AN INTERVIEW WITH…

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Dr. van den Heuvel discusses training of young interventional radiologists, unmet needs in CLTI, developments in venous arterialization, and his special interest in pulmonary artery vascular disease.

What was your path from medical school to interventional radiology (IR) like? How did you land in the specialty?

When I finished medical school at the University of Amsterdam, I knew I wanted to do something that combined hands-on practical skills with patient interaction. At that time, I had no idea that IR would become my specialty. During my 2 years of internship at the Department of Vascular Surgery, I learned a lot about open surgery but saw that the endovascular treatment of aneurysms and peripheral artery disease (PAD) had great potential. In the early 2000s, endovascular treatment in the Netherlands was almost exclusively offered by interventional radiologists. I can remember that in one of my on-calls, the interventional radiologist who later became my mentor performed a life- and limb-saving aortoiliac procedure. I knew from that moment on that this was what I wanted to do. So, I turned down a training position in surgery and applied for a radiology residency, with the sole purpose of becoming an interventional radiologist. After a 5-year residency in general radiology, I applied for an IR fellowship, where I focused on vascular and, more specifically, chronic limb-threatening ischemia (CLTI) procedures. I've been working at the same hospital since I finished my fellowship in September 2011.

How has training for IR evolved over the course of your career to date?

When I began my vascular surgery residency in 2001, interventional radiologists mostly performed endovascular interventions for PAD and urologic and biliary interventions. We are frequently asked to perform procedures to manage complications, whether from a primary disease or resulting from other treatments. However, minimally invasive, image-guided interventions have now become an integral part of contemporary medicine.

The interventional radiologist has been given an important consultation role in highly specialized teams, and therefore it is mandatory that they are trained differently today. We need to be knowledgeable and up to date with the latest developments in each specific territory, and this is why we see most residents following a specific vascular or nonvascular training program after the initial basic training program. This has resulted in highly specialized interventional radiologists performing complex procedures and taking responsibility for periprocedural, outpatient, and clinical care.

Which nontechnical or nonclinical skills do you focus on for the current generation of trainees?

We excel in following protocols and guidelines and sometimes forget that patients require a tailored approach. It's important that residents use their soft skills to take care of our patients and function in a multidisciplinary team (MDT). The ability to listen to patients and colleagues, be flexible, and have a sense of responsibility and empathy, for example, defines who you are and what makes you a good physician. Of course, you need to know and master technical and clinical skills, but your soft skills make you a better doctor. Every now and then, I have to remind my residents that they are treating a patient, not the disease.

Considering your work in CLTI and limb salvage, what are the biggest unmet needs for the patients you see?

We've made significant achievements in caring for our CLTI patients, but there is still a lot we can do to improve clinical outcomes and quality of life (QOL) for this challenging population. First and foremost, we need to improve durability of below-the-knee and below-the-ankle (BTA) revascularizations. In specialized centers, acute revascularization success rates exceed 90% to 95%, but long-term patency rates are still quite

(Continued on page 86)

(Continued from page 90)
disappointing. This is especially true for long, calcified lesions; chronic total occlusions; and BTA disease. We are getting better at saving limbs and lives via our MDT approaches, but unfortunately, patients still require frequent repeat revascularization procedures. Despite optimal wound care, foot care, and shoeing, we see too many recurrent foot ulcers and infections requiring minor or major amputations. In other words, these patients continue to be at risk for limb loss—I think partly due to a loss of patency of our revascularizations. In addition, we are facing an increasing number of patients with small artery disease (SAD) and failure of the distribution system of the forefoot, often with medial artery calcification (MAC). Patients with high SAD-MAC scores due to long-lasting diabetes, renal failure, steroid use, and old age have a high risk of major amputation and continued rest pain. Treatment of these "no-option" patients via transcatheter arterialization of the deep veins (TADV) has great potential, as shown by the PROMISE trials. We have achieved good results in TADV patients in our center as well, and I'm very interested in how TADV will evolve over the coming years and what it can do for our CLTI population.

