

Vascular surgery training in the United States: A half-century of evolution

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The purpose of this report is to succinctly review the history, evolution, and accreditation process of postgraduate surgical training programs in the United States, with emphasis on recent dramatic changes in vascular surgery training. Vascular surgery became a distinct specialty of surgery on March 17, 2005, when the American Board of Surgery (ABS) received approval from the American Board of Medical Specialties (ABMS) to offer a Primary Certificate in Vascular Surgery. The traditional requirement for 5 years of training and certification in general surgery was eliminated. Effective July 1, 2006, the ABS converted its certificate in vascular surgery from a subspecialty certificate to a specialty (primary) certificate. These landmark changes allowed the simultaneous development of new training paradigms. Multiple flexible training pathways leading to either dual certification (Traditional 5-2; Early Specialization Program 4-2) or vascular surgery certification alone (Integrated 0-5; Independent 3-3) now exist. New pathways require a minimum of 2 years of core surgery training and 3 years of advanced vascular training. There are currently 96 accredited traditional 5-2 programs, five 4-2 programs, and 11 0-5 integrated programs, with multiple additional institutions in the process of submitting 0-5 applications. The main obstacle preventing more rapid transition to the new pathways seems to be difficulty in obtaining funding for additional resident positions. Multiple flexible training paradigms are likely to coexist as vascular surgery continues to evolve. (*J Vasc Surg* 2008;48:90S-97S.)

Understanding the evolution and current status of vascular surgery training requires some background of the history of graduate medical education in the United States. The processes of development of curriculum requirements, program accreditation, and pathways to board certification are difficult to fathom without a brief review of the governing bodies involved and their underlying purposes, authority, and complex interactions. This background knowledge allows one to better appreciate why the ongoing process of definition, recognition, and independent certification of vascular surgeons has been such a contentious one. The primary reason is not necessarily due to the genes we inherited as descendants of the American Revolution, but to the maze-like arrangement of the numerous organizations responsible for the oversight and certification of specific aspects of medical education that developed in the early 19th and 20th centuries.

BACKGROUND: GRADUATE MEDICAL AND SURGICAL TRAINING IN THE UNITED STATES

In the mid 1880s, the number of bona fide medical schools in the United States was limited; standardized

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curricula, organized oversight and monitoring, and quality control were lacking; and many schools were simply diploma mills. "Medicine at the beginning of the twentieth century was in a sorry state."¹ The American Medical Association (AMA), founded in 1847, was one of the first voluntary nonprofit educational associations. Little progress was made in medical education until the early 1900s, when the drive toward the standardization and regulation of medical training and practice for the greater public good was led by the AMA and the American College of Surgeons (ACS).

In 1905 the AMA published, for the first time, medical school specific pass rates for licensure examinations, based on which only 50% of existing medical schools were approved. In 1910 Abraham Flexner and N. P. Colwell performed a landmark survey of all 155 schools, and the following decade saw the establishment of the AMA Council on Medical Education and Hospitals. Additional periodic surveys were conducted, and in 1928 the AMA House of Delegates approved the first training standards, *Essentials for Approved Residencies and Fellowships*.²

The development, standardization, and monitoring of training was also spearheaded simultaneously and jointly by the ACS. The first Clinical Congress was held in 1910 to improve surgical education, was conceived by Franklin Martin, and was enthusiastically attended by more than 1300 surgeons. This effort rapidly led to the development of the "Committee for Standardization of Surgery" in 1912, whose charge was to "formulate minimum requirements which should be possessed by any authorized graduate in medicine who is allowed to perform, independently, operations in general surgery and any of its specialties." The ACS continued to formulate educational standards during the next two decades, culminating in the 1937 publication of its own standards for

surgical residency programs, *Fundamental Requirements for Graduate Training in Surgery*.²

The American Board of Surgery (ABS) is an independent, nonprofit organization founded in 1937 for the purpose of certifying surgeons who have met a defined standard of education, training, and knowledge. After a series of meetings beginning in 1948, representatives from the ABS joined members of the ACS and the AMA Council on Medical Education and Hospitals in an effort to coordinate the evaluation of surgical residency training programs. From these joint discussions, a tripartite committee was formed and named the Conference Committee on Graduate Training in Surgery.

