stabilize. Coagulation, certainly we want the prothrombin and the thromboplastin times within normal limits for coagulation, and we want the INR within this range. But for those who are on anti-coagulation, it's not uncommon to see a level of two to three. That's of concern if it's on the higher level, and we want to keep an eye on the wound when the time limits for the PT and the PTT

elevate and the INR increases. Now, a lot of patients are on anti-inflammatories. They are also on blood pressure medicines. This can decrease potassium in their system. Potassium levels should be 3.5 to 5.0 milliequivalents per liter, and hypokalemia is lower than 4.0. Hyperkalemia, obviously above 5. Both, both low, hypokalemia, and hyperkalemia can lead to a lethargy, abnormal contractibility of the muscles. That muscles show, in testing, will show decreased strength, even as to the point of localized or generalized paralysis. If it is generalized you might see abdominal distention due to low tone in the wall. They also can have disorientation, muscle twitches, polyuria, so a large amount of urination, which goes along with the high blood pressure medicine. Heart can be involved, and EKG changes could be seen. Also look for clammy skin and respiratory issues.

All of these in increasing danger and it is something that should be critically analyzed in the first two to three weeks. And, as well, if they are decreasing in their weight bearing capabilities, they decide not to or during weight bearing you're seeing an issue where the knee is changing its alignment, like this lady who went from a straight knee to a valgus knee so that the, with her rheumatoid arthritis the medial capsule destabilized. If there's wound dehiscence and seepage and certainly other red flags that mentation changes with delirium or dementia, especially in the female population. So based on the wound healing those first four to six weeks, get that effusion under control and keep it under control.

The patient needs to understand how to do it and will be compliant at home. Range of motion will automatically improve when that happens. Strength and power will come back. The scar will heal, and pain will subside and they will improve functionally. And occupational therapy issues will abate fairly quickly as the patient gets more confidence. And confidence is the last thing that recovers in rehabilitation. Once they have their confidence in their physical capabilities they tend to be more active in their functional activities. So, let's look for that range of motion, zero to 114 to 120. Double

leg squat to 90 degrees without a hand hold is good at the six week mark. And improved neuromuscular control and balance. A test for that would be the ability to stand single leg stance 80% of the time of the uninvolved leg. So if the uninvolved leg can hold for 30 seconds then you want to be able to get between 20 and 25 seconds of stance time unilaterally in the involved leg. Wound maturation, no drainage, reduced swelling, and do your circumference measurements daily. And I suggest mid patella VMO six inches above and six inches below or mid calf, but be consistent and do it every visit. It takes less than 60 seconds to take it and document it. Once the staples are removed at 10 to 14 days, whether it be the nurse, the PT, or the first ortho visit, the patient is moving along very well. But it's at that critical time, this two to three week time is critical for range of motion because this is when the fibroblastic activity is ramped up and maximizing in its speed. And if range of motion isn't garnered, isn't successful in that time frame, then you're going to be looking at a stiff joint at one month to two months. And then you're going to have to be more aggressive in the outpatient setting.

So we want to avoid that. So in the home setting we want to make sure that range of motion is zero to 115 degrees by the time home care is finished at the third or fourth week of post-op care. Doing scar mobilization, patella mobilization, is essential along with active and passive range of motion. Certainly stretching of the gastroc and soleus is helpful. The patella modes, if you have to go baja, anti-baja so you wanna be able to mobilize the patella superior or inferior if the patella is high riding. Again, once they get to a stationary bicycle, their knee is greater than 90 degrees, they are able to successfully achieve their range typically. The sooner the better. Total leg strength. I've mentioned it several times before, but that is the quads, the hamstrings, the glutes, and the gastroc soleus. Hamstring, glutes, and gastroc soleus are knee extensors in the closed chain position so they will help with terminally extension at heel strike. We wanna make sure that they have that knee extension at heel strike or pretty close to it. Straight leg raising for both supine, for the anterior structures, side glutes, and glutes,

hams in prone on the bed. Starting at terminal knee extension going to short arc going to full arc obviously is the standard sequence. So for your outcomes, independent, pain free gait with an assistive devices in that first four weeks is what you'll typically see. And independent in all home TE. So education, education, education is critical for the patient to understand because they're only with us therapists three hours a week if we're lucky and the rest of the time is on them and/or their spouse to help them move forward. Because we do want them to return to previous functional activities and ultimately vocation and recreational activities, which we should be monitoring and having a goal towards.

