Endovascular Training for Cardiologists

A training proposal for endovascular intervention from an interventional cardiology perspective.

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The prevalence of peripheral vascular disease (PVD) and cerebrovascular disease (CBVD) is increasing significantly as the population ages.[1-3] In the Framingham Heart Study,[2] the onset of symptomatic PVD in patients aged 30-44 to 65-74 increased 10-fold in men and 20-fold in women. Moreover, there are ample data that coronary artery disease (CAD) often coexists with PVD and/or CBVD (Figures 1 and 2).[4-10] As patients with CAD survive their coronary events and live longer, the prevalence of PVD and CBVD is ever-increasing in this population.[1] The pathogenesis and pathophysiology of these diseases is the same. This has been the impetus for cardiovascular physicians and interventional cardiologists to adopt a strategy of global vascular management. In addition to the treatment of CAD, cardiovascular physicians are now grappling with the increased prevalence of vascular disease at other arterial sites, including the lower extremities, renals, and carotids. As such, we need to consider the expanding impact of diffuse atherosclerotic cardiovascular disease on the overall prognosis.

THE CARDIOVASCULAR PHYSICIAN AND VASCULAR DISEASES

Vascular diseases constitute some of the most common causes of morbidity and mortality in Western society. CAD is the number one cause of mortality in the US; stroke is number three.[11] Moreover, 75% to 80% of patients with PVD die of myocardial infarction or stroke (Figure 1). Vascular disease is often clinically occult, yet it may present with catastrophic events. Early recognition and appropriate treatment of underlying disease and its pathogenetic factors can potentially prevent such catastrophic occurrences. Currently, medical specialists trained in the distinct disciplines of cardiovascular medi-

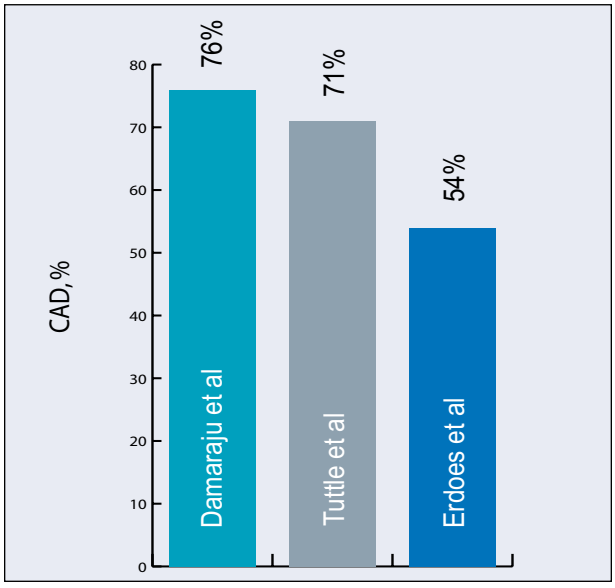

Figure 1. Studies showing a significantly high prevalence of CAD in patients with PVD.[5]

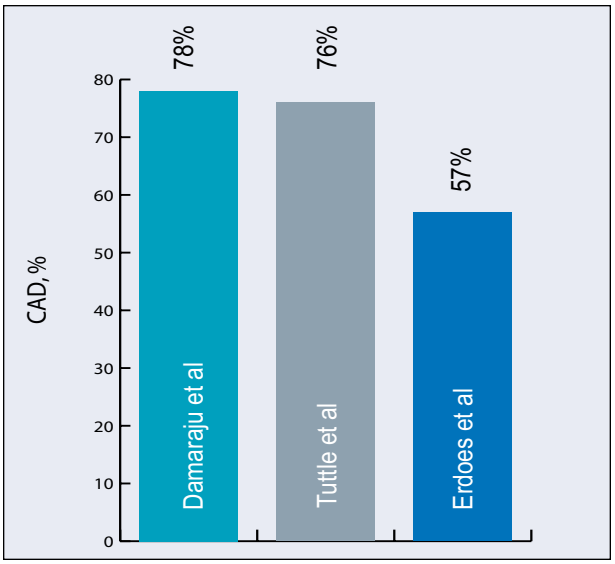

Figure 2. Studies showing a significantly high prevalence of CAD in patients with cerebrovascular disease.[5]