After a protracted process of negotiations over a period of years, this committee evolved into the Residency Review Committee for Surgery (RRC-S), which was established in 1951. The ACS, AMA, and ABS agreed to share committee appointments and divide administrative and accreditation costs among the three founding entities. The functions of the RRC-S, which remain basically the same to this day, were to develop program requirements and standards as well as to evaluate and approve or disapprove individual training programs.

The Medicare Program was developed in 1965 during the presidential term of Lyndon B. Johnson and included funding for graduate medical education with the attendant requirements for public and governmental oversight. The Liaison Council for Graduate Medical Education (LCGME) was founded in 1972, largely to provide such oversight. The LCGME was succeeded by the creation of the Accreditation Council for Graduate Medical Education (ACGME) in 1983, whose purpose was to oversee the administrative, policy, and business aspects of the accreditation. The specific duties of accrediting individual programs and monitoring their performance were (and still are) delegated to the RRC. The role of the ABS is to certify graduates of RRC-approved programs through a process of qualifying (written) and certifying (oral) examinations.

At the beginning of the 20th century, multiple surgical specialties were evolving. For example, the American Board of Ophthalmology was incorporated in 1917, followed by the American Board of Otolaryngology in 1924. With the rapid formation of more specialty boards, there was a perceived need for overall coordination of their various activities. The Advisory Board for Medical Specialties was formed in 1933 and is the predecessor of the American Board of Medical Specialties (ABMS), which was finally incorporated as such in 1970.³ The purpose of the ABMS is to function as a federation of autonomous boards and to work with both the AMA and ACGME to approve the establishment of new specialty boards. The ABMS now has 24 member boards, including the ABS.

VASCULAR SURGERY TRAINING IN ITS INFANCY THE UNITED STATES: 1960-1982

Before this period, no specific training programs existed in vascular surgery, and vascular surgery was practiced by general and cardiothoracic surgeons. Initial vascular

surgery training programs were basically apprenticeships with early pioneers in vascular surgery. One of the first such programs was begun by Edwin J. Wylie, MD, at the University of California, San Francisco.⁴ In his presidential address to the North American Chapter of the International Cardiovascular Society (ICVS, later NA-ICVS), Dr Wylie, also a future president of the Society for Vascular Surgery (SVS), called for the establishment of formal residencies in vascular surgery to improve training for surgeons and outcomes for patients. The SVS had been founded in 1947, and one of its primary purposes, as defined in its bylaws, was "To encourage hospitals to develop special training for young surgeons in this field."

Wiley Barker, William Blasidell, Jack Cannon, Andrew Dale, James DeWeese, Sterling W. Edwards, Henry Ellis, John Foster, Keith Reemtsma, Charles Rob, D. Emerick Szilagyi, Jesse Thompson, and many other individuals deserving of special recognition spearheaded these efforts to establish vascular surgery as a specialty. The Joint Councils of the SVS and NA-ICVS met in 1971 and 1972 and formed a vascular surgery committee for "Certification of Special Competence in Vascular Surgery" under the aegis of the ABS.⁵ Letters recommending the establishment of this certificate were sent to the ACS, ABS, and the American Surgical Association (ASA). The ACS was supportive of this initiative in principle.

During the next several years, Dr Wylie and a Vascular Committee of the Joint Council of Vascular Societies prepared guidelines for "the essentials of training programs in vascular surgery," which were presented to the ABS in June 1974. The ABS was not prepared to separately certify vascular surgeons at that time; instead, a standing Committee for Vascular Surgery was established. Then, as now, it is important to recall that guidelines and approval for training programs were under the purview of the RRC-S, not the ABS.

By the mid to late 1970s, the guidelines had been approved by the RRC-S and were forwarded to the appropriate governing bodies (ABS, ACS, and LCGME) for approval. The LCGME tabled the guidelines, primarily because of objections from the American Board of Thoracic Surgery (ABTS). Bypassing this roadblock, the Joint Vascular Council (SVS and NA-ICVS) and membership voted in 1979 to proceed with accrediting vascular training programs using the "essentials" document that had been prepared years earlier. The Joint Council, chaired by Dr Wiley and Dr Barker, appointed a vascular credentials committee, which was named the Program Evaluation and Endorsement Committee. Seventeen programs were initially approved, and by 1982, 52 vascular programs had been approved.⁵

The climate for vascular surgery gradually improved. In 1977 the ABS agreed to the principle that it could issue certificates in subspecialties of surgery. Five years of negotiations between the Joint Council, ABS, ABTS, and ABMS led to the creation of a "Certificate of Special Qualifications in General Vascular Surgery." The substitution of the term *qualifications* for *competence* caused some controversy, as

did the addition of the term “*general*,” which was apparently added to be sure that other boards of the ABMS would not block the certificate.