Getting that range of motion, you need the strength, the power, and the endurance. Strength is good. Power is better. Endurance is necessary. Keep effusion control. Keep pain modulation. And that's all through discharge, which is 12 to 16 weeks standard as reported in the literature. Car transfers, they get that when they're leaving the hospital. Stairs when they're leaving the hopsital. ADLs when they're leaving the hospital. But certainly all of this monitored at home by the home care therapist because you're seeing them day two through week three or four. Get those, all those household tasks that they need to have to be independent if they do not have someone at home. Ultimately, when they get to community mobility and can get to the outpatient setting then they will have to be able to be, certainly, more independent.

And this driving and recreational activities, that is where they wanna get to because they came to the doctor and they say, hey I can't recreate. I can't have fun. I can't work, and I can't drive my car because I can't get from the gas to the brake fast enough, safe enough, can't push enough with enough force. So those are the things when I talk about strength, power, and endurance, we need to get patients to these last three with all of our rehab in skilled nursing and home care so that the outpatient therapist can then maximize their efforts and strength and movement. So when we get to that are the patients satisfied? Satisfaction is key in today's healthcare world, and

our patients are asked to fill out scores on satisfaction. Higher scores in satisfaction equal higher payments from insurance carriers. Certainly we talked about decreased pain, functional improvement, whether you're scoring in on a certain score system, and monitoring mobility, strength, range and calculating the length of the stay in your facility. So if I had to put a time frame or a length of stay or numbers of visits in therapies, in the hospital, it's one to two days max. At this point the literature is pushing towards the 36 hour max. The home care, they're pushing for the three weeks max. And in outpatient setting, they're looking for nine to 16 visits. So that range is all dependent on how you record their function in your documentation so that you report what their functional activities are, what their functional test scores are, whether it be the KOOS, the KSS, the lower extremity functional scale, or the WOMAC.

You need to be tracking this, keeping this, documenting it so that your reimbursements are not challenged, and if they are you have the documentation to support where you're going with your rehab. I would like to say that lower pre-op function increases greater as far as an absolute number than patients who start out with a high number. Let's say on a scale of zero to 100 the patient's functional score is 50, and they get to an 85. That would be a good movement in their scale score. But there are patients that go from 40 and get to 80.

They made more gains, but their score was not as high. What Kennedy reported in his literature is that at 12 weeks you're gonna get the greatest improvement. Well, in the next 14 weeks or excuse me, yes, in the next 14 weeks, you're only gonna get mild improvements. So this is the window that you have to get to to improve as much as you possibly can before insurance carriers start to question your documentation. And lastly, anything greater than 26 weeks you better have great documentation and need by the patient's functions. Now, outcome scores, here's a litany of things that could be used, certainly at different times in your continuum of care. The short form 12 is a self-report and does a nice job. The LEFS, the lower extremity functional scale, can be

followed pre-op through post-op. Certainly the six minute walk is something that can be done in most settings. The TUG, after three months or after they reach their ability to do that at 10 seconds or less you're ready to move on to testing something else. But the standards of the WOMAC, KSS, KOOS, HSS are standard and used in multiple research articles. The Berg Balance if there is an issue with balance. I still prefer the long form, the 14 questions, and I don't support the use of the seven question Berg, but it is reported in the literature. Now, here are some norms that have been gleaned from the literature, divided by decade, by male/female, for both the six minute walk and the TUG time. And as you can see, for a normal person, these are norms, even into 90 years of age they should be able to get up and do 10 seconds, timed up and go test.

