Well thank you very much, I appreciate the invitation to be here and the opportunity to talk to you a bit about some of the updates, advances in pancreatic surgery and pancreatic cancer specifically. So I trained in surgical oncology with a focus on HPV surgery, and part of my training included some minimally invasive surgery so we in the past 6 or 7 years you may have heard of a lot of minimally invasive techniques being applied to pancreatic cancer and pancreatic surgery so I'm going to briefly talk about these as well.

So there is two main aims to the talk. The first 20 minutes or so I'll talk about the recent essential developments in pancreatic cancer and ways to improve outcomes, and particularly survival. We'll talk about definitions of resection, how we now are able to place buckets and actually put patients into categories where we think they'll do better rather than lumping them all up into surgery versus no surgery. We'll talk about improved chemotherapy in the modern age and how things are changing because of this improved ability to cytoreduce these cancers. And then talk about neoadjuvant and adjuvant therapy. There has been a lot of talk about neoadjuvant therapy in pancreatic cancer, and then talk about reductions in operative morbidity. But the reduction in operative morbidity is important because that's going to be the segue into the advances in robotics. And I'll particularly talk to you about robotics more than laparoscopic surgery because that's the majority of what we do at Presby and Shadyside and Montefiore nowadays.

We'll talk about the safety, the efficacy, the learning curve associated with pancreatic cancer surgery, any advantages to this approach versus the laparoscopic or open approach and we'll talk about how
we can disseminate it to trainees and residents and new staff. And finally talk about the implication and impact of enhanced recovery surgical pathways on pancreatic cancer surgery.

So this is just a bit of epidemiology and I'm sure everyone appreciates what's on the slide but essentially pancreatic cancer is way low in terms of incidence. It is increasing in incidence in both sexes but at the bottom part of this chart is really the problem where the incidence and death rate of pancreatic cancer is pretty similar. Pancreatic cancer is the fourth leading cause of death in both sexes but in the next 15 to 20 years it will be the second leading cause of death from cancer, so it is a major, major burden on our society.

This is also another telling slide. I always start the talk about pancreatic cancer in kind of a dismal fashion to outline the main problem which is over the course of the last 4 decades there has been improvements in every single cancer in terms of survival, however if you look at pancreas cancer down here the actuarial 5 year survivorship has stayed around 5%, so out of newcomers 5% or so have a 5 year survival rate which is really probably the worst cancer in terms of outcomes.

Another dismal slide, this is one of the largest series of resected pancreatic cancer, so these are the cases, not the metastatic ones, these are the ones that have been resected for cure. This is from Memorial Sloan Kettering and they outlined a 3 decade experience with pancreatic cancer resections. And there is a lot of telling information from that large experience. Number one is that the 30 day mortality has gone down from about 6% to about 2% in high volume centers. The 90 day mortality
has also gone down. 90 day mortality is a much better surrogate of outcome than 30 day mortality. You guys here probably know patients who have had pancreatic resections like Whipples they go home in 14 or 15 days, but they come back and they die around day 60, 70, 80, 90. Really the physiologic impact of these big operations are important, therefore the 90 day mortality is a better reflection, so we use 09 day mortality for all outcomes now. And really that has also dropped in half. The one year mortality has also dropped because we have better rehab services. These patients have better nutritional supplementation after major surgery. Then the length of hospital stay has also decreased from about 23-25 days down to a good 10 days, so we’re getting better at doing these operations. However, if you look at the survival curves for all 3 decades; green, blue, and yellow, we have not made a single impact in terms of the survival for these patients even though we are doing better operations.

So what is the reason for all of this? What’s the reason for this poor survivorship? I’m going to focus the next 15 slides specifically on this question. So the reasons for poor survival in pancreatic cancer can be summarized in the next 4 or 5 points. There are a lack of standardized definition of resectability. Not everyone that has no metastatic disease on a CT scan can go to the operating room. So I’m going to talk to you about these definitions about resectability. We’re able to actually prognosticate even before going to the operating room. Two is the lack of chemotherapeutic options. We don’t have anything better than Gemzar or 5FU until recently. So unlike colon cancer or melanoma or breast cancer, we don’t really have those therapeutic options. Third is a substantial post operative morbidity. I’ve showed you that it’s gone down however it’s not gone down enough
and there’s still a substantial morbidity associated with this cancer. And there’s really a sense of nihilism. There’s a famous paper by Bilimoria at Northwestern that showed for patients who had stage 1 resectable pancreatic cancer in the U.S., only about 30% of patients underwent resection. The main reason for not undergoing resection you’ll be surprised is not old age or comorbidities, it’s actually patients not referring themselves over for resection. There’s a sense of nihilism about this cancer that we need to overcome and hopefully I will show you ways in which we can overcome this with some of our technology.

So I’m going to focus on resectability first. If you have a patient with pancreatic cancer it is now known that you need 3 hallmark investigations to be able to put these patients into appropriate buckets. One is called this Triple Phase CT scan. This is not a regular CT scan it’s one that has arterial contrast, venous portal contrast, and delayed venous contrast. This is important to be able to ascertain the implication of the tumor with regards to the blood vessels around that area.

