Speaker 1:

Welcome to Optimal Neuro/Spine Podcast, a podcast about optimizing our brain and spine in health and disease. Each episode, leading neuroscientists, neurosurgeons, educators, patients, spine care, and quality improvement experts discuss their research, experience, emerging science, surgical advances, and insights about how to optimize neurological and spine care. Now here's your host, Dr. Max Boakye.

Dr. Max Boakye:

Welcome to the Optimal Neuro/Spine Podcast. I am Dr. Maxwell Boakye. Today is Episode 15, and we'll be speaking with professor Thomas Picht. Is that correct pronunciation?

Dr. Thomas Picht:

It's very tricky to pronounce for you. I know it Picht, but Picht is perfectly okay.

Dr. Max Boakye:

Yeah. Picht, who is a professor of digital neurosurgery at a Charite University Hospital, and he's the head of the image guidance lab and Co-director of the Berlin Simulation and Training Center of the Charite University Hospital. In addition, he's PI, Principal Investigator and board member at a cluster of excellence matters of activity at a Humboldt University in Berlin. He's also a clinician scientist, his research group deals with noninvasive brain function diagnostics, connectivity analysis, and neuromodulation with the aim of optimally treating brain diseases with individualized therapy concepts.

Dr. Max Boakye:

His research also focuses on modern visualization strategies for understanding and mediation of spatially complex structures, as well as establishment of novel simulation concepts in education and surgical practice. His research group is in contact with a large number of medical device manufacturers and startups. His comprehensive clinical and scientific experience in dealing with the highly dynamic materiality of the brain is decisive for his project, Adaptive Digital Twin. This is something that we're going to talk to him about. It's real pleasure to have the interview with professor Picht today. Welcome.

Dr. Thomas Picht:

Welcome. Thank you very much for having me.

Dr. Max Boakye:

Did I miss anything in your background in your training and background? I should mention that you completed your residency training in neurosurgery in 2007 at Free University in Berlin and currently a board certified neurosurgeon practicing there in Berlin. Anything else you want to add to your background?

Dr. Thomas Picht:

Well, that was actually very comprehensive. Thank you Max, for this nice introduction. I might mention that this position of the professorship for digital neurosurgery, it's a pretty recent thing. It started half a years ago. It's, at least in Germany, it's the first of its kind, which really shows that the Charite and the Humboldt University really think that this is a very important topic for clinical medicine.

Dr. Max Boakye:

And that's exactly my first question to you. I had never heard of the term digital neurosurgery. I want to clarify that you do actually do in contact physical brain surgery, right? Not just sitting on the screen doing some digital drawings on the screen. You're actually a neurosurgeon take care of patients, but maybe you won't want to explain to us what exactly is digital neurosurgery?

Dr. Thomas Picht:

Yes, obviously it's a huge field and I should stress in the very beginning that in the middle of all this is the patient and is the surgery. Everything else is grouped around it. So we understand digital neurosurgery not just as planning of surgery on a screen and then using those images more or less fluently during surgery, for us the concept begins really with the patient having the first symptoms.

Dr. Thomas Picht:

So if you think about it, there's not a single step in the whole patient journey where not any type of digitalization is involved. So we really, with this professorship, we really want to address the whole treatment process from the beginning to the end.

Dr. Max Boakye:

So were you the first university to do this, are there other universities doing this?

Dr. Thomas Picht:

No, I think we are really the first and interestingly, this professorship is funded not by the hospital itself, but as you mentioned in the beginning by Humboldt University and the background of this is humanities. So the incentive to install this professorship is coming from people who are interested to see how this digitalization influences or impacts our working environments and for example, our relationship with our patients. This humanistic perspective, which is in the background of all this, but it certainly also includes, and you alluded to my research background, it certainly kind of comes together in. What is commonly known as functional neuro navigation.

Dr. Thomas Picht:

So image based surgery, image guided surgery is at the center of all these efforts. But as I said, we really try to be holistic here and take all those diverse perspectives into the focus.

Dr. Max Boakye:

So in what key areas do you think that differs from what was previously done? So let's say how is what you're doing different from how things were done let's say 10 years ago?

Dr. Thomas Picht:

Yeah, that's a good question. I mean, for us being involved daily in treating patients, things progress so slowly step by step that sometimes you forget to realize what big steps have been achieved in recent years. So if you look at our practice, well, let's say 15 to 20 years ago and now, it's completely changed in the sense I would claim mainly that we changed from relying on our anatomical knowledge in our mental roadmaps to rely more and more on digital data. Mainly imaging data, but also multimodal other datas, which are, like I said at the center of our efforts to bring all those things together and not just with a research perspective, but really to have practical new workflows in the best interest of our patients.