And they should be able to walk their distance of 417 or 392 meters, yards. A report from the University of Delaware also shows some things over a 12 month following. And as you can see, the timed up and go, the vast majority of their patients reached at two months the minimum score that they needed to not be followed by the TUG. The quad strength, compared involved versus non-involved, reached 97% of the involved leg, but look at this, plus or minus 30 degrees. Excuse me, plus or minus 30%. So that's a big variation and can impact function significantly in quad side to side strength evaluation. Knee range of motion, 120 degrees.

That's where you wanna be. Knee extension, zero degrees. And note that at two months, eight weeks, they achieved for the most part 112 degrees to three degrees. Very good for all functions. And lastly, the KOS for ADL scores was 85 at the end of 12 months. And that is not an uncommon number in all scoring outcome tools. Other things that you can use are the self walking speed for five meters, the figure eight speed which is varied three dimensional, walking forward or walking backwards in a figure eight configuration on the floor. The repetitions timed for chair rise, and then ascending and descending steps. Now the Knee Society Scale, as I said, anything below 60 is poor. Most patients get to around 50, and that's where they're getting their

surgery done. Most patients get to 85 or better post-surgery. And that is typically 12 weeks to 12 months afterwards. Now, as I said, getting on a stationary bike previously, if they don't get 90 degrees, we don't wanna force them on the bicycle to do 90 degrees. I like the new step, actually, for reciprocal weight bearing and quad and lower extremity total leg strength work. The new step is a wonderful reciprocal recumbent activity. But if you're using a bicycle there's a thing called the Range Master. The Range Master is an additive device that can be put on a pedal that changes the arc of rotation required by the surgical knee to get around. And I said previously if they can get around on a bicycle their chances of improving their range of motion significantly increase.

Rather than forcing them to rock back and forth, work on a, acquire a Range Master, and move them forward that way on a stationary bicycle. Here is a fitter that does a nice job when positioned correctly to work on hamstring and gastroc strengthening, where this foot is pulling, this foot is pulling this pad underneath their knee and really working those flexor muscles. From a post-op week three to six and certainly well into outpatient and they're doing their resistance weights or elastic bands, they're doing their straight leg raise four ways, prone, supine, side lying, and contra lateral side lying, and more importantly, anything close chained.

I like the terminally extension against bands or a weight. I like a modified leg press. I like wall slides and partial squats. And lunges, once they achieve the capability of that unilateral step forward and dip, especially starting in the parallel bars and working their way out. If they do not like to weight shift very well and their weight shift time on the ipsilateral side is diminished, you may wanna try something where you back them up to a treatment table, raise that table up, put their uninvolved leg, foot, on an elevated board or step, and have them do partial squats. Touch down to the mat or the table and up. Down and up. And as they get better with each stand up, you lower the table down just a little farther, an inch, an inch, an inch, and that way they are going to start

shifting their weight more to this side. Now if you have to stand on the contralateral side and block them from shifting over to that side, that's something that from a technique standpoint, they may not love you for it, but they'll appreciate. From a balance standpoint, we gotta go static, especially on the older patient if they have a neuromuscular issue with MS, Parkinson's, or stroke. Getting to the standard flow from wide to narrow base, from firm to unstable surfaces, from eyes open to eyes closed, and then from double to single leg stance and going down the side of this wide, firm, eyes open, and double leg to maximum challenge of narrow base, unstable surface, foam, Bosu, et cetera, closed eyes, and single leg. That is static challenge to the max, especially for the higher level, younger patient who may go out and play tennis or golf or ski.

The balance progression, being dynamic as we said, flat, a progression, going from flat to uneven, ramped to steps, slow to fast, multidirectional, eyes open, eyes closed, certainly. Rhythmic, older populations really do like doing things to music so if you can get music involved that gets them into a rhythmic mode and therefore their muscles will react rather than having a thought process and their muscles not moving quite as well. Certainly stepping and ambulating in different directions, and then, of course, you can always go to dancing. From a balance and coordination standpoint, the use of a mini tramp is very nice.

