

PANEL DISCUSSION

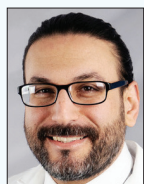
Carotid Artery Revascularization in 2026 and Beyond: Opportunities and Obstacles

Experts discuss the evolving roles of CEA, TF-CAS, and TCAR, the evidence still needed, and the technologies poised to shape the future of carotid intervention.

With D. Chris Metzger, MD, and Nicolas J. Mouawad, MD, MPH, MBA, DFSVS, FACS, FRCS, RPVI



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medical therapy compared to medical therapy alone. There is equal durability at 10 years compared to CEA, and TF-CAS data continue to improve after this. There was a prolonged period of decreasing CAS operators, with factors including a lack of CAS reimbursement or clinical trials, a shift of interventional cardiologists toward structural procedures, and a significant increase of adoption of transcarotid artery revascularization (TCAR).

Dr. Mouawad: We have very effective strategies for carotid revascularization where we need to continue to get to zero with perioperative stroke, myocardial infarction (MI), and death. However, I believe the clearest unmet needs today in carotid revascularization is overall durability and risk of reintervention/restenosis with minimally invasive methods. We know that CEA is durable, but what we need to see is whether CAS will demonstrate comparable durability in the long term.

What are the clearest unmet needs in carotid interventions today? Stroke reduction? Restenosis/reinterventional needs? Overall durability? Procedural simplicity? Training?

Dr. Metzger: I think that for transfemoral carotid artery stenting (TF-CAS), the biggest unmet need is experience and training, as well as broad acceptance of TF-CAS as a true frontline therapy. There have been thousands of patients in carefully adjudicated trials showing equivalency to carotid endarterectomy (CEA) with long-term data, as well as superiority of CAS with

In your practice, what factors most strongly or frequently drive modality selection—anatomy, symptom status, age and frailty, operator capability, resources, or costs/reimbursement?

Dr. Mouawad: As a vascular surgeon able to offer all modalities for carotid revascularization, I really do believe it is an individualized approach to each patient and the lesion itself. The anatomy and patient comorbidities/frailty are the largest factors for me. The goal is

clearly to achieve the best outcome, and if one modality can offer that with the least risk, then that is what I decide. Tortuosity, calcium, and vessel length all come into play. Of course, these are all based on operator comfort and capability with the planned procedure.

Dr. Metzger: We truly engage in a shared decision-making process to select the best treatment modality for each person with carotid disease. First, we assess the patient and determine together whether revascularization is appropriate. If it is, we then decide which treatment is best for the patient. For example, for patients with a good arch and anatomy for stenting, we choose TF-CAS. For patients with a difficult arch but good anatomy for stenting and who have increased risk for CEA, we choose TCAR. If patients have severely calcified or tortuous carotid arteries, we offer CEA.

How should proficiency be defined in carotid revascularization procedures? How might it differ between TF-CAS and TCAR? And CEA?

Dr. Metzger: Experience and proficiency are needed for each procedure. All patients should have pre- and postprocedure National Institutes of Health Stroke Scale scores, and stroke rates should be low and within guidelines for each operator. There are some suggestions that there may be less of a learning curve for TCAR compared to TF-CAS, although I am not entirely convinced and feel that training and experience are essential for each procedure.

Dr. Mouawad: With different options for carotid revascularization, it is important to look at both proficiency and efficiency in interventional care. The challenge is that proficiency should not be defined solely by case volume but rather by a combination of technical expertise, clinical judgement, and outcomes.

Clearly, different and specialized skill sets are required among the different modalities. Some are transferable while others are not. For TF-CAS, challenges include arch navigation, crossing unstable lesions, and embolic protection deployment; therefore, proficiency is dependent on complex catheter skills, wire control, and embolic risk mitigation and linked to cumulative endovascular experience. For CEA, proficiency requires expertise in cervical anatomy, shunt decision-making, and surgical technique. For TCAR, it is a combination of both. So, proficiency is not only based on volume but also other important factors. With increasing proficiency, efficiency increases.

Which patients remain the least well addressed by today's revascularization options and capabilities?

Dr. Mouawad: The unmet need remains the challenge of any transcatheter solution: calcium. CEA overcomes this; however, in patients considered at high risk for endarterectomy, minimally invasive solutions face the significant challenge of severe calcium disallowing adequate stent expansion and subsequent secondary complications such as restenosis and/or stroke. I believe that this is the next frontier, with innovative solutions using calcium-modifying technology and calcium management devices such as intravascular lithotripsy.