Dr. Max Boakye:

Now, you also mentioned image guided neurosurgery. Is that the same thing as digital neurosurgery or is one a subset of the other?

Dr. Thomas Picht:

Well, image guided neuro that's a subset of the other. Digital neurosurgery really alludes to the whole patient journey from the first symptom to the successful treatment. Image guided neurosurgery, what we mean by that is really carrying out the intracranial procedure with the highest safety and with the best outcome. This obviously is based on neuro navigation as the key technology, but we see the image part in this. So the image not really just as a tool to navigate in our patient's brain, but really as a knowledge space.

Dr. Thomas Picht:

So what we try to achieve is that we enhance the image with all the information we need at a specific point, at a specific time point as well. So what I mean by this is that for example, the functional imaging data and what we know about the individual connectivity in our patient's brain, this needs to be available in a way that it really supports decision making. Which means it must be available easily and the interpretation must be very intuitively. And so this goes into the direction of our concept of the Adaptive Digital Twin.

Dr. Max Boakye:

I'm going to ask you about that in a second, but one more question about the digital neurosurgery. So from the patient's point of view, what their experience is like to them, you mentioned digitization of their experience. So do the patients feel differently in terms of, are they experiencing new things? Are you digitizing their movements or what is different about compared to 10 years ago in terms of what the patient actually experiences?

Dr. Thomas Picht:

Well, the main difference for the patient is that the workup before surgery has become really, really extensive, I have to say. Just let me mention that for all our oncological cases, we are not doing only the standard MRI imaging, they all receive functional MRI imaging. They all receive transcranial magnetic stimulation workup. We are now including EEG recording in parallel to TMS mapping and we correlate all these technological driven investigations with a very detailed neuropsychological assessment.

Dr. Thomas Picht:

So this has become very time consuming for our patients. Apart from that, I mean, we try to have a very traditional close personal relationship with the patients. So actually we investigated this whether or not patients really appreciate it, if you expose them to a lot of, let's say, modern technology and the result was at least this is true here for our patients in Germany or in Berlin, that they don't really care so much about that. They want a close, personal relationship with their treating physician and they don't want to hear all those details about what is going on on the technological side in the background. But as I said, they have to go through these very extensive investigations. So, that has really changed.

Dr. Max Boakye:

Okay. I'll ask a little bit about why we are going through all this trouble of getting all this additional information, but let me ask you a little bit about the Adaptive Digital Twin. What exactly is that?

Dr. Thomas Picht:

Well, the concept, as such, you could say is that's stolen from other areas. This concept of Adaptive Digital Twins is present in the manufacturing industry for many years, if not decades, to monitor the aging of parts. So this is of course difficult to translate to the brain, but in the core is more or less the same. So what we try is, to come up with a virtual version of all patients brain and not in the sense that it is a perfect copy of the patient's brain, but that it allows us to perform realistic simulations. What we also like to call trial acting, so that we can test, let's say, different approaches to a brain tumor or different extents of resection in this Adaptive Digital Twin, in this simulation scenario. That it's a key of the concept.

Dr. Max Boakye:

I see. So you get it almost like a replica of the brain that you can study virtually and kind of plan your surgery even before the actual surgery?

Dr. Thomas Picht:

Exactly. I mean, the brain is such a malleable organ. So it's hard to predict what happens when. I'm talking here really about cutting a specific connection or cutting two different connections. And then to know what effect will this have on the overall functionality of a specific network? This is even for very experienced clinicians hard to say. So this is where this data driven technology comes into play. So we draw on large databases to come up with these simulations. And the tricky part is of course to make these predictions reliable in individual patients.

Dr. Max Boakye:

I see. So in this simulation, are you looking at physiological effects on network function or you're also trying to simulate things like paralysis and clinical effects?

Dr. Thomas Picht:

Well, the core is like you say, the network function. And it's actually not only about trying to prevent damage. These kind of simulations also allow us to even improve functions. For example, by disconnecting hearts of the network, which in response to the pathology are underperforming. So this opens up a whole new treatment options. Like I said, not only with the concept of do no harm, but also with the concept of maybe improve things.

Dr. Max Boakye:

Do you have publications on some of these newer approaches through the adaptive twin?