BAPS board is helpful, and eyes open, eyes closed could be essential, especially for patients who have difficulty at night. Aerobic work, cycling I said, the upper body ergometer for general conditioning and heart rate and pulmonary work. And I said the NuStep is excellent for the lower extremity. Aquatic exercise is helpful, but it has to be after the one month mark when the sutures is totally sealed. Progress to ambulation without the cane is essential. Now, this slide here I wanted to show the step ups and step downs using a down ramp. A down ramp will force more work on the quads. If you wanna add to that functional electrical stimulation or a biofeedback over the

quadricep muscle, doing a mini, mini dip with a heel touch only, holding on initially and then going away with the hold on is a very good way to challenge the legs for that functional return, especially for anybody going up ramps, down ramps, uphills, downhills, like golfers, et cetera. Now, if they're gonna return to impact sports, they should not have pain within 24 hours of doing their activity. Their sports can be modified, especially the shoes that they use. And they can return to the sport, but they have to do it gradually.

These are the sports that most of the articles report that senior citizens like to return to or active adults return to. Walking, cycling, swimming, golf, cross country skiing, but then there, if you're going to go back to golfing, there are things that you can do. You can use a natural swing, which is just the arm swing. So it's just a left to right sway of the body. This could be a more open stance, with the left leg turned out. Or, if it's a left handed golfer, a right leg turned out. Also, take off spikes. Take the spikes off of the back of the shoes and even the lateral component here to just leave the medial part of the spikes, and that will allow for the foot to rotate on the ground and not cause too much torque at the knee.

And certainly when they go golfing they should use a golf cart to start, and being a Philadelphia Flyers fan, I had to show that gold cart customized for that. Now, what if there are rehabilitation problems? Let's start with stiffness. Stiffness is defined as greater or equal to 10 degrees of flexion contracture or a loss a total arc only to 95 degrees. So if you have difficulty with full extension do you have hamstring tightness? Well you gotta stretch that out. But most likely you'll have posterior capsule tightness. So you need to have extension overpressure, possibly anterior glides unless you have the constrained prosthesis that is put in where that prosthetic spacer has a nipple into the femoral component and you can not do anterior mobilizations with that posterior stop. If they don't then you can do anterior glides in addition to extension overpressure. If they need an extension splint at night, that's your choice and they

need to be compliant with that. Applications of heat, mobilizations, massage work, myofascial work, low load prolonged stretch. Set up the leg with the bolster under the distal half of the calf and the weight about the patella on the femur. Low load prolonged stretch, five pounds, 10 minutes. 15 minutes. Something that will give them, the body time to say hey, I need to realign this matrix of collagen that I'm trying to lay down. Additionally, this slide showing the maximum overpressure, not a very comfortable set up with both legs over the edge of a table, but it has been done. There's the dynamic splints or braces that provide a mechanical overpressure, and literature does talk about serial casting and/or injections to break down the collagen to allow you to resynthesize the range of motion available. Now if they have an extension lag, you have to eliminate the edema.

We already talked about the RICE program. That's essential. Get the entire quad going. Entire quad strength with short arcs, lateral step ups, and especially closed chain isometrics. Here's your wall seat with closed chain isometric, which is very good for the vastus medialis. If you're gonna do electrical stimulation, you can use it at 2,500 hertz modulated at 50 bursts and a duty cycle of 10/50. Excellent possibility, certainly patient dependent on their tolerance. Now, as far as the non-operated leg, I certainly would say work both quads early and often. That's essential because weakness predicts a decreased in one year outcome on TUG, stair climb, and the knee outcome survey. So work both legs because both legs are involved in all of those outcome tools. Now if you have a difficulty with flexion, yes, edema. Maybe hamstring weakness. But most likely it's quadriceps tightness or patella extensor mechanism issues with scarring and adhesions. So that's something that needs to be taken care of, and any number of ways to do that. You can use CPM certainly. We talked about edema management. Patella mobilizations I talked about earlier. You can do lateral, but certainly you have to push superior for a baja patella, inferior for an alta. Stretch the quads in supine, side lying, but certainly get them prone. Prone. In this position you can strap down the buttocks to a table, put a strap over the foot, excuse me, the ankle. Put that strap over