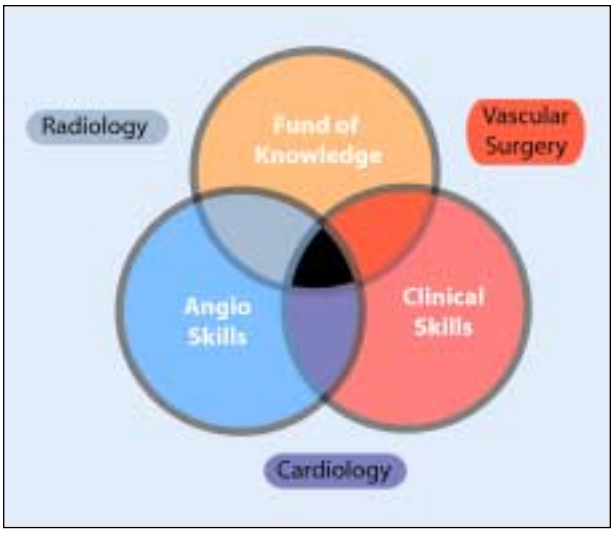

Figure 3. Endovascular skills. Contributions of different vascular specialists to the field of endovascular interventions. (Reprinted with permission from Christopher White, MD).

cine, interventional radiology, and vascular surgery are all involved in the diagnosis and management of patients with PVD, albeit from differing perspectives. These perspectives, however, also share many common features, emphasizing the importance of a broadly based, multidisciplinary approach for management.[12]

Physicians caring for patients with vascular diseases should have a comprehensive knowledge base, skills in patient evaluation, and a thorough understanding of the therapeutic options that are available to treat these patients. They should also be able to identify and treat disorders that contribute to vascular disease, such as dyslipidemia, hypertension, diabetes, and hypercoagulable states. This knowledge base of patients' management and follow-up are parts of training of cardiovascular physicians during their internal medicine residency and cardiovascular fellowships.[13] As such, cardiovascular physicians are well-positioned to provide comprehensive care to patients with cardiovascular diseases.

The field of vascular medicine is a unique area shared by several subspecialty groups of physicians. For cardiovascular physicians, recommendations for the minimum education, training, experience, and skills necessary to establish expertise in vascular medicine are depicted in the American College of Cardiology's Core Cardiology Training in Adult Cardiovascular Medicine (COCATS) document and the American College of Cardiology's Recommendations for Training in Vascular Medicine.[12,13] Many physicians will also acquire expertise in vascular medicine by supplementing their training during a cardiovascular medicine fellowship. Although not adequate to validate competence as an independent vascular medicine specialist, board certification in cardiovascular diseases acknowledges reasonable expertise in vascular medicine.

THE INTERVENTIONAL CARDIOLOGIST AND ENDOVASCULAR INTERVENTIONS

Currently, physicians from several subspecialty backgrounds, such as cardiovascular medicine, interventional radiology, and vascular surgery, have the interest and

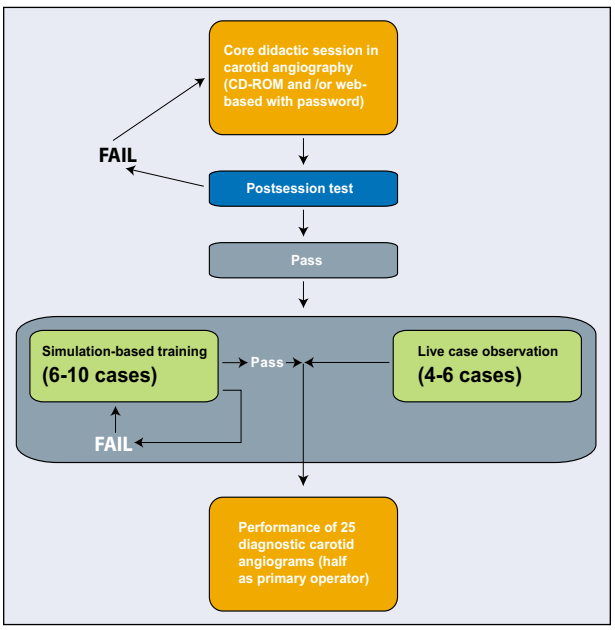

Figure 4. Algorithm for training in carotid angiography (proposed by Daniel McCormick, DO).

