EDUCATION CORNER

The 50 most influential original articles in vascular surgery during the last 25 years

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Objective: **We have compiled a list of the 50 most-cited original articles in the field of vascular surgery during the last 25 years to highlight the important changes in practice that have occurred during this interval and provide surgical trainees in vascular surgery ready access to such influential articles.**
Methods: **A Web of Knowledge Citation Index Search was performed in December 2013 for the most-cited journal articles in the discipline of vascular surgery. We searched the term "vascular" in the cited reference search area and then further narrowed our results to exclude all categories except "surgery," "general internal medicine," and "cardiac/cardiovascular systems." We included only documents labeled as "articles" and those published in English. Articles dealing with cardiac surgery, interventional cardiology, and cardiovascular biology were excluded. Our search period was from January 1, 1988, through December 3, 2013. The 50 most frequently cited works were chosen, and a citation density was calculated for each, reflecting the average number of citations each received per year since publication. The articles were then sorted into a defined category, based on the clinical subject to which they pertained.**
Results: **The Citation Index Search resulted 80,379 articles, of which the top 50 were indexed and organized according to their citation density and area within the scope of clinical vascular surgery. The number of citations ranged from 218 to 3593. The median citation density was 50.2 (range, 11.3-201.3).**
Conclusions: **This report is a representation of the most-cited original publications in the field of clinical vascular surgery during the last 25 years. This is an effort to highlight the seminal works that have shaped the discipline of vascular surgery as well as to provide a concise reference list for the surgical trainee in the process of his or her education. (J Vasc Surg 2014;60:786-91.)**

In today's era of evidence-based medicine, the importance of published science can hardly be overstated. Published works within scientific journals remain the chief mechanism through which new information is disseminated to fellow scientists and practitioners at large. They also form the foundation for the ever-evolving curriculum that new surgical trainees must understand for their future surgical careers. Many authors have extrapolated that the publications most cited in other scholarly works are the most influential in directing future practice patterns, which is clearly of great import to the surgical trainee. Therefore, a compilation of those highly cited manuscripts should represent a solid foundation for clinical practice within a particular discipline. Reports using a similar principle have been published in other fields of medicine, but none specific to the discipline of vascular surgery.[1-3]

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Author conflict of interest: none.
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The editors and reviewers of this article have no relevant financial relationships to disclose per the JVS policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.
0741-5214/$36.00

http://dx.doi.org/10.1016/j.jvs.2014.05.010

The purpose of this report is to compile such a listing of those original articles most frequently referenced pertaining to the clinical practice of vascular surgery with the hope of highlighting influential papers for the student's electronic library.

METHODS

Our search was conducted in December 2013 using the Web of Knowledge Citation Index Search. This search engine represents data from >12,000 scientific journals referenced from 1900 to present. This index allows for the search of multiple databases across scientific, humanities, and social science disciplines based on key terms, common themes, and related documents.

Our search included all works between the dates of January 1, 1988, and December 3, 2013. We searched the term "vascular" in the cited reference search area of the index. We constricted the document results to only include articles and those published in the English language. Within the research areas, we excluded all except those in the categories of "surgery," "general internal medicine," and "cardiac/cardiovascular systems."

The resultant publications were arranged in descending order by the number of citations. A citation density was then calculated for each referenced work, reflecting the average number of times the piece was cited per year since

Table. The 50 most-cited original articles in clinical vascular surgery by clinical subject