the shoulder and have the patient pull it or strap a weight to that so they have a low load, prolonged stretch inflection, and they don't flex their hip, which will allow for them to shorten the quad here while trying to lengthen it here. We want this hip flat, that knee stretched. Now if they develop arthrofibrosis, you have to be aggressive with your PT because they are gonna require a manipulation if within three months they do not get the range of motion that the doctor desires. If they're stuck at 90 at three months, they likely will get manipulation, and they will then gain maybe 20 to 30 degrees, but your program should be that they manipulate and see the outpatient therapist on the same day. Some surgeons do a scope and open debride, and if there is an issue with the prosthesis there may be a need for a revision.

Now, patello-femoral instability, that means the kneecap is subluxing. Problem is it's usually excessive tightness of the lateral retinaculum and a weak or poorly timed vastus medialis. So you gotta strengthen the vastus medialis and get it firing at the same time that the lateralis is firing. You can use a biofeedback device that is set up for both the lateralis and the medialis, and when they do terminally extension or short arc quad, it fires at the same time. Stretching out the lateral retinaculum with mobilizations and myofascial work is critical. Tibial-femoral joint instability. Well, if they have knee of giving away or slipping or a loose knee or a lax knee, that typically is a problem of a spacer that's not right. maybe the physician who only does 12 knees a year didn't do a good drop test and he put too big a spacer in and now they can't get terminal extension so their knee gives out.

Or they put too small a spacer in and their knee goes to recurvatum. Not a good option. Now, if the knees start to buckle and go into a valgus deformity, then they have some kind of stress that requires either revision and repositioning of that tibial component, or they may require functional bracing to control that medial plateau or that medial structure. In any case, those are essentially a surgeon's analysis. Now, if they have delayed failure of the knee so they have to do X-rays, but there's a thing

called a TPBS, a triple-phase bone scintigraphy, where they're looking for increased bone activity below or above or underneath the prosthesis, and that just means that the anchor of the prosthesis to the bone is failing and is typically in this active male who might be obese. Maybe they've had rheumatoid arthritis. They could've had osteoarthritis, but in any case the failure rate reported is 1% per year. So, the fracture/dislocation of a patella has a dramatic impact on the quad mechanism, and the surgeon really has to do a lot of work to stabilize that so all of these items here and stability components, progression of bone loss, and periprosthetic fractures all are surgical managed.

If they're gonna do a single stage or a two stage revision, in other words, they have to restore the mechanical capabilities of the redone prosthesis, they gotta get a good joint line. They gotta have a stable implant. No infection and they reduce pain and improve function, which is what we have to keep a mindful eye on. So those are the reasons or goals for a revision. The outcomes of a revision, 70% are good to excellent as compared to 85% are good to excellent for a first entrance knee replacement. It's usually better if it's loosening rather than an infection, and pain relief is variable and it's better than a primary knee. Range of motion, strength, and function are also better with the primary knee replacement, but it still improves.

Now a salvage procedure is an infected, revised knee. So they had a primary knee replacement. They had a secondary knee replacement, and it got infected. So they gotta do a resection of that second replacement. It's non-ambulatory. They have to clear the infection. They might do an arthrodesis or they might have to do an above knee amputation. If they do a third revision and they have to do bracing to keep the knee stable then that is, in fact, what they would have to do for a salvage procedure. Now, pre-op and post-op interventions, if you think about where we're going in our future, we gotta really work on early effusion control in those first 30 days. So you acute therapists, the skilled nursing, or excuse me, the acute care hospital, skilled

nursing, and home care, you're on the cross hairs for that management. Muscle remobilization, same issue. First 30 days. The continuum of care, talk to the people behind you and in front of you in the continuum. Make a phone call, send an email, find out how the patient had been doing, should be doing, and translate that to your program wherever you are. That continuum of care, continuity is critical. With the integration of documentations and electronic medical records, that is improving in large systems. It's the small systems, single hospital setups, and independent clinics that might struggle with that continuum of care documentation capabilities and sharing. So we have to be efficient. We have to be effective. And we should be following patients up to 10 years to see how we did with our rehab. That's it for me as far as the information. I'd like to thank you all for spending your time with me. I hope it gave you information that you can take back to the clinic tomorrow, and Saturday if you're working, Monday if you're working on Monday, and share that with your colleagues. I'd be happy to handle any questions if there are any.