In 1982 the first 14 ABS Certificates of Special Qualifications in General Vascular Surgery were issued after successful completion of a written examination. All of these initial examinees were members of the ABS, ABTS, or the vascular committee of the ABS; the first vascular certificate was, fittingly, issued to Dr Wylie.^{4,5} Written (qualifying-QE) examinations for the vascular qualifications certificate have been given continuously since 1983; oral (certifying-CE) examinations were added in 1986. As of December 2007, 2676 Diplomates have been certified in vascular surgery, 1612 have recertified once, and 444 have recertified twice. From 1987 to 2007, the first-time pass rates on the QE and CE have been 17.2% and 15.8%, respectively (data obtained from ABS).

VASCULAR SURGERY TRAINING IN ITS ADOLESCENCE: 1983-2006

The ACGME was founded in 1981 and soon thereafter approved guidelines for training programs in vascular surgery. The RRC-S began reviewing vascular training programs in 1983 and accredited the first such programs in 1984. Programs endorsed by the Program Evaluation and Endorsement Committee were transitioned to ACGME-accredited programs between 1984 and 1986. Beginning in 1989, after a 5-year transitional or grandfathering period, all those sitting for the Vascular Certificate (“Special” evolved into “Added” Qualifications, the latter term applied to graduates of ACGME-accredited fellowship programs; both designations on Vascular Certificates were dropped by the ABS in 1998), and all applicants for the Certificate of Special or Added Qualifications in Vascular Surgery were required to have completed ACGME-approved vascular training programs, which generally consisted of one dedicated vascular training year after completion of an accredited general surgery residency (5-1 pathway). ABS Certification in General Surgery was a prerequisite for vascular surgery training and subspecialty certification. In a few instances, Vascular Certification was possible after completion of an accredited cardiothoracic surgery program, if the vascular case volume was deemed adequate. The latter pathway was short lived and gradually disappeared.

The Association of Program Directors in Vascular Surgery (APDVS) began as an informal gathering of vascular program directors during the annual meetings of the SVS. It was formally incorporated in 1993, with two of its founders, William Baker and John M. Porter, serving as its first two presidents. The APDVS has been well organized, and during a relatively short span, developed detailed curricula in basic science, clinical science, and the vascular laboratory; it has also been very influential in providing input to the RRC-S regarding training standards.

From 1984 to 1995, many vascular programs added an additional year of training (5-2), but the second year was primarily research, and only the clinical year was an accredited one. Although the political landscape had smoothed

substantially since the 1970s and early 1980s, leading vascular surgeons in the 1990s pushed for recognition of vascular surgery as a specialty distinct from general surgery, based on the premises that the diagnosis and management of vascular disease had sufficiently evolved and that patient outcomes were improved when care was provided by a specialist in vascular surgery rather than a general surgeon who occasionally performed vascular operations.⁶⁻⁸ The increasing number of trained vascular surgeons who confined their practice to vascular surgery felt that the requirement to recertify in general surgery before being eligible for recertification in vascular surgery was nonsensical and unnecessary. In addition, an RRC-S-approved general surgery training program was a prerequisite for institutions to have an approved vascular surgery training program, excluding many solid freestanding vascular surgery programs from ACGME accreditation.

Vascular surgery was still defined an essential component of general surgery, with training requirements in vascular surgery mandated for general surgery residents. Many vascular surgeons believed this paradigm led to a two-class system for vascular training in the United States, with general surgery training preparing “the surgeon to perform certain simple vascular procedures, whereas the vascular surgery fellowship prepares surgeons for performing more complex vascular surgery.” The vascular surgeon was not really recognized as a specialist, despite the additional certificate, and the public was unable to distinguish between a general and vascular surgeon (certified in general surgery alone, with no additional vascular training) and the true vascular surgeon who had completed additional fellowship training.^{9,10}

In 1996 this impasse with the ABS and the RRC-S led to the decision to attempt formation of a Primary Specialty Board of Vascular Surgery, the American Board of Vascular Surgery (ABVS). This initiative was presented by consensus of the SVS, NA-ISCVS, and the APDVS and published in the February 1997 issue of *Journal of Vascular Surgery*.¹¹ The underlying two principles of this proposal were to provide “constant improvement in the efficient and excellent care of patients with vascular disease” and to develop and maintain “the best means for training professionals to care for patients with vascular disease.”¹¹ Although pursued with honorable intentions and based on sound premises, this application was ultimately denied in December 2002 by the Liaison Committee for Specialty Boards (LCSB), the organization that receives and responds to applications for development of a new independent specialty. The LCSB consists of eight members, four from the AMA, and four from the ABMS.

