Vision of the vascular surgeon as the vascular specialist of the future

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To conjure up a vision of the vascular surgeon as the vascular specialist of the future, it is important to track the development of vascular surgery as a specialty and the responsibilities of vascular surgeons 20 years ago, 10 years ago, and now. An attempt will be made to predict what the activities of the vascular surgeon will be in 10 and 20 years and whether these activities justify the title "vascular specialist."

VASCULAR SURGERY AS A SPECIALTY: HISTORY AND PREDICTIONS

Modern vascular surgery began in the 1950s and 1960s. By the mid-1970s a large number of vascular operations were being performed by surgeons with varying backgrounds. Relatively few operations were being performed by surgeons who restricted their practice to vascular surgery. Many surgical residents performed fewer than 10 arterial reconstructions during their training. The Society for Vascular Surgery (SVS) and the North American Chapter of the International Society for Cardiovascular Surgery (ISCVS) in 1972 passed resolutions that recommended and endorsed a method of certification to be administered for recognition of special competence in vascular surgery under the aegis of the American Board of Surgery (ABS).[1] Even though the concept was approved by the ABS in 1972, no action had been completed by the end of 1975.

In 1982, the American Board of Medical Specialties approved the application of the ABS with representation from the American Board of Thoracic Surgery to grant "Certificates of Special Qualifications in General Vascular Surgery." The term "Special" was later changed to "Added." By 1985, 545 surgeons had been certified.[2]

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As of June 1995, 1417 diplomates have received certification in vascular surgery. If the number of vascular surgeons who complete residencies remains stable, as it has in recent years, certificates will have been granted to approximately 2300 surgeons by 2005 and 3200 surgeons by 2015.

The current definition of vascular surgery as approved by the ABS is "Surgery of the arterial, venous, and lymphatic circulatory systems exclusive of the intracranial vessels and those vessels intrinsic to and immediately adjacent to the heart." The definition of certified vascular surgeons is surgeons "who, by virtue of additional training, dedicated practice characteristics and contributions to the discipline have demonstrated qualifications which are indeed above and beyond those expected of other Certified General and Thoracic Surgeons."[3]

The ABS specifies that vascular surgery is a primary component of general surgery and that board-certified surgeons in general surgery should be considered qualified to perform vascular surgery. The ABS has chosen to call the credential certificate one of "Added Qualifications in Vascular Surgery." Moreover, the ABS does not recognize vascular surgery as a subspecialty. On the other hand, the American College of Surgeons has established for vascular surgery an advisory council; such councils have usually been allocated to "specialties." In addition, vascular surgery is commonly found in lists of specialties.

The possibility of a separate Board of Vascular Surgery is not currently being considered.[4] It is likely, however, that over the next 10 or 20 years the downward trend in the number of vascular operations performed by cardiothoracic and general surgeons will continue, and that few if any vascular operations will be performed by urologists and orthopedists. Neurosurgeons, however, will probably continue to be involved in the reconstruction of extracranial cerebral vessels. Their training requirements now include experience in performing carotid endarterectomies. Nonetheless, it is predicted that vascular surgery will follow the path of other evolving specialties and that possibly by 2005 and certainly by 2015

a Board of Vascular Surgery will be established. Only then will the title "specialty" be fully acquired by vascular surgery.

TRAINING OF VASCULAR SURGEONS: HISTORY, PRESENT STATUS, AND FUTURE PREDICTIONS

Twenty years ago, there were hospitals with large numbers of vascular patients where residents in general and thoracic surgery could obtain additional vascular surgical training either in a fellowship or during their residency. In 1981 and 1982 a committee of the Joint Council of the SVS and ISCVS inspected and approved 52 such programs. In addition, in 1982 the Residency Review Committees (RRCs) for general surgery and thoracic surgery reached an accord and approved accreditation of general vascular surgery training programs by the general surgery RRC with input from the thoracic RRC.