- [Calista] Hello, everyone, again. This is Calista, your moderator. If you do have any questions for John, go ahead and place them in our question and answer pod and as well if you have any questions over the quiz, go ahead and ask those as well. As a reminder, to use that question and answer pod, go ahead and open that up. Type that question, and then hit send. And we don't have any in there right now so if you do have a question go ahead and place it in there. Okay, John, we have a question from Anchor. Is there a minimal patello-femoral arthritis, can the patella be spared?

- [John] That is a surgical decision. He wants to provide a surface that's gonna be gliding for the equad mechanism. I believe most surgeons, if there is a medial plateau of the patella that is compromised, they would sacrifice that surface of the patella, that 8 millimeters, and put a button in. Thank you for that question.

- [Calista] Kimberly asked what is the most cost effective therapy intervention?

- [John] The most effective?

- [Calista] Cost effective.

- [John] What is the most cost effective? Well, if you're looking at what the literature recently has been leading to, they've been comparing the one on one versus group versus supervised, unsupervised, and telerehab. The one on one and the group therapies show no difference in outcome. So if you had a high volume system where your system was doing 2,000 knees per year then you would want to be able to develop a rehab system where you're doing group. If you had a rural area you probably would wanna look at a telerehab. The problem always comes in does the hardware capabilities of the patients match what you're hoping to do. In today's world of cell phones, telerehab might be the, part of the future from an efficiency standpoint. Thank you for that.

- [Calista] And then Jill asked do they ever take out the complete patella during surgery?

- [John] Well, uh, a patellectomy is probably one of the most devastating surgeries for a quad mechanism for function. Typically that would be done when a patient falls and the patella is totally shattered and there was no chance of salvaging it. So that's somebody who's of significant age and has a significant osteoporotic bones structure and when they fall they shatter into multiple pieces. Sometimes they will try to salvage that, hold the knee in extension with a knee immobilizer and hope that Mother Nature agglutinizes or pulls those patellar microfragments, minifragments together into one bony surface that they then do a patella button on somewhere down the road, but again, surgeon's call at the time of surgery.

- [Calista] All right. We have a question on squatting. When is that safe to do post-op?

- [John] Well, if you think about it people are beginning their squatting when they're getting on and off the toilet on day one or day two, actually. Yes, they're using the arm rests of the three in one commode. They're using the walker to help lower themselves down. So in essence, that's starting right away. If you're using squatting as an exercise, you're probably looking at two to three weeks. And I think I said in the talk that at two to three weeks they should be able to squat down to 90 degrees without much hand hold. In other words lower themselves down to a commode or a chair. If you're using it for high repetitions, then a low number of repetitions at that time, at the two to three mark, would be doable.

- [Calista] All right, and we do have a question related to one of the quiz questions. And I'm gonna read that to you, John. It's regarding which post-operative therapy intervention is best supported by the literature as cost-effective? So

- [John] And that, I think I addressed that with the group therapy or the telerehab from a outcome standpoint, long term, as well as dollars spent.

- [Calista] We have another question. How often are uncemented prostheses used or in what circumstances? Are outcomes generally worse due to delayed weight bearing?

- [John] Okay, good, that's a good question. I don't have the statistic, whether it's 20% uncemented and 80% cemented. Uncemented, typically that bony ingrowth, once it matures, is much stronger than cemented, and a lot of time they might use that with a, someone who might be very active who is willing to wait for that osteogenic ingrowth to occur. Most people are not, and so the majority of knees are cemented at this point. There are hybrid prostheses out there, where there is a cemented component and a non-cemented so they would cement the femur and non-cement the tibial component.