Rank	*Publication information*	*Total*	*Average/year*
Carotid/stroke prevention			
1	Stenting versus endarterectomy for treatment of carotid-artery stenosis Authors: Brot TG, Hobson RW 2nd, Howard G, Roubin GS, Clark WM, Brooks W, et al Source: *New England Journal of Medicine* Published: July 1, 2010	604	201.3
2	Beneficial effect of carotid endarterectomy in symptomatic patients with high-grade carotid stenosis Author: North American Symptomatic Carotid Endarterectomy Trial Collaborators Source: *New England Journal of Medicine* Published: August 15, 1991	3593	163.3
3	Protected carotid-artery stenting versus endarterectomy in high-risk patients Authors: Yadav JS, Wholey MH, Kuntz RE, Fayad P, Katzen BT, Mishkel GJ, et al Source: *New England Journal of Medicine* Published: October 7, 2004	1342	149.1
4	Prevention of disabling and fatal strokes by successful carotid endarterectomy in patients without recent neurological symptoms: randomised controlled trial Authors: Halliday A, Mansfield A, Marro J, Peto C, Peto R, Potter J, et al Source: *Lancet* Published: May 8, 2004	1042	115.8
5	Benefit of carotid endarterectomy in patients with symptomatic moderate or severe stenosis Authors: Barnett HJ, Taylor W, Eliasziw M, Fox AJ, Ferguson GG, Haynes RB, et al Source: *New England Journal of Medicine* Published: November 12, 1998	1609	107.3
6	Endarterectomy versus stenting in patients with symptomatic severe carotid stenosis Authors: Mas JL, Chatellier G, Beyssen B, Branchereau A, Moulin T, Becquemin JP, et al Source: *New England Journal of Medicine* Published: October 19, 2006	737	105.3
11	Randomised trial of endarterectomy for recently symptomatic carotid stenosis: final results of the MRC European Carotid Surgery Trial (ECST) Authors: [No authors listed] Source: *Lancet* Published: May 9, 1998	1280	85.3
13	30 day results from the SPACE trial of stent-protected angioplasty versus carotid endarterectomy in symptomatic patients: a randomised non-inferiority trial Authors: SPACE Collaborative Group, Ringleb PA, Allenberg J, Brückmann H, Eckstein HH, Fraedrich G, et al Source: *Lancet* Published: October 7, 2006	480	68.6
14	Endarterectomy for symptomatic carotid stenosis in relation to clinical subgroups and timing of surgery Authors: Rothwell PM, Eliasziw M, Gutnikov SA, Warlow CP, Barnett HJ; Carotid Endarterectomy Trialists Collaboration Source: *Lancet* Published: March 20, 2004	584	64.9
17	Long-term results of carotid stenting versus endarterectomy in high-risk patients Authors: Gurm HS, Yadav JS, Fayad P, Katzen BT, Mishkel GJ, Bajwa TK, et al Source: *New England Journal of Medicine* Published: April 10, 2008	258	51.6
20	Efficacy of carotid endarterectomy for asymptomatic carotid stenosis. The Veterans Affairs Cooperative Study Group Authors: Hobson RW 2nd, Weiss DG, Fields WS, Goldstone J, Moore WS, Towne JB, et al Source: *New England Journal of Medicine* Published: January 28, 1993	838	41.9
22	Immediate and late clinical outcomes of carotid artery stenting in patients with symptomatic and asymptomatic carotid artery stenosis: a 5-year prospective analysis Authors: Roubin GS, New G, Iyer SS, Vitek JJ, Al-Mubarak N, Liu MW, et al Source: *Circulation* Published: January 30, 2001	462	38.2
30	Carotid endarterectomy and prevention of cerebral-ischemia in symptomatic carotid stenosis. Veterans Affairs Cooperative Studies Program 309 Trialist Group Authors: Mayberg MR, Wilson SE, Yatsu F, Weiss DG, Messina L, Hershey LA, et al Source: *JAMA-Journal of the American Medical Association* Published: December 18, 1991	591	26.8
31	The North American Symptomatic Carotid Endarterectomy Trial: surgical results in 1415 patients Authors: Ferguson GG, Eliasziw M, Barr HW, Clagett GP, Barnes RW, Wallace MC, et al Source: *Stroke* Published: September 1999	359	25.6

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Table. Continued.