TABLE 1. ADVANTAGES OF SIMULATION-BASED TRAINING

- Interactive, practical, case-based, not passive
- Real time and in a clinical environment
- No potential harm to the patient
- Standardized, comprehensive and reproducible
- Immediate, authoritative feedback
- Incorporates evidence-based medicine and expert consensus

potential expertise to perform endovascular interventions. Such a multidisciplinary approach will ultimately lead to improvement in the care of patients with vascular diseases because each subspecialty physician contributes a different set of skills (ie, knowledge base in vascular disease, clinical skills, angiographic expertise, etc.) (Figure 3). Although various guideline-establishing documents have been published in an attempt to set minimum requirements for training of endovascular interventionalists,[14-16] there is currently no uniform, standardized mechanism for evaluation of competence.

The ability to safely and effectively perform endovascular interventions requires specific knowledge about vascular biology and vascular diseases, as well as technical skills. Individuals performing endovascular interventions must be aware of the risk-versus-benefit ratio for each procedure. Indications and contraindications for interventions at each anatomic site must be clearly understood and considered in the context of the clinical scenario. The vascular interventionalist must be familiar with the use of adjunctive medications, such as antiplatelet, antithrombotic, thrombolytic, vasodilator, and vasopressor drugs.

For cardiovascular physicians, guidelines on minimum training requirements in endovascular interventions are set forth in the American College of Cardiology Core Cardiology Training Symposium document.[13] A fellow wishing to acquire competence as a peripheral vascular interventionalist is required to have a minimum of 12 months of training. This is in addition to the 24 months required for core cardiology training, and at least 8 months acquiring experience in diagnostic cardiac catheterization in an accredited fellowship program. It is recommended that the trainee perform 300 diagnostic procedures, including 200 with primary responsibility prior to beginning interventional training. The trainee should participate in a minimum of 50 noncardiac peripheral vascular interventional cases during the interventional training period; at least 25 should be performed as the supervised primary operator.[13] Advanced training in peripheral vascular intervention can be undertaken concurrently with advanced training for coronary interventions. The year devoted to interventional training should include at least 1 month on an inpatient vascular medicine consultation service, 1 month in a noninvasive vascular diagnostic laboratory, and one-half to 1 full day per week in the longitudinal care of outpatients with vascular disease.

The vascular bed that has been traditionally the principle focus of most cardiovascular physicians has been the coronary circulation. However, the strategy of global vascular management mandates cardiovascular physicians to achieve competence in peripheral endovascular interventions. Currently, a limited number of interventional cardiovascular fellowship training programs offer comprehensive training in noncardiac endovascular interventions. Cardiovascular fellows graduating from programs without adequate peripheral endovascular training would need to achieve competence in endovascular interventions via alternative routes.

Similarly, established interventional cardiovascular physicians without previous training in peripheral interventions may achieve competence in endovascular interventions via alternative routes. Interventional cardiologists

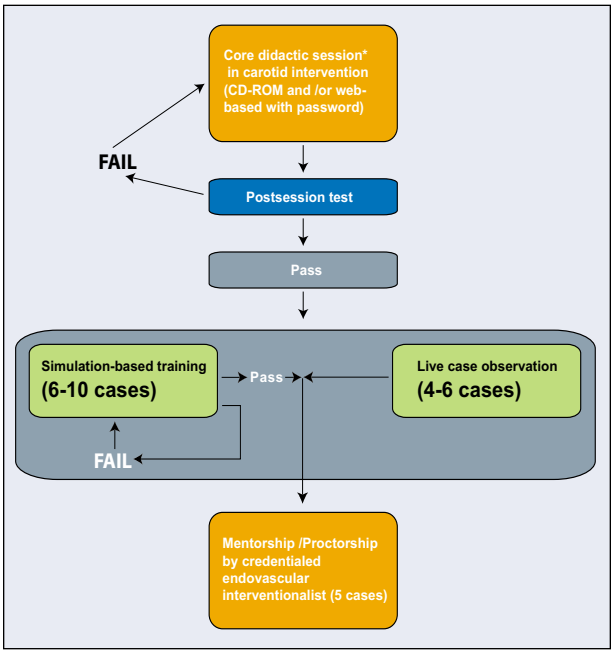

Figure 5. Algorithm for training in endovascular intervention of carotid arteries in anticipation of FDA approval of high-risk carotid intervention. *Core didactic session should include training on patient selection strategy and noninvasive carotid imaging such as carotid Doppler ultrasound (proposed by Daniel McCormick, DO).