Two is endoscopic ultrasound. You need to get a biopsy and you might need to give neoadjuvant therapy or radiation upfront. So these patients do get both these images and modalities.

And finally CA 19-9 is proven to be a major prognostic implicator. When you have these 3 pieces of information you can put patients into one of four buckets: either resectable, borderline resectable, locally advanced and metastatic. The term locally advanced is loosely used in the medical community but there are certain specific criteria to put patients into these buckets.
I’m going to focus here on one operation which is the Whipple operation for the majority of this background information. This is the cava, this is the aorta, this is the head and the neck of the pancreas the right side of the body, this is the spleen. So a Whipple removes everything in this box but very importantly is a relationship of the head of the pancreas and the tumor to these 2 blood vessels, the SMV, which is also called the portal vein for all intents and purposes just depending on location behind the neck of the pancreas is the portal vein, down here it’s the SMV, and then the superior mesenteric artery. So the relationship of the tumor to those blood vessels is crucial in being able to put these patients into these buckets and triple phase CT scan, endoscopic ultrasound enhance the ability to show us where to put these patients.

Why is this data important? The data is important because if you manage patients appropriately with resectable cancer you can have a long survivorship. This is data that almost approaches colon cancer data. Patients who have vessel involvement borderline resectable cases, these actually have managed well, can actually have a survivorship that’s very similar to resectable cases. Unfortunately it’s only 10% for resectable and 10% for borderline resectable. Local advanced patients are typically unresectable but if you give them chemotherapy and radiotherapy in the right fashion in the right sequence you can actually get these patients into a borderline resectable criteria and operate on them. The median survivorship for locally advanced unresectable cancer was 9 months; you can now reach almost a 2-3 year survivorship data with the right staging and the right treatment.
Finally metastatic cancer is still poor but rather than 6 months we know have a 12 months survivorship if you use the right chemotherapy agents. The problem is these buckets are small and the major bucket is the metastatic bucket and unfortunately I can’t tell you much more about this other than good chemotherapy. But it’s this area that we need to focus on.

So if you’re looking at a CT scan a Triple Phase CT scan of the abdomen and the pelvis and the chest, you’ll see that this tumor here is in hypodense tumor, you can see it right over here in the midst of the uncinate. And there’s a bile duct stent here, but it’s the relationship of the tumor in this red box that’s crucial. What is going on in this red box that allows a surgeon to decide which modality they’re going to treat first?

So in 2009 there was a consensus statement published by the American Society of Surgical Oncology, the NCCN was also involved and the American hepatopancreatic and biliary association, which all conglomerated really released a statement that truly differentiates these 4 buckets.

For resectable pancreatic cancer you must have a tumor that has a clear, fat plane between it and the SMV and the SMA this is crucial. So this fat plane here should be really a dark grey color as opposed to the tumor. You should also have no distant metastases as I said no abutment. You have these terms abutment, encroachment, encasement, all impingement, narrowing, any of those terms should not be present in resectable pancreatic cancer category.
And then for the SMA and the celiac trunk of the arteries you should also have a clear plane between them. If you look at borderline resectable cancers a triple phase CT scan allows you inappropriately sliced protocols to tell if the cancer is abutting the vessels or not. Any abutment or impingement of the vein, the SMV or the portal vein which allows you to reconstruct it in the operating room, so taking the jugular vein and plugging it in or cutting the tumor with the vein and putting it back together. Any impingement or narrowing of the vein that allows reconstruction is a borderline resectable tumor.

For the SMA you are allowed a borderline resectable if you are less than one hundred and eighty degrees abutted. So just like this case here. If you have more than 180 degree abutment of the SMA or you have a venous problem that is not reconstructible by the surgeon then that is locally advanced cancer, that should not be taken to the operating room. It’s amazing how many patients end up going to the operating room with locally advanced disease for the surgeon only to unfortunately chop off the tumor and leave tumor behind. That’s a really important issue that has arisen in the last few years.

For the surgeons in the room we were always trained in residency and fellowship that you mobilize the duodenum and you put your hand behind. And if your hand can feel the artery or the vein then you should go ahead and resect. It turns out multiple studies have shown that the hand is not good enough. You cannot, you don’t have that good of a sensation to detect the artery from the vein and 50% of the time you’re usually wrong in being able to detect if a patient is resectable or not so you
need the CT scan, you need it done in triple phase and you need someone who is experienced; a radiologist who’s been doing this for a long time to look at this.

The reasons are important because when we looked at data looked at patients who were completely resected that is margin negative resection versus those who had a margin positive resection the survivorship was halved. So if you take someone to the operating room and you leave tumor behind because it’s locally advanced disease then the survivorship is about 11 months that’s just as good as not doing anything, not even chemotherapy. However if you do resect with good margins then you could actually double and I’ll show you in a second, triple or quadruple the survival.