Another unmet need is the lack of a reliable tool to measure foot perfusion. Ideally, the tool should be easy to use in a home setting and tell us when a foot becomes at risk again due to reocclusion or stenosis of a revascularized artery. Getting the patient back in the treating center before complete occlusion has occurred and, more importantly, before not-yet-healed wounds start to worsen might save more limbs and lives and improve QOL. In the end, this is the goal of our treatment efforts.

Finally, and this might be a bit controversial, we need to investigate the role of treating asymptomatic coronary artery disease (ie, silent ischemia) in CLTI patients. Many of our patients die from ischemic cardiac events without having undergone major amputations. In these cases, we're successfully treating the disease but not the patient. There is still a lot of work to be done.

Along with your clinical responsibilities and academic efforts, you also train general radiology residents and are Program Director of the IR residency at St. Antonius Ziekenhuis. How can amputation prevention and awareness conversations be brought into mentoring junior physicians?

Typically, radiology residents are not as clinically involved at the beginning of training. They focus on learning everything there is to know about the different imaging modalities and the specific imaging findings of diseases. It is often in their differentiation phase when they become more clinically involved. During this phase, which starts in the third year, participation and presenting in MDT meetings in which highly specialized physicians are present is one of the entrusted activities. It is here that they learn more about treatment goals, plans, and methods; for cardiovascular and interventional residents, this includes amputation prevention. Other residents learn about this during weekly teaching hours where residents and trainers present cases supported with an evidence-based medicine or critically appraised topic approach.

Ideally, I think the awareness should start during medical school. There is a role for academics/lecturers to

DR. VAN DEN HEUVEL'S TOP TIPS FOR TADV PATIENT SELECTION

01 **Select Rutherford 5 and 6 patients in whom traditional revascularization (endo or bypass) is not feasible due to lack of a target artery.**

02 **Ensure uninterrupted inflow directly into the donor artery, and confirm that foot veins should be disease free.**

03 **Fistula creation should preserve collateral flow to the foot, preventing an ischemic hit of the foot.**

04 **The patient should be able and willing to visit the outpatient clinic on a regular basis, especially in the first 2 months postprocedure.**

teach students about CLTI: that these patients are sick and have a higher death rate than, for instance, colorectal or breast cancer, and with the proper care, we can keep their legs and good QOL. Hopefully, this will help our junior physicians recognize CLTI even when they are not directly involved in the care of these patients.

The increase of awareness initiatives can also come with concern for potential overapplication of treatment. What is your advice for achieving a balance and ensuring appropriate care?

I stated earlier that we need to improve the long-term patencies of our revascularizations. Very likely, this will require use of additional devices because we know plain old balloon angioplasty has a very limited durability. The key to reducing overapplication of devices is to know when to use which devices. Every day, we hear and learn about vessel preparation and the use of drug-coated or -eluting technologies. Under the condition that there is high grade and level of evidence of certain treatment modalities or combinations, I would use this approach in all my patients. However, we also must consider the cost.

Limb salvage is a longitudinal process that is highly impactful on patient QOL while also being challenging and time- and resource-intensive. How do you help hospital administrators and colleagues understand the benefits of a lower extremity revascularization focus while acknowledging these potential hurdles? How do you express the necessity of a practice specifically focused on this?

It's not only about how you do it but also when you do it, in which patients, and what the outcomes are. This applies to not only lower extremity revascularizations but also wound care, off-loading treatments, and corrective surgery of foot abnormalities. I have an excellent and close collaboration with my vascular surgeon who is also dedicated to CLTI and wound care. By extracting and analyzing key endpoint data from the hospital's administration system over the last few years, he was able to show that investing time and resources in managing CLTI patients results in improved outcomes, such as lower major amputation rates and faster wound healing.

It is our responsibility to use the limited financial resources wisely. This means I cannot use the combination of dedicated vessel preparation devices with drug-coated or -eluting technology in every case. Using these expensive devices only in specific circumstances, tailored to the patient's clinical situation, has helped administrators understand the need for these devices. In my opinion, this decision-making process is only possible in dedicated MDTs focused on limb salvage with a wholistic approach of the patient. Furthermore, if you can present these data to your colleagues and hospital administration, they will have a better understanding of what taking care of CLTI patients entails, what the costs are, and that we need to invest resources if we want to provide optimal and cost-effective care.