Dr. Thomas Picht:

Well, we recently published together with the colleagues from the Technical University in Munich here in Germany, a paper on using TMS for therapy. This is still rather untargeted, but it already shows how noninvasive brain stimulation can enhance function. So the concepts are there and I truly believe that with this knowledge about the individual network function, we will have very efficient, targeted approaches in the future to induce neuromodulation even before surgery to make surgery more

successful. Or in the case of new deficits to treat those very early after surgery. Not only after in the chronic phase, but very early on.

Dr. Max Boakye:

So can you describe what kind of challenges do brain tumor neurosurgeons face? What are the main problems that you're trying to solve?

Dr. Thomas Picht:

Well, I think one of the main developments in recent years was this paradigm shift from function being localized in specific brain areas to function being represented in highly dynamic networks. I think this is a mindset, hopefully every current resident has on his mind and will learn how to apply this in his practice. But I think the challenge is that it became obviously much more complex to plan brain surgery with this new concept.

Dr. Thomas Picht:

So for me, the challenge which we are undergoing currently and which I think will dominate our practice in the coming years is to make these new concepts in combination with the new technologies which are available, really practical applicable. I think this is always the main challenge. I mean, you can have wonderful theoretical concepts, but when it comes to performing brain surgery, it needs to be very robust and applicable in daily clinical life. And this is for me the main challenge for the academic and scientific side and as well, the main challenge for the generation of neurosurgeons.

Dr. Max Boakye:

So what are some of the most exciting technological advancements that you're currently using? Maybe you can talk about the navigated TMS, augmented reality, what else that is new that you want to talk about?

Dr. Thomas Picht:

Yeah, I mean, I have to say that after many years of doing TMS research, I'm still fascinated by the fact that you can really pain less and noninvasively induce an electrical current wherever you want on the surface of the brain. And this opens up so many opportunities to better understand the individual brains wiring. But as I mentioned earlier, also to come up with new strategies to induce neuromodulation. I mean, we are all aware that slow growing brain tumors, for example, can be clinically silent until they become huge. So the brain obviously has a lot of potential for neuromodulation. TMS is a technology which allows you to speed up this physiological neuromodulation. This physiological plasticity. And I find this extremely exciting.

Dr. Max Boakye:

What is augmented reality?

Dr. Thomas Picht:

Well, working a lot with images and planning surgery based on images, it is obvious that looking at a 2D screen is these days not really state of the art anymore. So what we are trying to use in our clinical practice is augmenting the visual field during surgery with additional information which until now, until the introduction of augmented reality as a concept, it was always a sequential practice. So you look at

the 2D screen, make up your mental roadmap and then you perform surgery and try to remember everything.

Dr. Thomas Picht:

Now we have the opportunity sensitive to the current surgical situation to inject the information you need into your field of view. And I think this has great potential to make the whole process of surgery much more efficient and also safer obviously.

Dr. Max Boakye:

Let's talk about simulation. You do have a Berlin Simulation Center. Can you describe the types of research that you're doing there and how are you using simulation training?

Dr. Thomas Picht:

Well, the Berlin Simulation and Training Center here at Charite is a field for academic research for training our own residents, but also for corporation projects with the industry, because most technological advancements, big steps forward, are triggered by industry. I mean, they have the power, the money to put into these new technologies, but what often missing is really taking into account the real world scenarios we all encounter in our daily clinical life. The Berlin Simulation and Training Center is trying to bridge those two worlds.

Dr. Thomas Picht:

So what we are in particular good at, I believe, is coming up with very immersive simulation scenarios. So we are able to create clinical situations in a simulated setup, which for example, during training courses frequently lead to a situation where our participants forget that it's not a real clinical scenario they're in. This is very important for two things. One is the training effect is just much more efficient if you don't feel it's an artificial setup, but if you really believe you are in a real clinical scenario.

Dr. Thomas Picht:

The second thing is, this is a beautiful opportunity to test new things. So this is why our industry partners are so eager to test their new prototypes in our center. So they don't have to go through the very cumbersome process of performing a clinical study with real patients, but they can do it in our simulation center with artificial or virtual patients. One other thing I would like to add is that these days in a modern hospital, you have so much technology that we all run into problems of interoperability. So device 'A' cannot speak with device 'B'. So this motivated us to come up with, and I believe at least in Germany is the first of its kind, a simulated hospital for interoperability. Where new devices can be tested in a completely virtual scenario in terms of how do they interact with the other devices in a real clinical setup.