without formal peripheral training already possess certain cognitive, clinical, and technical skills that provide a foundation for further training. Depending on the availability of resources, a coronary interventionalist may opt to acquire competence in endovascular interventions on an unrestricted or restricted basis.[14,15] For an unrestricted technical competence in endovascular interventions, coronary interventionalists require the performance of 50 to 100 diagnostic peripheral angiograms and 50 peripheral interventional procedures; this is similar to those participating in formal training programs. For such training experience to be meaningful, these physicians should be the primary operator for 25 of the peripheral endovascular interventional procedures. It is important that these procedures be performed under the proctorship of a skilled, credentialed peripheral vascular interventionalist. However, the problem with such credentialing is that it does not ensure diversity of experience and can be very time-consuming. Moreover, to ensure exposure to diagnosis and endovascular management of diseases of different vascular beds, there should be a reasonably even mix of interventional cases. Although there are no firm established guidelines on the number of cases required to achieve competence on an unrestricted basis, it is suggested that experience in 10 to 15 cases is required in each specific vascular bed, including brachiocephalic, renal, mesenteric, aortoiliac, and infrainguinal arteries. For each of these procedures and vascular beds, the physician must be the primary operator for at least one-half of the cases.

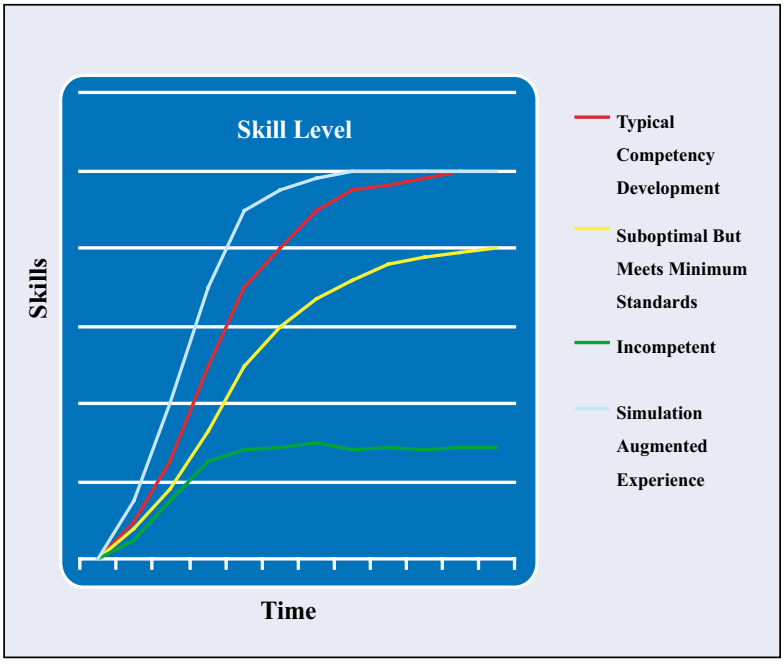

Figure 6. Impact of simulation-based training on the learning curve phenomenon.

Obtaining competence in carotid and vertebral interventions is different from other peripheral endovascular interventions because there is a very narrow safety margin with interventions in the cerebral vascular bed.[4] Moreover, the current status of such interventions is high-risk and investigational, as mandated by the FDA. Vascular interventionalists who pursue carotid and vertebral interventions must have an in-depth understanding of the anatomical and pathological characteristics of this vascular bed. It is imperative that prior to becoming competent in carotid interventional procedures, physicians need to have core familiarity with and exposure to at least 25 to 50 diagnostic carotid angiography procedures (Figure 4). Similar to other endovascular peripheral interventions, there are no established guidelines on acquiring competence in endovascular carotid interventions. However, in anticipation of FDA approval of high-risk carotid interventions, there is a need for a logical and reasonable method of acquiring competence in endovascular carotid interventions (Figure 5).[4]

Although it is desirable to have unrestricted expertise and competence in peripheral endovascular interventions, cardiovascular physicians with previous training in coronary interventions may opt to achieve competence to perform interventions only in limited peripheral vascular beds. In such a restricted competence, a coronary interventionalist may initially acquire competence, for example, performing endovascular renal and iliac interventions by fulfilling the minimum requirements.[14,15] Although there are no firm guidelines on the number of cases required to achieve restricted competence, a minimum of 20 to 30 diagnostic angiograms and 10 to 15 endovascular interventions in a given vascular bed may be required.