In 2023, you joined the Board of the Europe Chapter of CLI Global Society (CLI GS). What are some of the Europe-specific initiatives of the group?

The mission of the CLI GS is to improve the QOL of CLTI patients by preventing unnecessary amputations and death. Empowering physicians through supporting them in research projects and providing important data concerning the costs and cost-effectiveness of our treatments helps achieve this goal. An example of this is the "The Economic Burden of Chronic Limb Threatening Ischemia (CLTI) in Germany: A modelling study" performed by the WifOR Institute in 2024. This study provided important data about the socioeconomic impact of CLTI and can serve as template, with potential extrapolation of the results to other European countries. Another initiative is WOUNDSinCLTI, a physician-initiated study that received a grant from the CLI GS and is planned to start in Q2 or Q3 2025. This study will hopefully provide new insights into the relationship between specific pathogens and the risk of major amputation. The goal is to reduce the major amputation and death rate but also to obtain faster wound healing, all of which should translate into more cost-effective treatments.

How would you describe the main themes in deep venous arterialization research over this last decade, and what would you like to see in the next phases of research?

Until now, research has been focused on the typical endpoints for new treatments. We must recognize that a lot of this work has been done by LimFlow, which investigated and proved the safety and efficacy of their dedicated system for TADV. The PROMISE I, PROMISE II, and PROMISE-UK trials showed impressive results and exceeded the performance goals set by the FDA in a true cohort of no-option patients. The LimFlow system (Inari Medical) is currently the only FDA-approved system for TADV in the United States. There are reports on off-the-shelf TADV methods that also show promising results, although the numbers are relatively small and most reflect single-center experiences. In Europe, the

LimFlow system was not available for quite some time, and as such, we have more experience with off-the-shelf techniques. Time will tell if results are comparable to the PROMISE trials, but they look promising so far.

To date, many patients require additional procedures to optimize TADV flow and speed up or direct the maturation process needed for an optimal clinical outcome. The next phases of research should therefore focus on optimizing acute TADV results and understanding the maturation process. Future efforts should be focused on predicting acute TADV flow, the type of maturation a patient will have, and the results of maturation-modifying procedures such as embolization. If we have a better grasp on this, we will hopefully be able to improve the overall results and the often labor-intensive post-TADV course. I'm also very interested in the role of TADV in our CLTI population with rest pain, who typically require multiple repeat interventions to remain pain-free for a long period of time. Of interest, we know that a significant percentage of TADV patients do not relapse into CLTI after the circuit has gone down. Angiography in these patients shows extensive neovascularization, opening of hibernating arteries, and the existence of a new distribution system of the foot. If we can predict acute TADV flow and prevent the acute ischemic hit while at the same time promote venous maturation, this might be a method to treat rest pain patients with long-lasting, durable results. Last but certainly not least, we need more data on the QOL of our TADV patients. In the end, we are treating the patient, not the disease. I have patients who would not go through the entire process of venous arterialization, surgical debridement, and minor amputations again, while others would. I think this shows that we are not there yet and that there is a lot of room for improvement.

You also specialize in treating pulmonary arteriovenous malformation (PAVM)—can you give us a preview of anything you're working on or hope to focus on in the future?

I practice in a tertiary referral center for hemorrhagic hereditary telangiectasia (HHT) patients. PAVMs are very common in these patients and require embolization to prevent complications from paradoxical emboli such as brain abscesses and stroke. The acute technical success rate of embolization approaches 100%, but unfortunately, we find persistent perfusion of the PAVM at 6 months in up to 50% of cases. If you dive into the PAVM literature, you'll find there is wide variation in persistence rates, from 0% to 50%. This might be due to the different embolic devices used but very likely is also because of the different endpoints used to define PAVM persistence. One problem is that we lack consensus on what study endpoints should be when investigating embolic devices. As a result, studies use different follow-up methods at different time points and have different definitions of PAVM persistence. Therefore, it's not a surprise that there is so much variation in reported persistence rates. The focus of my research and subject of my thesis is "improving diagnosis and treatment of PAVMs." Together with my team, I'm focusing on optimizing imaging protocols of de novo and treated PAVMs. Some of the questions we aim to answer are: What is the role of contrast-enhanced CT (CECT) in detecting PAVM persistence? Where does it fit into the follow-up algorithm? Is it safe to perform CECT considering there is a higher chance of causing paradoxical air embolism?