By 1985, 29 vascular surgical programs had been approved for the education of 42 trainees. Residents who successfully completed vascular surgical training in programs accredited by the vascular societies or the general surgery RRC through June 1985 were eligible to take the examination for the certificate of "Special Qualifications in Vascular Surgery."[2]

As of June 1995, 71 programs have been approved by the general surgery RRC for the training of 92 residents who can then take the examination for a certificate of "Added Qualifications in Vascular Surgery."

Many health care analysts predict that the need for all surgical specialists will plateau or decrease in the next 20 years. Because the numbers of vascular operations being performed continue to gradually increase and because an increasing percentage of these operations are being performed by certified vascular surgeons, the need for vascular surgical training programs will continue to gradually increase.

Current training requirements for vascular surgery as defined by the Accreditation Council for Graduate Medical Education[5] are as follows:

1. "The program must provide instruction and require the resident to become knowledgeable in the fundamental sciences including anatomy, embryology, physiology and pathology as they relate to the diagnosis and treatment of vascular lesions."
2. "Familiarity with special diagnostic techniques is of great importance in the management of vascular lesions. It is essential that the resident have an acquaintance with the methods and techniques of angiography and competence in the interpretation of angiographic findings. The resident should have experience in the application, interpretation, and limitations of noninvasive vascular diagnostic techniques."
3. "The resident must be provided with progressive senior surgical responsibilities . . . in patient evaluation, therapeutic decisions, operative experience and postoperative management."

Although these training requirements assure that the trainee will have adequate preparation to practice vascular surgery, it does not, in our opinion, describe the additional preparation required to make that trainee a competent vascular surgeon in the sense that he or she would also be a complete "vascular specialist." The responsibilities of such specialists would include the ability to recognize all vascular diseases and to be capable of performing and interpreting all of the diagnostic techniques required to make accurate diagnoses. In addition, he or she should have the capability of prescribing or performing all possible means of treating the disease that is found. These treatments include conservative noninterventional treatment, medical therapy with pharmaceuticals, catheter-directed endovascular treatments, and operative treatment.

FUTURE RESPONSIBILITIES OF THE VASCULAR SURGEON AS A VASCULAR SPECIALIST

Diagnosis of vascular diseases

Knowledgeable clinical examination. The vascular surgeons of 10 and 20 years ago benefited from their teachers' experience and accumulated skills in and out of the operating room. These skills included clinical expertise with the ability to take a complete vascular history and to perform a knowledgeable physical examination. Patients were referred to them who had peripheral vascular lesions that were not always simple. These cases included patients with diabetes with extremity infection and necrosis, the entire spectrum of extremity ulcers, congenital vascular abnormalities, a variety of obscure venous and lymphatic disorders, collagen diseases, thoracic outlet and other neurovascular compression syndromes, arteritides, and many other vascular disorders. Many of these entities require long-term follow-up and treatment, and many require operative intervention only in unusual circumstances.

Many vascular surgeons continue to serve as a specialist for all vascular diseases. Others have become so busy performing surgery that they discourage referral of nonsurgical cases. Others are in practice in

institutions or communities where the referral of nonsurgical vascular problems has already been lost to other specialties. Unless the office practice of vascular surgery is more heavily stressed in the training programs of the future, the ability of vascular surgeons to learn how to be true vascular specialists may be lost in 10 years and will certainly be lost in 20 years.

Noninvasive studies. Noninvasive testing evolved out of research techniques developed by blood flow laboratories. Twenty years ago routine clinical use of the early tests had become accepted, and the number of inpatient and outpatient noninvasive laboratory facilities gradually grew. Most of these facilities were established by vascular surgeons who used the results for evaluation and management of their patients. The techniques were limited to simple physiologic methods using inexpensive plethysmographs and continuous-wave Doppler flow detectors. Ten years later the main changes were the increase in the volume of testing and the shift to more complex technology with the acceptance of duplex scanning as a major tool for cerebrovascular evaluation. A survey of vascular surgeons in 1985 documented that 60% of respondents used carotid duplex scanning.[6]