So I’m going to give you a lot of data from Pittsburgh covering from our institution which I think we’ve contributed immensely to the field. I’ve told you about the use of CT scan but we went ahead and combined CT scan with endoscopic ultrasound. We have people like Adam Slivka and his group and Kevin McGrath and his group that do a lot of ARCPs and EUS and it’s the combination of CT and EUS that seems to actually give you the best prognostic indicator of how to put these patients into those buckets. So this is complicated but this is a validated, simple model of how you can use CT and endoscopic ultrasound to see which patients are at risk of bad resections vs. good resections. So if you combine CT and endoscopic ultrasound we have essentially 3 criteria that we use. If the mass is more than 2.6 centimeters on endoscopic ultrasound, if there is vessel involvement whether it’s abutment 180 degrees, 90 degrees, narrowing, any tumor touching one of those blood vessels, or if the tumor has lymphadenopathy surrounding that area on endoscopic
ultrasound, the chance of an R0 non curative resection actually goes up substantially. So in this validated model, I’m must showing you the validation cohort there’s actually an initial implementation cohort before this, so the actual study is much bigger. But in the validation cohort we show that if you don’t have any of those 3 features then the chance of an R0 resection or a marginated resection is about 80%. However, if you have any of those characteristics the chance of an R0 resection is as low as 30%. So you combine a CT with an endoscopic ultrasound under specific criteria by good people who know how to do this and you can come up with a validated model. The survivor graphs were pretty impressive so there’s really good separation for patients who on this side were able to get a margin negative resection and those on this side who with combination of CT and endoscopic ultrasound are not able to get a margin negative resection. Margin negative is R0 in the world of oncology. R1 is microscopically, disease left behind microscopically, and R2 is macroscopic disease left behind. So here we’re talking about R0 specifically so even though the surgeon thinks he’s removing it, it’s also microscopically negative. So R0 is much better than R1 which is much better than R2. So we now use the combination of these modalities to give us a better predictor of who is borderline resectable, who’s resectable and which patients can go to the operating room and get a better result.

So in the last about 10 years or so data from MD Anderson from Pittsburgh and Fox Chase and a few of the other major cancer centers have shown that you want to increase that piece of the pie that you can operate on. You want to get the locally advanced and the borderline resectable tumors to operate on them. So how can you do that? And this is where the role of neoadjuvant therapy comes in.
What you really want to do is increase the potential of operable cases so that you’re able to get a bigger chance of these locally advanced and borderline tumors into the operating room and getting margin negative resections. Unfortunately there is no level 1 evidence for neoadjuvant therapy. There is no clinical, randomized clinical trial that compares neoadjuvant therapy with no neoadjuvant therapy. All we have because this is relatively recent is phase 1 and 2 trials and the outcomes for these have never been overall survival or progression free survival. The margins have been the outcomes have been how can we increase the rate of R0, increase the rate of margin negative resections. How can you reduce the amount of lymph node positivity around that area? And then how can we spare patients who have initially occult metastatic disease and operation and then having them develop metastatic disease 3 or 6 months after the operation. So neoadjuvant therapy achieves all these things. It increases the R0 rate, it decreases the rate of lymph node positivity, it spares patients with metastatic disease a big, big operation because you eventually give these patients a tincture of time, you give them chemotherapy and you wait. You try to shrink them down, you sterilize the lymph nodes but then the ones that have bad biology will declare themselves so you’re able to increase the survivorship. But very importantly is it gives you a real time assessment of the pathologic response of chemotherapy. So you give someone chemotherapy just like colorectal cancer, you see it shrink, you take it to the operating room and then you know if that chemotherapy agent worked because you see a response in terms of the microscopic findings on the slides.
So what are the best markers for neoadjuvant therapy? You give someone neoadjuvant therapy can you take them to the operating room after 3 or 6 months? There’s 2 good papers about this, one is from MD Anderson. They looked at 129 patients again small numbers but these were significant; 129 patients with borderline resectable tumors. They were truly borderline in about 122 of them locally advanced, unresectable in a small number of patients. Interestingly only 1 patient converted from advanced to resectable, only 1 patient on imaging. Only 12% had a response by resist criteria but 80% of the cases had a margin negative resection. So they took 66% of those patients to the operating room the ones that did not progress, the ones that did not get metastatic disease and they said let’s see what we can get with this chemotherapy. Eighty percent of cases had a margin negative resection. So CT scans are good to put the patients in buckets up front but they’re not good after neoadjuvant therapy.

So is there something better? And there is and it’s this CA19-9 response. This is data from one of my residents Brain Boone who published this a couple of years ago and it showed that the CA19-9 response on neoadjuvant therapy for patients with borderline or local advanced tumors actually predicts survival and actually predicts R0 resections. So what I’m trying to tell you here is the following. You’ve got to use a CT scan up front but you’ve got to use it again but don’t be discouraged if the CT scan does not show a response, use that in combination with a CA19-9 and see where that takes you in terms of resection. If I get a patient who has a borderline resectable tumor I’ll give them chemo up front. If the CA19-9 decreases then I take them to the operating room. Interesting to hear the Brain Boone data from Pittsburgh any increase in CA19-9 on neoadjuvant
therapy was associated with a 0% chance in resection. Zero is a powerful number; I mean none of the patients were able to get a margin negative resection. So this is a really important thing to consider.