While pursuing the direct route to recognition of vascular surgery as a distinct specialty (an independent board), the leadership in vascular surgery simultaneously continued to work within the existing governing bodies to achieve the same goal. This latter approach resulted, after complex negotiations and considerable deliberation, in the formation of the Vascular Surgery Sub-board of the ABS, established in June 1998 as the first ABS sub-board and pat-

Table I. Vascular surgery resident match data

<i>Variable</i>	<i>2000</i>	<i>2001</i>	<i>2002</i>	<i>2003</i>	<i>2004</i>	<i>2005</i>	<i>2006</i>	<i>2007</i>
Enrolled programs	81	84	87	88	90	94	92	92
Active positions	91	93	98	103	110	117	112	119
Filled	86	89	89	91	87	93	106	115
Unfilled	5	4	9	12	23	24	6	4
Active applicants	107	107	108	108	100	108	129	139
Matched	86	89	89	91	87	93	106	115
Unmatched	21	18	19	17	13	15	23	24
Applicant demographics								
US graduate			84	81	68	76	82	95
US foreign			3	1	14	7	14	15
Pathway			0	0	0	1	1	1
Osteopath			5	2	3	5	10	4
Foreign			16	23	14	19	11	24
Canadian			0	1	1	0	0	0
			108	108	100	108	118	139

turned after sub-boards of the American Board of Internal Medicine (ABIM); this ingenious approach was spearheaded by Richard Dean.¹²

The Joint Council of the SVS and ISCVS (subsequently fused into a single vascular society—the SVS—in 2003) outlined 14 specific points that would be used to assess the success and progress of the Vascular Surgery Sub-board. These included primarily issues related to control of training and certification and recertification requirements in vascular surgery, oversight of Vascular QE and CE, appointment of examination consultants, relationships with other specialties, establishment of RRC requirements for vascular surgery, and the elimination of complex vascular surgery as an essential component of general surgery. In large part, these issues were resolved, thereby setting the stage for the recent major paradigm shift in vascular surgery training in the United States.

RATIONALE FOR FURTHER CHANGE

The explosive development of endovascular therapy in the 1990s forced the establishment of training requirements in endovascular surgery. Endovascular training and volume requirements for vascular programs were submitted to and approved by the RRC-S in 2000 and became mandatory for accredited vascular surgery training programs in 2004. By this juncture, the 5-1 training pathway had functionally evolved into a 5-2 model, the second year being necessary to provide adequate exposure to endovascular surgery, with the research year falling by the wayside in most programs. The result was a training period of at least 7 years (after 4 years of college and 4 years of medical school), with up to 9 years for those pursuing any research. Trainees were thus in their mid 30s before they could begin independent practice and many had already accumulated substantial student loan indebtedness, estimated on average to be \$100,000.¹³

The protracted training period and large incurred debt were strong disincentives for medical students and residents to pursue vascular surgery. The difficulties in trainee recruitment into the 5-2 pathway for vascular surgery were

highlighted in the 2004 and 2005 vascular surgery matches, when there were insufficient applicants to fill the available vascular surgery positions (Table I). Prolonged training and the prerequisite for 5 years of preliminary general surgery training with its perceived poor lifestyle were major reasons cited by medical students for not selecting a career in vascular surgery.^{13,14}

It also was apparent to many vascular surgeons involved in training that because of the rapidly changing and increasingly endovascular landscape, the parallel decline in the number of open procedures and the corresponding need to preserve those procedures for trainees who would most benefit, the need to expand training in vascular medicine and noninvasive testing, and the inherent imbalance (reversed weight) between general and vascular training in the 5-2 model, it would be necessary to develop new training pathways not only to preserve the specialty but also to provide sufficient vascular specialists to meet the needs of patients in the 21st century.¹⁵ There was widespread agreement that the total training period could be shortened and should be refocused, but the precise method to best train the next generation of vascular surgeons was unclear.