It is generally agreed that a strategy of retraining established coronary interventionalists to perform peripheral endovascular interventions benefits patient care and facilitates medical and scientific progress. However, with rapid advances in the field of endovascular interventions, achieving competence in peripheral interventions poses significant challenges with regard to the availability of resources, trainee time, and credentialed endovascular interventionalist proctors. This has prompted some cardiovascular physicians to envision and implement more innovative modalities of teaching and training.[4] One such recent innovation is simulation-based training.

SIMULATION-BASED TRAINING

In comparison with the traditional methods of training, simulation-based training has multiple advantages (Table 1). It is an interactive, practical, case-based method of training. Moreover, it is implemented in real time and in a clinical environment with no potential harm to the patient. It can be standardized, comprehensive, and reproducible with immediate, authoritative feedback. It incorporates evidence-based medicine and expert consensus. It reduces patients' exposure to physicians with limited experience, physicians in training, and the distractions of a training environment.[17] With traditional methods of training, there is a wide variation on how physicians develop competence in a particular new technique—some may achieve suboptimal competence, whereas others may not obtain adequate level competence to allow them to perform a specific intervention (Figure 6). Simulation-based training, by providing a venue that is safer, less time-consuming, and more cost-effective, is expected to alter the learning curve phenomenon in a favorable fashion.[4]

One of the major advantages of the simulation-based training is the notion of patient safety while cardiovascular physicians acquire additional training to ultimately improve the care of their patients. In a recent report from the Institute of Medicine, adverse events occurred in 2.9% to 3.7% of hospitalizations, with more than half of all adverse events resulting from medical errors.[18] Overall, adverse events led to death in 6.6% to 13.6% of cases. In addition to jeopardizing patients' care and safety, such adverse events significantly increase the total cost of healthcare. The development of a culture of safety will require dramatic changes in our system of training and evaluation of healthcare professionals.

Figure 7. Simulation-based training is an innovative approach in training endovascular interventionalists (Courtesy of Medical Simulation Corp., Denver, CO).

It is imperative to note that simulation-based training addresses many of the needs for a paradigm shift in medical education, including patient safety, multimodal education and evaluation of skills and knowledge in a reproducible and standardized fashion, utility in interdisciplinary team training and crisis management, new product development and training, and continuous professional development (Figure 7).[19] The growing importance of simulation-based training is underscored by the fact that several societies and organizations, including the American College of Cardiology, American Board of Internal Medicine, Society of Cardiac Angiography and Intervention, and the Society of Vascular Surgery, have all developed pilot programs to explore simulation for training and credentialing purposes.[4]

CONCLUSIONS

The patient population with vascular diseases requiring endovascular peripheral interventions is expanding rapidly. As the population ages, the prevalence of PVD increases significantly. As a result, there is an increasing impact of PVD on morbidity and mortality. The role of endovascular interventions in the treatment of patients with vascular diseases is expanding, whereas there is a shortage of trained endovascular interventionalists to provide care to patients with vascular diseases. Coherent and cohesive training and credentialing programs will require extensive cooperation among the societies. Due to continuous major advances in the field of endovascular peripheral intervention, there is a need for cooperation among different specialties of vascular physicians, which can lead to a multidisciplinary approach in optimizing the care of patients with vascular diseases. Such a multidisciplinary approach is also needed to foster further developments in the field of endovascular peripheral intervention. Moreover, there is a need for innovations in training methods, such as simulation-based training. With development of new products, incorporation of innovative training methods, and a multidisciplinary approach, we can expect significant advances in endovascular treatment of patients with vascular diseases in the near future. ■

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