Dr. Max Boakye:

That's very interesting. So how has your education of your residents and medical students changed as a result of these simulation? And have you noticed a significant change in their rotation schedule and the duration of the residency training in any way or in their skills?

Dr. Thomas Picht:

Well, our concept there is that the curriculum of our residents is very dense and the learning curve in each resident is a bit different. We try hard to have high standards of education in daily clinical life, but I believe I don't have to explain that it's the same here as in the US and in many other countries. The day only has 24 hours, so there's not much time for, let's say, relaxed learning and apprentice situations like that might have been there many years ago. So what we are trying to achieve here at Charite is to frame the whole residents.

Dr. Thomas Picht:

So from day one to year six or seven, to frame all those critical steps, learning steps in the life of a resident with a tailored simulation set up with a tailored course to train specific capabilities, which you need to have as a resident. Those are becoming more and more not your typical, let's say, anatomical cadaver course, but simulated setups or hybrid setups where we combine classical learning scenarios life and anatomy lab with, for example, augmented or virtual reality setups, because those hybrid setups are so efficient.

Dr. Thomas Picht:

I mean, this enables our residents to, when they have the time, spend just a few minutes on a specific topic. And so to enhance their knowledge in the fields where they still need to improve. So our goal is to have a really continuous steep learning curve from day one to the end of residency, to have an overall high quality of treatment also then in our department.

Dr. Max Boakye:

With the simulation, is it a situation where a resident can, let's say, work on their own in the middle of the night, go to the simulation center and practice some things, or this is more always under some of supervision?

Dr. Thomas Picht:

Exactly. I mean, we have both things on our mind. So we have regular training courses with experienced consultants. And for example, dummy brain surgeries where residents can train, for example, subpial dissection. They shouldn't train it first on the patient. So we have setups where they can train this. This is then under classical supervision of consultant, but we also have self-learning educational center where the residents, like you say, I mean, they can go there in the middle of the night and improve their anatomical knowledge, their knowledge about positioning in the O.R, about anatomical access pathways and also hands on scenarios where they can, without any supervision, improve their manual skills.

Dr. Max Boakye:

So how do you assess if somebody's learning during simulation? Do you track error rates or what do you track things over time, how do you assess that?

Dr. Thomas Picht:

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Dr. Max Boakye:

What about for experienced neurosurgeons? Let's say you're a board certified neurosurgeon, you're 10 to 15 years out, do you think they would benefit for from simulation training and simulation as well?

Dr. Thomas Picht:

Well, you can always improve, I would say. For experienced colleagues, I mean, if you think about those new technologies which are now coming up, I don't know later, interstitial therapy, all those minimal invasive procedures, I mean, specifically, if you have been in the business for a long time, you have ways of doing things. It's not always easy then to adapt to new parts in your procedure which you are expected to implement it. So I think this is for example, a scenario where those simulation trainings and also trainings in VR scenarios to get used to those new technologies and new steps in your highly trained procedures can be very efficient, also for experienced colleagues.

Dr. Max Boakye:

The emphasis has been on emphasizing training for residents and trainees, but perhaps we should also emphasize that if you are a practicing neurosurgeon, maybe they should be encouraged to continue practicing the simulation as well.

Dr. Thomas Picht:

Yes, absolutely. I do believe that those simulation scenarios can also be very beneficial for experienced neurosurgeons. For example, when we implement new technologies here at Charite, there's often let's say, the unspoken rule that the older colleagues don't really want to change their practice anymore. So in the sense of let's do the younger ones, but I don't think that this is good because I mean, all those years of experience are so important. All this implicit knowledge which you gain when you do this for many years is also very important to implement those new technologies in an efficient way and in a way, which is really in the best interest of the treatment outcome of the patients.

Dr. Thomas Picht:

So I think here is another field where simulation setups and specifically VR trainings can help, let's say, older colleagues to accept those new challenges and get familiar with new technologies very efficiently in contrast to the typical setup, that new technology is kind of introduced by a technician from the company, and then you are more or less on your own with this new technology. So I think that those simulation setups can be very efficient in this field of introducing new technologies also for experienced neurosurgeons.

Dr. Max Boakye:

Now, you mentioned that your simulations are now so real that often residents they feel like it's a real clinical experience, not indistinguishable basically from the actual patient. So has that modified your view of learning? Do you now view learning or the skill as a surgeon, as something you're born with or more like something that you can train and with these simulations and sufficient hard work and practice that you can acquire level of technical dexterity and skill that previously would only available to truly gifted people?