So I’ve told you about definitions of resectability, I’m going to talk about the effective chemotherapeutic options next. This is a busy slide but the aim of the slide is to show you 3 decades worth of data that shows that the chemotherapy that we have is not good. This slide shows you 2 main things. Five clinical trials over the course of the last 3 decades have shown that if you resect pancreatic cancer and you give chemo at the back end, that’s called adjuvant therapy, then you prolong survival. But the problem is that you don’t prolong survival much. It’s about 1-3 months. This trial here was in the 1980s maybe some of the gray haired surgeons in the room may remember this the GITSG trial was a it’s a problematic trial, we don’t use that anymore but it’s it accrued a small number of patients and the results were not really substantiated. So the take home message here is that adjuvant therapy or chemo after resection is good but it’s not great because we don’t have good chemo. And the chemo here is 5FU Gemcitabine based chemotherapy with or without radiation.

However in the last 3 years there’s been a really revolutionary change in chemotherapy. We are now seeing numbers that kind of approach colon cancer response rates. If you look at this trial which looked up FOLFIRINOX versus Gemcitabine, Gemcitabine is standard of care just like 5FU was for a long time for colon cancer; you will see that the response rate for the FOLFIRINOX is actually
30% as opposed to 9% of for Gemcitabine. It’s not great but it’s much better, it’s a tripling of response. The survivorship was actually doubled for patients who received FOLFIRINOX versus Gemcitabine for metastatic cancer.

Quickly in addition to this trial there was another trial that came about 6 months later this is the Gemcitabine combined to ABRAXANE trial so Gem and ABRAXANE vs. Gemcitabine alone. And again response rates of about 30% and an almost 3 month increase in survival. So FOLFIRINOX is better than GEM/ABRAXANE we think but we have not gone head to head. But what I’m trying to say here is that there’s better chemotherapy so why not use this chemotherapy in the neoadjuvant setting and the adjuvant setting.

The other problem with the survival in pancreatic cancer is the morbidity of the operation and a lot of you probably know about the Whipple and the morbidity of those patients. I’m going to show you here data from 4 decades. This really summarizes a lot of the data on Whipple and I want to show you briefly that the operative time has come down nicely. EBL from a liter down to about 700 which is good, length of stay as I showed you has come down. Mortality has gone down from 30% to 1% that’s the post operative mortality. But the morbidity has actually stayed the same in fact it’s actually going up. The reason it’s going up is because we’re doing tougher and tougher cancers than we have been doing in the past. So the morbidity is a huge, huge problem, it’s still 45%. Why is this a problem for patients with pancreatic cancer? This is really a seminal, seminal paper for pancreatic cancer. It’s busy but it’s actually simple. The MD Anderson group looked at patients
who had resected pancreatic cancer, looked at the impact of complications and neoadjuvant therapy. Briefly I want to separate the graphs for you in 2 chunks. If you look at this group of patients here who had really dismal survival a median survival of about 13 months, those are patients who had surgery up front followed by major complications. So even if you do an excellent operation but you have complications your survival is just as bad as having no resection at all. If you get chemotherapy up front but you progress, you don’t get resected it’s also bad. However, you come to this group of patients, if you get surgery first with no complications then you’re good but I showed you just now that 45% get complications. It’s not common for patients not to get any complications. However, the important part is that if you get neoadjuvant therapy, surgery, or no major complications or you get neoadjuvant therapy, surgery and major complications you do just as well. So again the theme here is this last one. If you get neoadjuvant therapy, you get surgery, but you suffer complications like everyone does, surgeons are really pretty much equal when it comes to major complications after Whipples, then you actually have a better survival. So you get your chemo up front and that really gives you the survival benefit that you need and you anticipate complications post operatively. So getting the surgery first, I come back to these 2 points. Getting the surgery first but getting major complications in the presence of R0 resections is just as bad as doing nothing at all.

So we’ve spoken about these 3 things and then I really want to for the next part of the talk, talk to you about reductions in post operative morbidity, how can we reduce the morbidity from 45% to something lower. And then show you a little bit about the Pittsburgh paradigm of how we’ve come
to manage pancreatic cancer based on what I’ve showed you in terms of data. I think the best way to show how we manage it at Presby and Shadyside and we hope in other places as well, is to show you this timeline. We have a pancreatic multidisciplinary Tsung, Dr. Marsh, Dr. Ken Lee and also includes a GI doctor, a pathologist, radiation oncologist and a chemo doctor. It also includes people from palliative care; nutrition, behavioral therapy and so forth. So we see patients on day zero we do get a CT scan and an endoscopic ultrasound and CA19-9 just like I showed you before because this is important metrics. We then give neoadjuvant therapy. There’s a lot of stuff that goes on here in terms of neoadjuvant therapy. What regimens to give, what clinical trials to give, we have a bunch of clinical trials for these patients. But the important thing is that we’re giving GEM/ABRAXANE and FOLFIRINOX the data that I showed you is good for metastatic cancer. We then restage and we use Brian Boone’s paper the CA19-9 and we also use a CT scan as well.