Noninvasive testing is now widely available in most medical communities. In the last 10 years, duplex scanning has been applied to all areas of noninvasive testing. The introduction of color-flow duplex technology has facilitated testing in some areas that were difficult or tedious to scan with the conventional duplex systems. Surgeons have continued to be involved in vascular testing; a survey found that 80% of vascular fellowships have a specific component of teaching in noninvasive diagnosis. Another major change in the last decade has been the entry of other specialists into the vascular laboratory. Radiologists represent the largest group of newcomers, and many radiology residencies provide specific training in duplex scanning. Other specialties involved in vascular testing include neurologists and cardiologists.

In the next 20 years, noninvasive testing will continue to be important in the clinical management of vascular disease. Although magnetic resonance angiography is noninvasive, it is unlikely to displace ultrasound methods because of cost. The biggest question is whether vascular surgeons will continue to have a major role in vascular laboratories in view of pressures from other specialists. It is essential for vascular training programs to increase the teaching of noninvasive techniques and interpretation so that surgeons can retain a credible role in this field.

Invasive studies. Twenty years ago most vascular surgeons performed their own diagnostic angiograms. By 10 years ago the number was declining, particularly in academic institutions. At that time the RRC for surgery asked representatives from the Joint Council whether the performance of angiography should be a requirement for vascular residents. Because many programs could not provide the experience, the Joint Council representatives recommended only that "an acquaintance with the methods and techniques of angiography and competence in the interpretation of angiograms" be considered sufficient.[5] Certainly the vascular specialist of the future will have to be competent in catheter-guidewire–imaging techniques to perform endovascular treatments. Furthermore, it is true that many of these skills could be obtained during the performance of diagnostic arteriograms. These skills, however, can also be obtained in other ways and in locales other than the diagnostic angiography suite. For example, residents who completed their general surgical training at the University of Rochester in 1994 performed 31 to 61 catheter-guidewire–imaging procedures during their training; most were performed in the operating room. Other programs provide an even more extensive experience. Accordingly, the performance of diagnostic angiograms, although potentially useful, need not be a prerequisite in the training of the vascular specialist.

Treatment of vascular diseases

Noninvasive management. Twenty years ago most vascular surgeons assumed the main role in both medical and surgical care of patients with vascular disease that affected the arterial, venous, and lymphatic systems. The spectrum of underlying disease encompassed atherosclerosis and vasospastic and thrombotic diseases. Then, as today, the majority of patients were initially referred to the vascular specialist for some manifestation of their underlying systemic atherosclerosis. Thus the vascular surgeon became a primary care physician, managing hypertension, diabetes, cardiac disease, and anticoagulation. As it became apparent that coronary artery disease was the major cause of death in this patient population, attention became focused on the heart. The specialty of cardiology became more clearly defined and focused so that graduates of cardiology training programs were no longer interested in peripheral vascular disease and concentrated on the management of cardiac disease to the exclusion of the periphery. Simultaneously, as the pharmacologic options increased and decision-making processes for intervention in patients with coronary artery disease became more complex, parallel efforts in both medicine and

surgery developed in which internists and cardiologists who managed the heart-related problems were teamed with vascular surgeons who managed noncardiac vascular problems. Institutions that use this team concept are the Cleveland and Mayo Clinics, which have used this approach since the 1950s. During the last decade, the management of associated cardiac complications has become even more complex with regard to both pharmacology and interventional options. Pure cardiology specialists, particularly in the academic centers, became even more compartmentalized as the specialty became progressively more procedure-oriented. It was in this setting of increasing demands on both vascular surgeons and cardiologists that many saw a need for a special group of internists who would be concerned with peripheral vascular diseases as well as heart-related problems.