Dr. Metzger: The population who are the least well addressed are probably those with heavy calcium and high CEA risk. It is possible that this subset may be addressed with improved intravascular lithotripsy options for TF-CAS and TCAR, and this is being studied in the SKYWARD clinical trial (NCT07512128).

Have you seen changes in referral patterns or volume based on the emergence of TCAR in the past decade and the reemergence of TF-CAS in the past several years?

Dr. Metzger: Yes. There was a shift toward TCAR referrals before the new National Coverage Determination (NCD) in 2023 and with an enthusiastic adoption of this strategy by the vascular surgery community. After the NCD was followed by excellent results in the CREST-2, C-GUARDIANS, and PERFORMANCE II trials, there has been an increase in referral for TF-CAS.

Dr. Mouawad: Absolutely! Previously, I felt we would get referrals for carotid stenosis, but nowadays we see referrals for TCAR. The move toward more minimally invasive technologies continues to captivate health care providers and patients alike. However, I caution that the indications for intervention have not changed despite the availability of different treatment modalities, and such interventions should only be performed when specific diagnostic criteria are met.

How do you balance the rapid changes in the device landscape and emergence of new tech generations with the need for comparative effectiveness data?

Dr. Mouawad: This is a challenge because technology often evolves much faster than the evidence base. By the time long-term comparative effectiveness data become available, we may already be on a newer-generation device or innovation.

I support continued technologic evolution. It is one of the many exciting aspects of managing vascular disease. New devices may improve deliverability, simplify procedures, increase efficiency, and reduce embolic burden, but widespread adoption should ideally be driven by evidence demonstrating improvement in meaningful clinical outcomes rather than surrogate measures alone.

Dr. Metzger: There will not be any comparison trials between technologies in my opinion. Each of us will decide based on trial results, theoretical advantages, and our experience.

Which outcomes or endpoints matter most to you? To your patients?

Dr. Metzger: The most important are low periprocedural stroke rates and long-term patency and prevention of strokes.

Dr. Mouawad: The most meaningful endpoints to me from a physician and health system perspective are stroke, MI, death, durability, need for reintervention, and cranial nerve injury, as well as cost-effectiveness and resource utilization.

For our patients, they want answers to various questions such as, “Will this prevent me from having a stroke? What are the chances that this procedure itself causes a stroke? When will I get back to my normal life?” The key factors here for my patients are preserving independence, recovery time, and, of course, procedural safety and avoiding complications like a disabling stroke.

What further capabilities would you like to see in imaging and plaque analysis? Are these the next major opportunities for technologic advancement?

Dr. Mouawad: I believe measures of plaque vulnerability will be helpful in the future. These are being studied with MRI to identify which lesions would be considered unstable or higher risk—even if they don’t achieve the stenosis threshold.

Dr. Metzger: Some measures of vulnerable plaque will add to our armamentarium, but in my opinion, it will not replace measures of lesion severity and assessment of symptoms.

What are the unanswered questions that most need to be addressed in terms of comparative effectiveness among current options? Are such trials likely?

Dr. Metzger: We need more long-term, independently adjudicated data for TCAR. Ideally, there would be one randomized controlled trial for TCAR for noninferiority versus other strategies. CEA and TF-CAS have extensive data already, so comparative trials in the future are unlikely to occur.

Beyond comparative effectiveness among current modalities, what questions should future trials aim to answer?

Dr. Mouawad: Some long-term events I would be interested in outside of the traditional endpoints would be cognition and memory. Also, is there an effect of anesthesia (general vs regional vs sedation) on some neurologic outcomes in the elderly? And finally, long-term durability of the stent.

Dr. Metzger: There are a few questions I would want future trials to focus on. What are the total periprocedural morbid events to the patient, including wounds and cranial nerve injuries in addition to strokes? Long term, are there differences in cognition of the patient? Long-term patency and absence of ipsilateral strokes are important, as well as need for target vessel revascularization. ■

Disclosures

Dr. Metzger: Co-Primary Investigator for C-GUARDIANS (InspireMD), PERFORMANCE III (Contego Medical), CONFIDENCE (Terumo), and SAPPHIRE WW (Cordis) trials; proctor fees for Abbott Vascular and Contego; scientific advisory boards for Boston Scientific and Cordis.

Dr. Mouawad: Consultant to Boston Scientific Corporation and Medtronic.