Again, surgeon's decision. Patient selection is critical. And that patient selection based on potential activity post-operatively and the patient's patience to the, how much time they can spend less weight bearing and being less mobile.

- [Calista] John, are you aware of the current rates of post-operative infections with total knees?

- [John] Well the rates of infection vary, depending on the research, the volume of number of patients reported, the range is anywhere from one to 3% at this point post-operatively. The lower the infection rate, obviously, the better because you're not getting readmission so hospitals are really working on whatever is causing those infections. And a lot of times because it's reported in the acute care hospital setting, the hospitals are pushing home care and skilled nursing facilities to manage the infection in their phase of the continuum of care and not refer them back to a hospital emergency room for a hot joint program, where the orthopedic surgeon has to be called. The may have to go in and irrigate or they may have to readmit the patient because of a so-called infection that possibly can be managed by skilled or home care providers. So the numbers vary because most infection rates in the literature are reported on those patients directly that were in the hospital or were readmitted and not necessarily who were maintained in skilled nursing or home care infection management programs. So one to 3% is still a good number.

- [Calista] Okay, all right. We have a question on is there a week that you, that you could see the greatest amount of progress with these patients over the continuum or does that not occur?

- [John] Well, I think the patients are most apprehensive in the first two weeks. But they have the most, they've gained the most range of motion. They should be at zero to 100 to 110 degrees of range of motion. And I said that confidence finally comes when they

have the strength and range of motion and they've practiced what it is they're practicing or need to practice with someone supervising them. So that two to three or two to four week phase is where you're going to see most of that confidence start to build enough that they get to outpatient. But, again, it's in that outpatient setting where they maximize or optimize their functional capabilities, and as Kennedy said, it's the first 12 weeks that are going to make the maximum change, and after 12 weeks you have a diminishing return for your dollar and time.

- [Calista] Interesting question, do you know the thought process for removing the PCL and the ACL and how common that is during surgery?

- [John] Oh, it's very common to remove the ACL. The PCL sparing is becoming more common, and today they are even working on a prosthesis that spares both the ACL and the PCL so that the patient has the proprioceptive nerve endings in those tissues to help them with knee stability during ambulation on level and unsteady ground. But it is more common for the ACL to be removed, most common to be removed at this time. Does that answer that question well enough?

- [Calista] Yeah. All right, and it looks like we have time for one more question. And this looks like sort of like a case study, and we'll see how much time you're able to do here. But this member here has a patient who's had three knee revisions and is in home care, is very sensitive to touch. How would you start the plan of care for somebody that's went about and has started and you're starting to see this patient that's had three knee revisions?

- [John] Three knee revisions is a very tough patient. They're very apprehensive about anyone touching them. If it was for an infection, anyone touching them they're worried about a transfer of infection. So gaining their confidence in how you manage and hands on yourself to that patient is critical with hand washing prior and post, gloving if

necessary, draping over if necessary, desensitizing the skin with a desensitizing program, whether you're doing padding with light cotton balls or a terry cloth or a sponge and then moving on to a little bit more assertive pressure on the skin so that they get used to that, that desensitization. If you have to go to electrical stimulation, I'm not sure whether than patient would be amenable to a TENs program where you're doing a two channel crisscross electrode placement that would desensitize for 10 to 15 minutes prior to your hands on approach. Also using ice would desensitize the skin if, in fact, your goal is to desensitize the skin enough that you can lay hands on so you can do some myofascial work or scar mobilization if it is at three to four mark. That would be the short version.

- [Calista] Well, thank you so much. All right, well that is gonna wrap up our course for today. Again, thank you so much, John, for sharing your expertise with us today on total knee. And thank you so much for everyone for attending.

- [John] Yes, thank you, everyone for coming and taking and listening for today. Hope you have a great weekend.

- [Calista] Yes, everyone have a great weekend, and we hope to see you back in the classroom throughout the month of August. Have a great day, everyone, and thank you again, John.