Dr. Thomas Picht:

Yeah, that is a very good question. I'm convinced that those technologies can help us to bring every resident to a very good to a high standard of care, to a high quality of performing the typical neurosurgical procedure. This may sound trivial, but if you look at it from the perspective of the overall provision of healthcare in a country, this is very crucial. I think in every country, those challenges are

similar. You have, of course, your high end academic centers where we are lucky to work at, but we also have new surgical centers with a bit of a lower overall quality of treatment.

Dr. Thomas Picht:

So I think this is one way to look at it, that those new technologies allow us to really bring every resident to a very good standard of care and improve overall standard of care in neurosurgery, therefore, significantly. But then also to bring, I mean, you mentioned those gifted residents, I don't know the percentage of those, but it's rather low. I mean, those who really thrive, but also those residents can be supported by those new technologies and also can be maybe identified early in their career and then really be on the correct career pathway early on in their career.

Dr. Max Boakye:

Now you're at a one of the top university centers in Europe and in the world, right? Do you have an example of a resident that on day one you're like, this guy is terrible. There's no way can be a surgeon. And with all these training you turned them into an amazing or good surgeon? Do you have any examples of that?

Dr. Thomas Picht:

I would like to say yes to that question, but I mean, that would go a bit too far. But I mean, we have seen amazing progress in the attitude and the self confidence of our residents while doing those simulation courses. Because I mean, yes, it's very immersive and they kind of lose this vision that they are in a simulation setup, but of course, at least subconsciously they know that it's simulated. And so they are a bit more bold and try out things. This is just so effective in terms of improving your confidence to perform brain surgery. And confidence is important.

Dr. Thomas Picht:

I mean, of course you need to be very humble, but you also have to have a certain self-esteem and attitude toward this to perform at your best every day. So this I can claim, I have seen that those simulation setups and training courses have tremendously improved the confidence and therefore then also the perform of many of our residents.

Dr. Max Boakye:

And of course, being a world class neurosurgeon is more than just your technical skills, right? There is judgment and compassion and a number of other things that go into it. I don't know if simulation can really train those things as well. I guess that's remains to be seen. Any comments on that?

Dr. Thomas Picht:

Well, of course, it's very true. It's not only the manual part of this practice we call neurosurgery, it's much more. Here actually what we have started a few years ago that we try to identify promising future neurosurgeons already at medical school. So we offer courses to students at medical school with an interest in neurosurgery during their studies to expose them to those challenges and possibilities modern neurosurgery offers. Exactly to identify those people who seemingly have the whole package. So not only the manual skills, but also the right attitude, compassion to really do the best for their patients every day.

Dr. Thomas Picht:

I think this is important because the residency is short. I mean, in those six years, we have to learn a lot. So ideally, we select residents or residents select us who really have it all. This is what your question alluded to. I truly believe that those new tools help us with this.

Dr. Max Boakye:

So getting back to why the need to add all these newer things, EEG, TMS, have you evidence that it improves outcomes, that it makes surgery shorter, safer patient outcomes better in some way? Do we have a lot of evidence for that?

Dr. Thomas Picht:

I mean, the disappointing answer is no, we don't have good evidence. I mean, as you know, it's very tricky to really come up with level one evidence in terms of blinded randomized studies. Yes, we have become significantly better in the last 10, 15 years in terms of outcomes, in terms of hospital stay, in terms of treatment efficiency overall. But the exact role of those new technologies in this is not really clear, but there are many, many papers on this topic obviously. They all claim that these technologies, TMS being one of them, have helped to improve treatment efficiency.

Dr. Thomas Picht:

IF I look back now 10 years ago, or let's say when I started my residency 20 years ago, I wonder with how little individual information about our individual patient, we went into surgery. So we had rough functional, anatomical knowledge, but that was it. Nowadays, and this is why we spent the effort and also the money to perform all those additional investigations, I think we just owe it to our patient, that we do everything we can to know as much about the individual patient's brain as we can. This is what we are trying to do here with the Adaptive Digital Twin. We feed all those information into it from TMS, EEG, FMRI and all those clinical investigations, and in the end, we try to annotate every voxel in our image with the information at this place in our patient's brain, which is needed to achieve the best possible surgical result.

Dr. Max Boakye:

So then can you virtually get rid of some voxel and then see some predictions of what that would do?