The initial step toward reducing the training length occurred in 2003 when the RRC-S and ABS approved initiation of the Early Specialization Project (ESP). This model began as a pilot project. It requires 4 years in general surgery training, followed by 2 years in vascular surgery training¹⁶; both general and vascular training program must be ACGME-approved, and all 6 years of training must be at the same institution. The fourth year of general surgery training is at the chief resident level and is counted toward both general and vascular certification.

The ESP (4-2) shortened total training by 1 year and leads to dual board certification, but has been limited in its application. Currently, only five such programs are in existence (Table II). Most projections have indicated a sharply increasing demand of at least 50% for vascular surgeons in the next 20 to 25 years, primarily due to the epidemiology of vascular disease (baby boomers, increasing rates of obe-

Table II. Accreditation Council for Graduate Medical Education–accredited integrated and early specialization vascular surgery programs

0-5 Integrated vascular surgery programs
<ul style="list-style-type: none"> ● Dartmouth-Hitchcock Medical Center ● Indiana University School of Medicine ● University of Michigan ● University of North Carolina Hospitals ● University of Pittsburgh Medical Center ● University of South Florida ● Mount Sinai School of Medicine ● Stanford University ● State University of New York at Stony Brook ● University of Rochester ● University of Massachusetts
4-2 Early Specialization Programs
<ul style="list-style-type: none"> ● McGaw Medical Center of Northwestern University ● Oregon Health and Science University ● University of California, San Francisco ● University of Texas Southwestern Medical School ● Washington University, St Louis

sity and diabetes) and the increasing use of endovascular therapies.^{13,14} The 4-2 training model was an insufficient response to accommodate this developing critical need.

In 2004 the VSB, SVS, and APDVS began joint preparation of an application for a primary certificate in vascular surgery, seeking elimination of general surgery certification as a prerequisite. The three organizations recognized the need for a new paradigm in vascular surgery training that would better address needs of the specialty and patients. These efforts came to fruition, and vascular surgery became a distinct specialty of surgery on March 17, 2005, when with ABMS approval, the ABS agreed to offer a Primary Certificate in Vascular Surgery.¹⁷ In October 2005, training program requirements for this certificate were approved by the RRC-S, with substantial input from the VSB and the APDVS. The traditional requirement for 5 years of training and certification in general surgery was eliminated.

With the ACGME's approval, effective July 1, 2006, the ABS converted its certificate in vascular surgery from a subspecialty certificate to a specialty (primary) certificate.¹⁸ The Vascular Surgery Sub-board became the Vascular Surgery Board, a component board of the ABS, a model that may be applicable to the further evolution and recognition of additional surgical specialties. The VSB was formally recognized by the ABS and the SVS, in a joint statement issued in June 2007, as "the sole body that has authority and responsibility for defining vascular surgery training requirements, certification standards, and examination."¹⁹

VASCULAR SURGERY IN THE UNITED STATES IN THE 21ST CENTURY: CURRENT STATUS OF TRAINING PROGRAMS

The Primary Certificate allowed the creation of new training pathways in vascular surgery to enhance its attractiveness as a career choice and to potentially increase the supply of vascular surgeons by shortening the training period.¹⁸ There are now four possible training pathways in

Table III. Accreditation Council for Graduate Medical Education–approved vascular surgery training pathways in the United States^a

<i>Track</i>	<i>Board certification</i>	<i>Duration</i>	<i>Details</i>
Traditional ^b	GS and VS	7 (5 + 2)	GS/VS training may be at different institutions
ESP ^b	GS and VS	6 (4 + 2)	GS/VS training at same institution
Independent ^c	VS only	6 (3 + 3)	Single institution
Integrated ^d	VS only	0-5	Single institution

ESP, Early Specialization Program; GS, General surgery; VS, vascular surgery.

^aNo more than two vascular surgery training pathways will be approved for the same institution (ESP pathway not included in this limit).

^bMinimum of 2 additional years of vascular surgery training required.

^cThree years of vascular surgery training.