Consequently, during the past decade a Division of Vascular Medicine was created at such institutions as the Brigham & Women's Hospital in Boston and Yale-New Haven Hospital for the purpose of providing more efficient and comprehensive care for patients with systemic atherosclerosis. The Division of Vascular Medicine has become an equal component in a dedicated Vascular Center composed of the Division of Vascular Surgery, the Division of Vascular Medicine, and the Division of Interventional Radiology. Over the ensuing years, a working relationship evolved to provide expeditious care of a patient with peripheral vascular disease. Patients were evaluated by internists or cardiologists, surgeons, and radiologists on the day of referral to develop a plan to manage the problem immediately. After appropriate intervention, a comprehensive longitudinal-care plan was developed for the primary care physician for subsequent management of both cardiac and peripheral disease and associated risk factors. In this fashion, patients received the most comprehensive care from specialists in three disciplines, none of which can realistically assume mastery of the other two fields. As nonoperative methods for the treatment of systemic atherosclerosis continue to emerge and patients need frequent follow-up visits, the vascular internist is reliably available for patients with respect to exercise training programs, pharmacologic intervention for claudication, and vasospastic or thrombotic disorders. Vascular surgical residents, however, should be exposed to and involved with all of these activities.

To enhance this working relationship, the National Heart, Lung, and Blood Institute established a series of academic awards in vascular medicine. In 1991 awards were given to Brigham & Women's Hospital and Stanford for 5 years to explore the feasibility of this interdisciplinary approach. In the intervening years nine additional centers have been funded, and in 1995 another five programs were funded.

This approach is most suitable for large academic regional facilities. Some small groups of community practitioners have joined under a variety of economic plans for the same purpose. It is not known whether these centers can be economically justified or whether they will survive if governmental support is withheld in the future. In many communities the vascular surgeon continues to be the specialist for the diagnosis and, frequently, management of all peripheral vascular and lymphatic diseases. The vascular surgeon must remain aware of the appropriate therapies applicable to peripheral vascular diseases of all types, and vascular residents should have exposure to these patients during their training. Twenty years from now integrated groups of physicians will probably be oriented around disease entities and will practice together under an integrated economic reimbursement system. If the vascular surgeon is going to be the vascular specialist of the future, it is important that the vascular surgeon have a significant leadership role in these groups. In addition, if vascular surgeons are in communities without such multidisciplinary groups, they must be prepared to diagnose and manage many vascular problems that do not require operative or interventional treatment. This ability can only be obtained with training in vascular medicine.

Endovascular treatments. Although Dotter and Judkins[7] introduced percutaneous transluminal angioplasty (PTA) in 1964 and Gruntzig and Kumpe[8] improved the procedure by introducing noncompliant balloon catheters several years later, few vascular surgeons at first used these techniques themselves or referred patients to their interventional radiology colleagues to have this catheter-based therapy performed.[9,10] Subsequent experience, however, proved that PTA could be a valuable treatment in certain circumstances.[11-13] With this increasing evidence that PTA could be effective, vascular surgeons began to use this technique more widely and to have PTA performed in their patients by their interventional radiology associates to replace open surgical procedures or as an adjunct to simplify or improve the results of standard operative treatment.[12,13] Nevertheless, only a small fraction of vascular patients who require invasive therapy can be treated solely by this endovascular catheter-based method.

In contrast, the introduction of endovascular stents and stented grafts have the potential to provide less-invasive intraluminal treatment for a substantially

Table I. Vascular operations performed in the United States (1979-1991)

Operation	*1979*	*1985*	*1991*
Peripheral Vessel Bypass	46,000	72,000	75,000
Carotid Endarterectomy	54,000	107,000	91,000
Abdominal Aortic Aneurysm	19,000	33,000	40,000
Aortoiliofemoral	18,000	30,000	33,000
Other	223,000	329,000	344,000
All Vascular Operations	360,000	571,000	583,000

Data from the National Center for Health Statistics.

larger fraction of vascular patients with a variety of vascular lesions that previously required major vascular surgical procedures.[14-21] In view of this potential, vascular surgeons may fairly ask what role they should have in the performance of these newer endovascular treatments that may replace many of their current operative procedures.