It’s not as informative but we still use it make sure patients don’t progress or have metastatic disease and then we take them to the operating room and we do a fair number of this robotic type minimally invasive operations to reduce morbidity. And I’ll show you more about this in a second. But then we discuss them in Tumor Board and we look at their response. Is there a response to these agents pathologically, is there a pathologic response? And then we give neoadjuvant or adjuvant therapy based on the data that I showed you before that is really, really geared based on what we found here. So if GEM/ABRAXANE doesn’t work we’ll give FOLFIRINOX and vice versa.

So what about robotics? I’m going to discuss these issues about robotics, safety, efficacy and the advantages and so forth and how we can really strive to reduce the morbidity of pancreatic
operations. This is a timeline for surgeons really. The Whipple was discovered or was first implemented in 1935 by Dr. Whipple at Columbia and since then there’s really been nothing other than laparoscopic and robotic Whipples. I have done both at Pittsburgh, I used to operate with Steve Hughes when I was training here. Steven Hughes left us a while ago but I’ve done both and I really feel the robotic approach is a better platform for this. For those of you who know robotics it’s different from laparoscopic surgery because there’s a lot of magnification in it, there’s stereotactic vision you actually see things in 3D, whereas laparoscopic surgery you’re seeing things as you’re seeing them here in 2D it’s like looking at a screen. Robotics is 3D you’ve got depth perception which is really much more comfortable. You actually have complete range of motion within the instruments so and it’s even better than the human hand and it allows you to be ambidextrous whereas laparoscopic surgery you’re using essentially your wrist with sticks to go into the belly so it’s much better. And actually those complete, you actually work through a computer platform and the computer platform eliminates the tremor completely so where as with your laparoscopic instruments you come in with long instruments. If you’re holding a stick and you’re trying to get to something with the stick there’s a lot of tremor at the end of the stick. But with robotics there’s completely nothing.

Finally the surgeon sits on the console not scrubbed, comfortable, no shoulder pain, no neck cervical spines down the road, so that could be something that we’re going to see down the road. But these are the advantages.
At the University of Pittsburgh our program has done nearly 700 robotic pancreas cases. I’m going to focus on pancreas here but we’ve done a lot of livers and other things but we think it really pertains to pancreas because that’s the highest morbidity, that’s where you want to try to reduce the morbidity. We’ve done about 330 Whippets, 200 distal pancreatectomies and then a bunch of other operations. For the surgeons in the room these are all operations that are just extensive, extensive operations. They aim of this slide is not to show you that we do a lot but it shows you that the platform is versatile. You could use it for any type of operation in the belly and specifically for the pancreas. I spent the last 5 or 6 years trying to prove that it’s safe and we’ve published a lot, these are all in the literature. I’m not going to go through them in detail but I want to show you one telling slide. After about 300 cases we now have the operation down to almost as well as we think we can get it and the data is pretty good. The OR time has gone to about 6 hours, the blood loss down to 250ccs. Blood loss is important. If you lose blood and you give transfusions there’s a higher risk of recurrence of cancer. So we think this is an important metric. Length of stay is down to 7 days. Morbidity is substantially down it’s still going down, but it’s substantially lower than what’s been published out there and the mortality has not suffered. So 30 day mortality is pretty much at par with what we’re seeing recently from the other slide that I showed you.

Everyone accused us of taking the simple cases so they’re saying you guys are doing Whippets and distals on the easy cases, the benign cases. But the data that I’m going to show you now really stresses the fact that we’ve expanded the selection criteria to include all cancers and even the tougher cancers. This is a case, the surgeons in the room might appreciate this, this is a case in which the
patient has a completely replaced common hepatic artery coming off of this SMA. Usually the common hepatic artery comes off of the anterior to the portal vein off of the celiac trunk, but this comes off the SMA and of course is right next to the tumor behind the portal vein. From a surgical perspective this operation is a nightmare it’s a tough, tough operation. The patient has what we call borderline resectable cancer just like I showed you before. We did an EUS to confirm that it touches the portal vein and that it’s close to the SMA. We gave the patient neoadjuvant chemotherapy the CA19-9 responded, it went down to a normal value and we took the patient to the operating room and did a robotic Whipple on this patient. So we just used a few ports just like you do with laparoscopic surgery and there’s going to be a bunch of videos but there’s no way of showing you really what it is until you see it. So this is the duodenum we’re flipping it up and essentially we divide it and mobilize the duodenum, this is the stomach, the stomach is removed at the time of the Whipple operation 10% of it is removed, and then we divide the small bowel very early on. For the surgeons in the room this is important because this is usually a late stage but for us when we have a good CT scan we know that we’re going to get this tumor out with good margins. Then we dock the robot. I don’t know if you’ve noticed the difference can we, if we can have the lights down that would be great. But essentially the robot has many arms which are all controlled by the surgeon and this is the bile duct here that was the cystic duct and this is going to be clear in a second to you. This is the bile duct which we dissect out and we cut the bile duct, so you have to cut the bile duct in this operation. We use staplers in addition to the robotics. But then very importantly this is the pancreas, this is the pancreas. The tumor is over here and this big blue structure that you’re going to see in a second is actually the portal vein. So we lift the tumor and the pancreas off of the portal vein,
there’s no tremor at all, this laparoscopic suction these instruments are those of the laparoscopic assistant. This is the assistant that’s standing at the bedside. The surgeon is controlling all these arms and seeing this in 3D and magnified. So the pancreas is then cut in the middle again we want to, this is the good part, this is the bad part, things will become a bit clearer in a second for the non surgeons obviously in the room. But the tumor is in this area and the key is to get it off of this vein and the artery that I showed you before. So we have energy, you have clips, you have the robotic arms are very versatile they have a lot of equipment attached to them. You can see here we’re getting around major blood vessels. The good thing about robotic surgery is that blood loss is minimal and it’s mandatory because if there’s blood loss you cannot do the operation. So you’ve got to do it with less blood loss.