Dr. Thomas Picht:

Exactly. I mean, these are all probabilities and this is also why this wasn't possible 20 years ago, because you need a lot of computational power to do this. So for every voxel, for every possible cut in the brain, we have a likelihood of what is going to happen. The best possible next step or might there be a better next step. This is the approach we are following here to really go into scaling up and down. I mean, we look at the whole brain if we look at functional networks, but then during surgery, we have to be very specific at the place where we perform the surgery in this moment. This is why I mentioned the voxel level.

Dr. Thomas Picht:

So I mean, we are talking then about little volumes of tissue and we really want to know what's the role of this specific little piece of tissue. How likely is it that it's tumor, for example? How likely is it that it's

part of the language network? How likely is it something bad will happen if we remove it? So this is what we are aiming at. To be that specific at this micro level.

Dr. Max Boakye:

Wow, that is really fascinating. And actually you and I were talking about how our paths crossed. I can't believe I'm dating myself almost 20 years ago when I was doing a rotation at the Boston Children's and you were, I think, spending some time at the Brigham in Boston, Brigham, Harvard, Boston. I didn't speak to you a lot back then, maybe we spoke on rounds and something, but how did you go from that point to becoming interested in these types of research and in digital neurosurgery? Was it some experiences you had? How did you kind of end up follow up this research path?

Dr. Thomas Picht:

Well, I think if I look back for me, deciding moment was when I first became exposed to awake surgery. It was pretty early in my career that I became part of our awake surgery team. Awake surgery is still a very important tool in our [inaudible 00:33:35] but I was fascinated by it. I also thought, I mean, this is a highly invasive and highly demanding procedure for the patient and for the whole team. I think that was my starting point to think about what can we do to get this information in a less invasive way, and we still can in many domains only achieve during awake surgery?

Dr. Thomas Picht:

So it's still an ongoing process. I'm not saying that I want to get rid of awake surgery, not at all, but I think from the patient's perspective, we have the technologies these days to plan individual surgery beforehand very safely. For me, this started many, many years ago with this experience of highly invasive procedures on the brain and why don't we try to get this information beforehand, noninvasively?

Dr. Max Boakye:

So approximately what percentage of time is doing actual surgery and what percent is in the research and simulation?

Dr. Thomas Picht:

You mean in my case individually or?

Dr. Max Boakye:

Yes, yes.

Dr. Thomas Picht:

Actually these days I'm spending 99.9% in research and doing those simulation and training courses because of the demand for this became so high that we had to decide in our department to have somebody doing this more or less full time. And this somebody became me. Because I was the most interested in it and through the Humboldt University, you mentioned, I was lucky enough to get the funding to build this group and work on this very intensively. It starts to show that we are now able really to, like I mentioned earlier, to frame our residency program with all those new technologies and this makes it much more efficient. And like I said earlier, I think that we can really train our residents much better than we were a few years ago.

Dr. Max Boakye:

One last question for you, and this is really fascinating. So for young neurosurgeons wanting to become more of expert digital neurosurgeons, and let's say they're in an environment where they don't have these technologies that you have at Charite, how do they go about kind of developing their interests and expertise in these areas? Do you have fellowships that people can come there for some time to learn from outside Germany?

Dr. Thomas Picht:

Yes, we regularly welcome international fellows to spend time with us. So, that is one option. In general, I think residents need to be of course curious and open minded. It's also just a question of time management. So there's no much extra time for those things, but I think residents need to take this challenge serious. So this digitalization of the life of a neurosurgeon in terms of performing surgery, but also in terms of doctor-patient relationship will become more and more important. So I think it's very wise if the residents today really take this serious and spend time on this and fellowships at Charite or other centers who are the forefront of this development are one way to do it, but there are also more and more courses, international conferences on those topics where people should keep their eyes open and attend those if possible.

Dr. Max Boakye:

Thank you very much. This has been a very interesting discussion with professor Thomas Picht, at the University Hospital of Charite in Berlin, Germany. Thomas, thank you so much for taking the time to speak with us, this has been really incredible discussion.

Dr. Thomas Picht:

Thank you very much, Max.

Speaker 1:

Thanks for listening to Optimal Neuro/Spine podcast with Dr. Max Boakye. If you enjoyed this episode, we hope you share it with others. Leave us positive reviews on social media or leave a rating and review on iTunes. Check out our website, maxwellboakye.com/podcasts for show transcripts and other information. Join us next time for another edition of Optimal Neuro/Spine show.