^dTwo years core surgical training, 3 years vascular training integrated during 5-year program.

vascular surgery, two allowing dual certification in general and vascular surgery, and two leading to vascular certification alone. The Traditional (5-2) and ESP (4-2) pathways leading to dual board certification remain in place, but development of independent (3-3) and integrated (0-5) pathways leading to vascular certification alone was also authorized (Table III). It was initially anticipated that the 3-3 paradigm would be the most widespread, but to date, the only such program has already converted to the 0-5 model. This situation could change if global surgical training in the United States were to evolve into a core 3-year "plus" model, with 3 years of broad, core surgical training followed by 2 to 3 additional years of focused training in areas of specialization such as trauma, acute care surgery, surgical oncology, and transplant. If such an evolution occurs, however, it looks as though the process may take a significant period of time. The RRC-S further established that as of July 1, 2006, all vascular surgery programs must be at least 2 years in duration; the initial 5-1 model thus became extinct.

As of June 2008, the distribution of ACGME-approved vascular surgery training programs in the United States is as follows: traditional (5-2)—96 programs; ESP (4-2)—5 programs; integrated (0-5)—nine programs; independent (3-3)—initially, one approved program, but it converted to 0-5 after only 1 year. An informal poll at the 2008 APDVS meeting in Toronto indicated that 20 to 30 program directors plan to prepare applications for integrated programs.

All four vascular training pathways have the same operative requirements; these have recently been updated and are summarized in Table IV. There are specific minimum operative requirements in defined categories such as abdominal, cerebrovascular, and peripheral, as well as minimum volumes for endovascular procedures and endovascular aneurysm repair. The total major vascular case volume of 200 will increase to 250, effective July 2009.^{20,21} The

Table IV. Case requirements^a

Defined category cases	Minimum No.	
	Current	Effective July 2009
Abdominal	30	...
Cerebrovascular	25	...
Peripheral	45	...
Complex (major)	10	...
Endovascular diagnostic	50	100
Endovascular therapeutic	50	80
Endovascular aneurysm repair	5	20
Major cases	200	250

^aNew Current Procedural Terminology (CPT, American Medical Association, Chicago, Ill) codes included in Residency Review Committee vascular case log: Thoracic endovascular procedures, spine exposures.

integrated (0-5) minimal total operative volume is 500 cases. A review of the operative experience of vascular surgery trainees from 1994 to 2003 documented that endovascular volume for vascular surgery trainees increased by 50% in the latter years of the period with only a 12% reduction in open case volume.²² An update of this analysis that includes 2007 data (Table V) documents progression of a similar trend.

Total case volume for vascular surgery trainees has continued to increase, driven primarily by increases in endovascular volume. Open experience is generally stable, with the notable exceptions of a continued decline in open AAA repair and direct reconstruction for intra-abdominal obstructive disease, particularly aortoiliac and renal artery occlusive disease. Nearly all trainees met RRC minimum requirements (Table IV).

The unique integrated (0-5) model requires the program to recruit candidates from medical school. The traditional target for vascular surgery training since its inception has been the general surgery resident. Success of this new paradigm will require early exposure of medical students to vascular surgery and suitable mentors and role models to foster interest in the field. Applicant volume has been excellent to date; although only nine such programs currently exist, the number of applicants for the first two matches exceeded the number of available positions by a factor of three to four. This pathway requires all 5 years of training to be at the same institution. Two years of core surgery education are required and may be integrated throughout the first 4 years of training, or may be concentrated during the first 2 years. The final year is a chief resident year, with all 12 months dedicated to vascular training.

This paradigm is inherently flexible, although approval of a Program Information Form submitted to the ACGME/RRC-S by the program director and signed by the designated institutional official is required. Core training varies somewhat among the currently approved integrated programs but includes general surgery (primarily abdominal), trauma, and acute care surgery, intensive care,

Table V. Changes in vascular surgery resident operative experience: 1996-2007

Category	1996	2001	2007
Total primary operations	262	279	459
Major open operations	201	176	175
Aneurysm	39.5	41.2	26.5
Cerebrovascular	59.5	49.4	50
Peripheral	73.5	68.2	80.8
Abdominal obstructive	10	6.0	14.5
Upper extremity	3.7	3.4	3
Complex			21.6
Minor open	54	39	
Vascular access	21.4	18.7	34.0
Venous	5.5	8.2	18.9
Endovascular	7	64	216.7
Diagnostic	NR	22.5	113.1
Therapeutic	7.2	41.5	103.6
Selected procedures			
Infrarenal AAA, ruptured	4.0	3.8	3.8
Infrarenal AAA, open elective	21.5	22.1	14.8
Carotid endarterectomy	54.3	43.6	43.4
Aortoiliac occlusive disease, open	15.8	12.6	10.5
Femoral-popliteal-tibial	55.1	NR	NR
Femoral-popliteal vein	NR	8.3	8.8
Femoral-popliteal prosthetic	NR	7.3	8.0
Infrapopliteal vein	NR	19.5	16.1
Celiac/SMA endarterectomy/bypass	2.9	4.3	4
Renal endarterectomy/bypass	6.6	1.7	0
Axillofemoral bypass	4.4	3.4	3.3
Femorofemoral bypass	4.3	4.5	4.9
Endovascular aneurysm repair	NR	16.9	44
Arteriography	NR	18.7	88.3
Balloon angioplasty	3.6	10.6	50
Stent placement	NR	6.4	31.5
IVC interruption/filter	NR	NR	15.4