We are analyzing data from a prospective trial investigating the safety and efficacy of a next-generation embolic device. It's a lot of work and not always easy or even possible to find the extra time to work on this, but with the support of my colleagues and a little bit of extra free time investment, I'm hoping to have most of the work done by the end of this year. Hopefully, the results will support consensus on reporting on PAVM embolotherapy. If we only use the same endpoints, we will be able to compare studies and choose the best treatment for our patients. The aim is to defend my thesis in the beginning of 2026.

In 2024, you and colleagues published two papers on balloon pulmonary angioplasty in patients with chronic thromboembolic pulmonary hypertension (CTEPH), with one specifically focused on complications.[1,2] What are your best practices for minimizing complications, in terms of both patient selection and technique?

Now you know that in addition to CLTI, my other passion is pulmonary artery vascular disease. Reducing the risk of procedure-related complications starts with selecting the right patients. As in CLTI and HHT, these patients are discussed in MDT meetings. Patients with high peripheral vascular resistance (PVR) have a higher risk on procedural complications. Lung injury is the most serious complication and associated with a resistance > 6.6 Wood units. For this reason, all our patients are pretreated with pulmonary hypertension–targeted medical therapy. In addition, this subcohort of CTEPH patients often has tortuous pulmonary arteries that have a higher risk on wire perforation, especially in the lower lobes. Interventionalists thus need to focus

on being meticulous when wiring stenoses, webs, and occlusions. This starts with using low-tip-load hydrophilic wires and, if possible, loop wires distal from the lesions to prevent perforations. Also, buddy wires help prevent complications because by providing stability and improving orientation in sometimes very complex anatomies. By doing this, the risk of severe vessel injury and hemoptysis is significantly reduced, and we haven't had a procedure-related death yet.

We've also learned that the pulmonary vasculature has an impressive remodeling capacity. Unlike in peripheral arteries, it is not always required to perform nominal dilations. My standard approach is to use an undersized 3-mm balloon for proximal segments and a 2.5-mm balloon for more distal lesions. In doing so, I haven't seen a perforation due to overdilation. Follow-up angiography of these lesions typically shows a nice remodeling of the artery with brisk parenchymal enhancement and venous return.

Finally, depending on the PVR, we are inclined not to open too many occlusions during one session due to the chance of late lung injury requiring oxygen therapy and a prolonged hospital stay. Typically, patients with CTEPH undergo four to six treatment sessions to reduce these risks as well as the risk of volume overload and contrast-induced nephropathy, which can have serious consequences.

What do you do for fun outside of work? What are your main interests?

In my free time, I really enjoy listening to music, especially metal. It's a genre that resonates with me and energizes my day. I also love going to concerts and festivals whenever I can. There's something exhilarating about experiencing live music and being surrounded by people who share the same passion. These events really boost my energy and provide an unforgettable way to connect with both the music and the community. Overall, music is a significant part of my life and a perfect way to unwind and recharge. I also like to spend free time practice playing the guitar. I'm still at a beginner level, so I'm working on building up my technique and getting comfortable with basic riffs and power chords. It's a lot of fun, although my family might think differently.

And of course, my wife and two daughters are incredibly important to me. We enjoy going for hikes, spending nights at home talking about things that keeps us busy, or exploring new places. I'm a very lucky father and husband, and I truly cherish the time we have as a family. ■

1. van Leusden FJ, Staal DP, van Thor MCJ, et al. Complications of balloon pulmonary angioplasty: a comprehensive analysis based on the latest ESC consensus statement. J Clin Med. 2024;13:4313. doi: 10.3390/jcm13154313
2. Staal DP, van Leusden FJ, van Thor MCJ, et al. Optimizing medical pretreatment for balloon pulmonary angioplasty: overshoot or stride toward optimal multimodal treatment. Pulm Circ. 2025;15:e70028. doi: 10.1002/pul2.70028

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