Here’s the SMA you’re going to see it again in a second but we’re clipping all these blood vessels. This is, for the surgeons, this is the inferior pancreaticoduodenal artery, we see every vessel. You can tell the level of dissection we’re removing all the tumor off of those blood vessels. This is the gastroduodenal artery and again this is a tough case where the tumor is here and this artery comes up behind the portal vein. Usually it’s way out of your way out of your vision. Major artery the patient cannot live without these vessels. This is all tumor tissue and again you’re seeing it in 3D and you have a hook that has complete range of motion. So we’re slowly getting the tumor off of those blood vessels. This may look a bit confusing but for the surgeons we flipped the entire tumor and then you’re left with the back end of the tumor and it’ll be clear to the audience just in a second how
intricate this dissection is in getting the tumor out. Again really a tough case but showing you that
we can expand our criteria with this.

So these are the lymph nodes they’re completely removed and in a second you’ll see the final picture
which is very telling. And you can see here, the artery, the vein, look at this is the SMA completely
skeletonized. This is a vision that you don’t see in open surgery and it’s hard to see with
laparoscopic surgery. So not just easy cases but really the tough ones are being approached this way.
The entire specimen, the entire vessels are skeletonized. This is inferior vena cava right here. Okay
we’re going to leave there.

So this patient was discharged home on day 8. He had a 2 centimeter tumor with a moderate
response, 56 lymph nodes were removed, we’re seeing this often. We’re seeing more
lymphadenectomy obviously that depends on the pathologist but we’re seeing a definite trend there.
Only 2 lymph nodes were positive this is the neoadjuvant treatment effect we’re sterilizing the
lymph nodes. And then we got R0 margins for this which is the most important thing to get.

Here’s another one. Can we have the light down just for a few minutes because there’s a bunch of
videos back to back. This is a tumor in which we’ve removed the 70% of the vein completely and
we’re now sewing a pericardial patch onto the vein. But here the surgeons in the room I’m using the
left hand to sew, I’m a right handed dominant person and this is not about skills. The robotic
platform allows you to use both hands just as you’re using you know your dominant hand. So this is
6.0 suture and then we essentially reconstruct the vein. We remove the bad portion of it and reconstruct it. So this is a bovine pericardial patch that’s used and this is another area where we actually sew the 2 ends of the vein together. So for the surgeons again in the room we’re doing the tough, tough cases.

Here’s another one where the tumor is completely involving the entire vein. This is the SMV this is the portal vein and we literally transect the entire vein so you’re the liver is left with no blood supply and the intestines cannot drain. So you’ve got to connect it quickly. This is a scary, scary moment for a surgeon because if you lose one of those clamps the patient can exsanguinate and die on the table. So we bring both ends together, this is a tough operation open and then to be able to do it this way is pretty remarkable.

So you can see here the distance the whole distance of just no blood flow into the liver. This is a complete portal vein resection again using 6.0 suture and then bringing the entire specimen up and then sewing the vessels together to get negative margins but again with minimal blood loss and hopefully some of the better technology.

So we put this in a paper which was published by (inaudible) she was a resident with me she’s now at the Cleveland clinic. But essentially we looked at robotic cases who had weird vessel anatomy and advanced cases vs. ones that were simple cases if you like, simple robotic cases. You can see
here the blood loss, the conversion to open, the morbidity, the pancreatic leak and the length of stay all similar. So this is a good technology for tough cases.