AAA, Abdominal aortic aneurysm; IVC, inferior vena cava; NR, not reported; SMA, superior mesenteric artery.

anesthesia, pediatrics, plastic surgery, cardiac, thoracic, and transplant rotations.

The 3 years of vascular training include traditional open and endovascular experiences, but the 0-5 model has also allowed the addition of focused rotations in important content areas that were given inadequate time in the traditional and ESP models, including rotations in cardiology and vascular medicine, axial and intracranial imaging, neurology, vein clinic, vascular laboratory, simulation training, as well as additional senior level experience in the vascular components of cardiothoracic or transplant surgery. It was realized and acknowledged that individual programs would be able to take advantage of local, institutional opportunities for important educational experiences for their trainees that would not have been possible under the more rigid 5-2 paradigm.

The VSB and the APDVS are in the process of defining essential content areas, educational objectives, and competence levels for elements of the core curriculum. Once this process is completed, it is anticipated that individual programs will nevertheless retain considerable flexibility regarding specific rotations as long as the core content areas are covered and the educational and competence targets are met.

The APDVS has developed detailed clinical and basic science curricula, which are available on its Web site (vascularweb.org, affiliated societies, APDVS). There is also a defined vascular laboratory curriculum as well as a CD vascular laboratory lecture series (dedicated to Eugene Strandness); both are available to all program directors and vascular surgery residents. The APDVS is in the process of actively reviewing and updating all these curricula with the goal of developing specific training modules and review questions that would be available on the Web for all trainees. In addition, simulation for both open and endovascular training was the subject of a detailed session at last year's annual meeting of the APDVS, and a committee is being formed to make recommendations for the use of simulation in the training of vascular surgery residents.

At first glance, the initial roll-out of these new vascular surgery training pathways, after several years of complex negotiations, appeared to some as a state of confusion regarding how we should train vascular surgeons in the United States. In fact, the approval of multiple pathways presents a remarkable opportunity to increase the number and quality of vascular surgery trainees. Vascular surgery, with the advent of the primary certificate, has finally been recognized as a true specialty, rather than just a subspecialty of general surgery. We can continue to attract outstanding trainees from general surgery programs as we continue to teach them basic vascular principles.

The Patient Care Curriculum Outline, developed by the Surgical Council on Resident Education, is Web-based and includes 113 clinical modules with specific performance objectives. It is expected to be available to general surgery residencies for beta testing in September 2008 (personal communication, Richard H. Bell Jr). This curriculum outline covers 28 content areas and categorizes disease processes into two levels (broad and focused) and operations into three levels (essential–common, essential–uncommon, and complex). The details of this curriculum outline are beyond the scope of the present review; briefly, general surgery residents will continue to be exposed to vascular surgery during their training but will not be expected to provide comprehensive management for most vascular problems.²³ Such residents, through this exposure, may continue to be attracted to vascular surgery, and for these individuals, the 5-2 and 4-2 pathways remain options for advanced vascular training and either subsequent dual board certification (requires passing CE and QE examinations in GS followed by QE and CE in vascular surgery), or vascular surgery only (Primary Certificate in Vascular Surgery, effective July 2007, requires a core knowledge written examination in surgery before sitting for vascular surgery QEs and CEs).

The 2007 vascular surgery match for 119 positions in traditional 5-2 programs had 139 applicants. This represents the highest number yet, and the last 2 years demonstrate some recovery from the concerns generated by insufficient applicants to fill available positions in 2004 and 2005.²⁴ Trainees favorably exposed to vascular surgery as medical students who are confident of their career choice

may match directly out of medical school into either integrated 0-5 programs or 3-3 ACGME-approved programs. These pathways lead to vascular surgery certification alone. Success of these new programs will depend on the development of a sufficient number of such programs. Time will tell whether these multiple models continue to coexist or whether we evolve to a single training system. Our trainees will help us make that decision.