Members of the three specialties that perform these procedures have written their own guidelines for who in their specialty should perform these procedures, as is appropriate. Members of each specialty have expertise and experiences that with additional training would qualify them to care for patients who might benefit from endovascular procedures, including the insertion of stents and grafts.[22]

Vascular surgeons of the future should actively use endovascular treatments, either by acquiring enough training and experience to be fully competent in all areas, as has already been accomplished by some vascular surgeons, or by being an integral part of a multidisciplinary team that performs a variety of endovascular procedures. This team should include individuals who have (1) clinical experience in the natural history of vascular lesions and the role of all the various forms of treatment for managing these lesions, including nontreatment, various noninvasive forms of therapy, the complete range of endovascular treatment methods, and open surgical procedures; (2) a high level of skill in the use of catheter-based endovascular treatment methods; (3) a high level of vascular surgical skill; and (4) the necessary skill to evaluate the outcomes of procedures after they are performed. This skill includes the ability to interpret clinical findings and the various forms of imaging techniques and noninvasive laboratory results that may be needed to evaluate endovascular treatments. The vascular surgeon of the future should be a vascular specialist and be adequately trained to possess skills in all four of these areas. Whether he or she bears primary responsibility for the procedures will depend on local circumstances and the availability of specialists from other disciplines.

For all vascular surgeons to become complete endovascular specialists, further training will be required. The RRC already recognizes the importance of general surgical residents obtaining skills in catheter-directed techniques by requesting them to list the number of Hickman catheter, Greenfield filter, and other insertions they perform during their residency. Many vascular surgeons have recognized the importance of this training and have recommended that vascular surgery training include exposure to and actual experience in endovascular techniques. For programs that are not involved with endovascular treatments, it has been suggested that programs that have operating rooms equipped for endovascular techniques, and particularly those that are rich in numbers of endovascular procedures, train not only their own residents but also vascular surgeons from other institutions.[23] Alternatively, vascular surgeons could be trained in programs that have a "healthy collaborative relationship" with specialists such as interventional radiologists.[20] The site of training may be in the operating room, the radiology suite, or in both places.[20] Any training program for endovascular specialists should also include experience with the insertion of devices in large animals or mock circulatory models.[24]

It will be necessary for vascular surgeons who wish in the future to perform the total spectrum of vascular treatments that they also become endovascular specialists. The endovascular insertion of stents and grafts for the treatment of vascular lesions will probably be widespread within 10 years and certainly within 20 years.

Surgery. Operative rate data for common vascular operations have been included in vascular surgical manpower reports published in 1986 and 1987.[25,26] The data were obtained from the National Center for Health Statistics through its National Hospital Discharge Survey. The major index vascular procedures included abdominal aortic aneurysm repair, aortoiliac-femoral reconstruction, carotid endarterectomy, and femoral-popliteal-tibial bypass. In 1985 operative rates for these procedures appeared to be

approaching a plateau; this observation has been confirmed by more recent data (Table I).

In 1985 the proportion of all types of vascular operations performed by vascular surgeons was 41%,[26] and by 1992 this proportion had risen to 51%. These percentages were determined from data supplied by the National Center for Health Statistics and 1406 questionnaire responses from vascular surgeons regarding their case loads. This is possibly a reflection not only of the evolution of vascular surgical training and recognition of vascular surgery as a specialty by most hospitals, but also of the result of socioeconomic factors, including the impact of medical liability and insurance costs for high-profile, high-risk vascular surgeons. The 51% of all vascular operations performed by vascular surgeons represents a 24% increase during a recent 6-year period, and it is expected to increase to 75% in the next 20 years.

Although predicting future vascular surgical case requirement rates is clearly an inexact science that is affected by numerous uncontrollable and unforeseen variables, it is quite likely that as endovascular procedures are refined and made safer for patients such procedures will increase in frequency, probably at the expense of traditional open operative procedures. Consequently, it is important that current vascular surgeons and vascular surgical training programs adapt to this evolving process and become actively involved in endovascular therapy. Vascular surgeons of the future, as complete vascular specialists, should be able to perform such procedures.

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