What about the cancers? Were we doing justice to the tumors? Were we able to get R0 margins and you can tell here that 93% of the cases had a margin negative resection and we were able to get a lot of lymph nodes with these tumors and essentially good, good short term surrogate of oncologic markers. What about tumors that are not on the pancreatic head tumors in the body and the tail. These you do a distal pancreatectomy for them an operation called the distal pancreatectomy where you cut at the same place but you take out the body and the tail of the pancreas. However, if the tumor is involving the celiac trunk this is a locally advanced unresectable tumor. In any other institution this patient would only get chemotherapy. In Pittsburgh we’ve been doing the chemotherapy to shrink them but we’ve also been doing another operation called a distal pancreatectomy with a celiac trunk resection where we remove the entire celiac trunk and leave the gastroduodenal artery and blood flow goes from the SMA into the GDA into the liver. This is also called an Appleby operation it was discovered awhile ago but now recently has been rejuvenated.

So when we looked at open versus robotic cases there was really no difference except that the robotic cases had less operative time, less blood loss, less transfusions, and more lymph nodes retrieved. So this technology works for a diverse group of operations in the pancreas.
For people who know much about pancreatic surgery the problem with the pancreas is that it produces enzymes so when you hook it up to the bowel it leaks because it digests your sutures. So the main morbidity of a pancreatic operation is what’s called the pancreatic leak when they leak amylase rich fluids that causes havoc; infections, pseudoaneurysms, death and so forth. So the main criteria for safety is actually how well you are able to sew the pancreas. If you have a very soft pancreas or very small duct you have a higher leak rate because it’s harder to sew. I’ll show you here again.

This is a very, very small pancreatic duct, 1mm which is very small and we’re sewing this duct to this tiny hole, again this is magnified so this is 5.0 suture. You can see here the way the angles work you can use both hands and you can use angles that are better than the human hand. You see the angles again this is not afforded to you by laparoscopic surgery. And you’ll see now left handed sutures being thrown as you can see here. So this is a soft gland and a very, very small duct. This gland is going to leak. So we decided to look at the outcomes of pancreatic leaks with robotic technology because this is really the main impact of morbidity.

This is Patricio Polanco, Patricio for those who know him was one of our residents he’s now at UT Southwestern he just had twin girls which is befitting for him. He actually published his data on pancreatic fistula and showed us that the rate of pancreatic fistula at Pittsburgh using the robotic approach was actually very similar to what is seen with open data. This is a very famous paper about open Whipples and how much they leak about 18%. We had a 17% leak rate and the leaks
that were significant the ones that caused ICU admissions, deaths, infections and so forth were only half of this group which is very, very encouraging. I’m not going to go into his multi-varied model but we then went ahead to validate what we saw here. We went ahead and then put our data with about 3,000 Whipples done open fashion so these are done by the standard open technique. And we actually performed a matched analysis of power, 3 surgeons; myself, Herb Zeh and Melissa Hogue doing the robotic Whipples versus 51 surgeons who are all high volume at centers of excellence around the world, Europe and the United States. So this was propensity matched again minimal retrospective bias here. And you’ll see here that the leak rate was similar, the P value is the same, but there is a trend. All other outcomes were similar but the length of stay there was also a bit of trend. So what we have here is a technology that’s safe and effective and it’s not biased it’s not just us having this case selection criteria. This is also you know data that’s really worldwide when you put the robotic information in it.

So we talked about safety, efficacy, oncologically it is a sound operation. I showed you some of that data on R0 margins and lymph nodes. But what about the learning curve? How long did it take us to achieve this? And if you wanted to have surgeons here at McKeesport who are very versatile in liver and pancreatic surgery for them to apply this technology how long does it take for them to get over the learning curve and apply it here? This is data that I just published with Brian Boone, Brian Boone was one of our residents and Brian looked at the learning curve. This is what’s called a CUSUM analysis. CUSUM is a great way of looking at the learning curve of a procedure. You essentially take the mean difference between each case consecutively and you add them onto each
other and if the graph continues to go upwards that means that you’re still learning and you’re getting faster and faster because the mean decreases. However, when the graph starts to plateau that means you’ve either hit your learning curve or you either have hit a problem. There’s bad outcomes, surgeons need to get better, they need to be educated better, they need to be retrained. So this has been used extensively in other scientific fields so we looked at it for Whipples and distal pancreatectomies and low and behold the number was staggering. It took us 80 cases to learn this technology for Whipples and about 40 cases to learn it for distal pancreatectomies. Initially here there was a plateau, there was a change in technique and we got back on the horse again and kept going and then this was the plateau. So 80 for Whipple and 40 for distal pancreatectomy so that sounds like a huge number. You need 80 cases to get to where you want to get to, but the good news for us is that there’s 3 seminal publications from 3 major institutions that show that the open learning curve if a surgeon comes out of residency and wants to do Whipples he needs anywhere between 60-100 cases to become proficient. The learning curve, this is the most complex operation there is in the belly arguably in the body. So if you need 80 cases robotically that means it’s probably the same learning curve as it is for open Whipple, so it’s not that daunting when you consider this information.