CONCLUSIONS

Multiple flexible and distinct training pathways leading to either dual certification (Traditional 5-2; ESP 4-2) or vascular surgery certification alone (Integrated 0-5; Independent 3-3) now exist, with most still being 5-2. All paradigms require a minimum of 2 years of core surgery training and 3 years of advanced vascular training. There are currently 96 accredited traditional 5-2 programs, five 4-2 programs, and nine 0-5 integrated programs, with many additional programs in the process of submitting 0-5 applications. The main obstacle to more rapid vascular training paradigm change seems to be the difficulty of obtaining funding for additional resident training positions. Multiple flexible training paradigms are likely to coexist as vascular surgery continues to evolve.

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DISCUSSION

Dr Chris Liapis (Athens, Greece). What do you think that we are gaining by changing the pattern of training and having independent vascular training? Right now we are in need of more vascular surgeons because of the aging population and especially of surgeons that can adapt to new developments and techniques like endovascular. Can you achieve this by the new paradigm in training?

Dr Joseph L. Mills. I think so. Most of us trained inefficiently, and our training included many nonessential procedures and content areas. The Vascular Surgery Board recently reviewed general surgery training and scored all aspects on a 0 to 5 scale with respect to what was necessary to be a vascular surgeon. It seems possible to eliminate components of what we used to do and produce a well-trained person. There will soon come a time when funding will no longer be available to train residents for 6 to 9 years. It is probably going to be limited to 5. If we restructure the curriculum correctly, we can train good people in 5 years, especially if they are going to focus on vascular surgery.

Dr Liapis. I fully agree on that. And I think we have to put numbers into what we are talking about. And in Europe we are trying to introduce what we call an endovascular index, meaning a number of endovascular procedures per 100,000 population. What we found out was that in contrast with vascular surgery as an independent specialty, this index is much higher, and it is increasing year after year comparing with countries with non-independent vascular surgery. So I fully agree.

Dr Jean Bismuth (Houston, Tex). I have two questions. Are there any thoughts of creating visiting fellowships for some of the other countries to alleviate the problems that we heard about this afternoon? And the second question: Is there any reciprocity between the different bodies to allow people to move between continents?

Dr Mills. The first question I can partially answer. I think one of the reasons to develop this organization and to expand is to address these issues, because it is not just a vascular surgical issue in one country. Despite our cultural and economic differences, it is very clear that we all face similar training issues. With the explosion of diabetes, as the speakers from Asia pointed out, vascular disease is going to be an epidemic in developing parts of the world just as

it already is in developed countries. These are some of the major reasons to have a Society like this.

The second question about reciprocity is more difficult because of US federal and state licensure requirements. There are creative ways to utilize telemedicine; for example, my own university has done this with Central America. Visiting fellowships also allow interchange.

Dr John Harris (Sydney, Australia). You expressed concern about the age of residents when they enter practice, which has been a problem. What strategies are being followed to try and get them into practice earlier than they are at the moment?

Dr Mills. The main one is to try to shorten training. The limitation we have is that in most medical schools in the United States, vascular surgery is an elective. Medical students usually have only 4 to 6 weeks of specialty surgery, and they can pick and choose from urology, orthopedics, neurosurgery, etc. One of the keys will be to make sure that we get trainees exposed to our field and interest them in it. They need role models. It can be done, but it differs from what we have ever done before.

We also must design a proper curriculum. We used to really not have a curriculum; we just had the residents hang around for years, and they learned because of the prolonged exposure. When you shorten the training time, you must develop a curriculum that is competency-based, not so much a volume issue, but a content one.

Dr Andre Van Rij (Dunedin, New Zealand). I have been very interested to hear in this session the broad spectrum of approaches taken around the world. And the whole issue of finance and cost seems to come in to it so often, particularly when it comes to the development of curricula, which is very expensive. My question, therefore is, who should pay for the education and for the assessment of training in vascular surgery?

Dr Mills. That is a double-edged sword. Medicare has funded resident training since the 1960s. This approach comes with many rules and much oversight but doesn't focus on training needs. It also makes it difficult to develop new programs because in most hospitals, the number of training positions is capped. We must navigate this issue. We will need many more of these integrated, shortened training programs to make these new paradigms work.