How did we implement this at UPMC? We implemented it by doing 2 attending cases. So either I was at the console operating the robot and one of my senior partners or junior partners was at the bedside or vice versa. You need 2 attendings that are experienced to be able to get this done. Two you need high volume. You need 80 cases but you need to get through the 80 cases quickly you can’t be doing one every month or 2 months, you need a high volume of cases. This is data from
Intuitive the company that makes the robot. This is upper GI and complex HPB surgery. You don’t need to worry about the divisions here, green in pancreas. You can see University of Pittsburgh is actually the number one institution in terms of volume for robotic surgery. These are the top 20 centers. Even if you’re down here it’s not sufficient to get over the learning curve you need a lot of cases.

But most importantly you need guidance, you need mentorship, simulation and curriculum. We did not have this when we started. We did not have a curriculum, no one guided us on how to put in the ports or how do to this, so it took us 80 cases. What we’re now seeing is we educate surgeons from abroad that the number is actually lower. The number can be reduced by half or even further if you have good guidance, mentorship, simulation techniques, there’s a simulator that comes with the robot, and if you have a good curriculum. We are now working on establishing these and finalizing them. We do have a very good curriculum for the residents and the fellows and the new staff.

What are the implications of this learning curve? This is where probably one of the most important slides in this talk is Herb Zeh and Jim Mozer who some of you know started this technology in 2008 at Pittsburgh. I was a fellow back then with them. And then I joined them on case 93. Melissa Hogue our other partner joined them during case 164 but then we’ve had a multitude of trainees do these entire operations from start to finish even without the huge learning curve that you saw before. So this technology can be disseminated safely to people who have an interest in this, but people who have good guidance, mentorship and simulation and curriculum.
Are there any advantages? I’m going to spend the last few minutes just talking about the advantages. I think we started about 5 minutes after so I’m going to stop around 1:00. So we know that laparoscopic distal pancreatectomy is superior to the open approach. This has been shown before in the last 10 years. Our UPMC experience with laparoscopic pancreas surgery started in 2002, but is there a benefit to the robot compared to the distal laparoscopic pancreatectomy. And we just published this. A very seminal paper in the annuls of surgery that showed us when we compared laparoscopic and robotic distal pancreatectomy together there were reductions in operative time, blood loss, margins and conversions to laparotomy. You’re able to complete an operation with the robot a minimally invasive fashion more than you’re able to complete it in laparoscopic fashion. Interestingly there were more cancers in the robotic groups. You would expect the cancers to be tougher cases but we had a 0 conversion rate to laparotomy.

I then went ahead took our data and combined it with the NSQIP data. NSQIP now gives you data on which type of operations and what the outcomes are. And if you just focus on this area here for Whipple and distal pancreatectomy we compared open, lap and robotic in NSQIP so that’s not just UPMC data that’s American National Data. And you’ll see here that again the robotic approach you can complete it across the nation with more success than laparoscopic for both Whipple and distal pancreatectomy. So you can harness the benefits of minimally invasive surgery more with a robot than you can with the laparoscopic approach.
There’s more of this data I think for the interest of time I’m going to leave it. But I’m going to show you that we only do, we do this for cancers but we do this for benign disease. And this is a case that I’ve done many, many times. This is a patient who had pancreatic necrosis and he’s developed a walled off necroma. This would require a major operation, multiple drains, feeding tube, in the hospital for about 7-10 days to get this done. Essentially what you need to do is connect the stomach to this area, get inside and remove all that dead pancreatic tissue. I went there for all pancreatic conditions. We make a hole in the stomach, and we then get into the back wall of the stomach and then we pop into this big balloon which is the necroma. And I know you guys just had lunch, this will be a bit not pleasant to the eye but it’s interesting nevertheless. So you get that pus out and then we create a connection between the stomach and the wall of the cyst. You do this open it’s called a cyst gastrostomy, all the surgeons here know this operation. We do it with a stapler you would do that laparoscopically but then, this is the benefit of the robot, you get in with your camera, and then you remove the dead pancreatic tissue. This is all this looks like a sponge but it’s actually dead pancreatic tissue completely debrided. This causes sepsis sickness. If you were to do this endoscopically and you know our group does it endoscopically it just takes a lot of multiple debridements to get this done. Surgically it’s a one stop shop. You do this quickly, no drains, nothing, patients go home at about 5 days or so and are back to work sooner. Then you know you close the hole of the stomach up essentially.

So just to show you that we looked at robotic vs. endoscopic cyst gastrostomy and the cost was beneficial for the robotic, so it’s a one stop shop. So these patients who have acute necrotizing
pancreatitis bring them in to get this done is a better deal, it’s a better one stop shop for these patients.

So I’m going to leave the rest of the talk I only have 5 more slides left but the ERAS portion of it I think is not important for this group. But I want to summarize for you by telling you that multimodality treatment for pancreatic cancer is effective in prolong survival for these patients if done appropriately. Robotic pancreatic surgery is definitely safe when you’ve passed the learning curve and it’s feasible and it’s versatile. You can use it for a lot of diseases. The learning curve for the robotic pancreatic operations is now well defined and the outcomes beyond the learning curve do suggest that we do have advantages compared to open and laparoscopic approaches. Thank you very much.