Rank	*Publication information*	*Total*	*Average/year*
43	Prediction of benefit from carotid endarterectomy in individual patients: a risk-modelling study. European Carotid Surgery Trialists' Collaborative Group Authors: Rothwell PM, Warlow CP Source: *Lancet* Published: Jun 19, 1999	239	17.1
Aortic/aneurysmal disease			
9	Endovascular versus open repair of abdominal aortic aneurysm Authors: United Kingdom EVAR Trial Investigators, Greenhalgh RM, Brown LC, Powell JT, Thompson SG, Epstein D, et al Source: *New England Journal of Medicine* Published: May, 20, 2010	285	95
10	A randomized trial comparing conventional and endovascular repair of abdominal aortic aneurysms Authors: Prinssen M, Verhoeven EL, Buth J, Cuypers PW, van Sambeek MR, Balm R, et al Source: *New England Journal of Medicine* Published: October 14, 2004	813	90.3
12	Endovascular aneurysm repair versus open repair in patients with abdominal aortic aneurysm (EVAR trial 1): randomised controlled trial Authors: EVAR trial participants Source: *Lancet* Published: June 25, 2005	560	70
15	Two-year outcomes after conventional or endovascular repair of abdominal aortic aneurysms Authors: Blankensteijn JD, de Jong SE, Prinssen M, van der Ham AC, Buth J, van Sterkenburg SM, et al Source: *New England Journal of Medicine* Published: June 9, 2005	485	60.6
16	Endovascular vs. open repair of abdominal aortic aneurysms in the Medicare population Authors: Schermerhorn ML, O'Malley AJ, Jhaveri A, Cotterill P, Pomposelli F, Landon BE Source: *New England Journal of Medicine* Published: January 31, 2008	266	53.2
19	Immediate repair compared with surveillance of small abdominal aortic aneurysms Authors: Lederle FA, Wilson SE, Johnson GR, Reinke DB, Littooy FN, Acher CW, et al Source: *New England Journal of Medicine* Published: May 9, 2002	503	45.7
21	Endovascular treatment of thoracic aortic aneurysms: results of the phase II multicenter trial of the GORE TAG thoracic endoprosthesis Authors: Makaroun MS, Dillavou ED, Kee ST, Sicard G, Chaikof E, Bavaria J, et al Source: *Journal of Vascular Surgery* Published: January 2005	327	40.8
24	Endovascular aneurysm repair and outcome in patients unfit for open repair of abdominal aortic aneurysm (EVAR trial 2): randomised controlled trial Authors: EVAR trial participants Source: *Lancet* Published: June 25, 2005	289	36.1
26	Incidence and risk factors of late rupture, conversion, and death after endovascular repair of infrarenal aortic aneurysms: the EUROSTAR experience. European Collaborators on Stent/graft techniques for aortic aneurysm repair Authors: Harris PL, Vallabhaneni SR, Desgranges P, Becquemin JP, van Marrewijk C, Laheij RJ Source: *Journal of Vascular Surgery* Published: October 2000	392	30.2
29	Abdominal aortic aneurysm expansion: risk factors and time intervals for surveillance Authors: Brady AR, Thompson SG, Fowkes FG, Greenhalgh RM, Powell JT; UK Small Aneurysm Trial Participants Source: *Circulation* Published: July 6, 2004	242	26.9
32	Prediction of rupture risk in abdominal aortic aneurysm during observation: wall stress versus diameter Authors: Fillinger MF, Marra SP, Raghavan ML, Kennedy FE Source: *Journal of Vascular Surgery* Published: April, 2003	254	25.4
36	A multicenter controlled clinical trial of open versus endovascular treatment of abdominal aortic aneurysm Authors: Matsumura JS, Brewster DC, Makaroun MS, Naftel DC Source: *Journal of Vascular Surgery* Published: February 2003	218	21.8
38	The "first generation" of endovascular stent-grafts for patients with aneurysms of the descending thoracic aorta Authors: Dake MD, Miller DC, Mitchell RS, Semba CP, Moore KA, Sakai T Source: *Journal of Thoracic and Cardiovascular Surgery* Published: November 1998	306	20.4

Table. Continued.

Rank	*Publication information*	*Total*	*Average/year*
39	Significance of endoleaks after endovascular repair of abdominal aortic aneurysms: the EUROSTAR experience Authors: van Marrewijk C, Buth J, Harris PL, Norgren L, Nevelsteen A, Wyatt MG Source: *Journal of Vascular Surgery* Published: March 2002	223	20.3
40	Mycotic aneurysms of the thoracic and abdominal aorta and iliac arteries: experience with anatomic and extra-anatomic repair in 33 cases Authors: Müller BT, Wegener OR, Grabitz K, Pillny M, Thomas L, Sandmann W Source: *Journal of Vascular Surgery* Published: January 2001	224	18.7
41	Transfemoral endovascular repair of abdominal aortic aneurysm: results of the North American EVT phase 1 trial. EVT Investigators Authors: Moore WS, Rutherford RB Source: *Journal of Vascular Surgery* Published: April 1996	313	18.4
48	Multicenter prospective study of nonruptured abdominal aortic-aneurysm. Part II. Variables predicting morbidity and mortality Author: Johnston KW Source: *Journal of Vascular Surgery* Published: March 1989	292	12.2
Vascular medicine			
7	Aspirin and clopidogrel compared with clopidogrel alone after recent ischaemic stroke or transient ischaemic attack in high-risk patients (MATCH): randomised, double-blind, placebo-controlled trial Authors: Diener HC, Bogousslavsky J, Brass LM, Cimminiello C, Csiba L, Kaste M, et al Source: *Lancet* Published: July 24, 2004	904	100.4
8	Effects of extended-release metoprolol succinate inpatients undergoing non-cardiac surgery (POISE trial): a randomised controlled trial Authors: POISE Study Group, Devereaux PJ, Yang H, Yusuf S, Guyatt G, Leslie K, et al Source: *Lancet* Published: May-June 2008	487	97.4
18	Coronary-artery revascularization before elective major vascular surgery Authors: McFalls EO, Ward HB, Moritz TE, Goldman S, Krupski WC, Littooy F, et al Source: *New England Journal of Medicine* Published: December 30, 2004	445	49.4
27	Statins are associated with a reduced incidence of perioperative mortality in patients undergoing major noncardiac vascular surgery Authors: Poldermans D, Bax JJ, Kertai MD, Krenning B, Westerhout CM, Schinkel AF, et al Source: *Circulation* Published: April 15, 2003	283	28.3
28	Reduction in cardiovascular events after vascular surgery with atorvastatin: a randomized trial Authors: Durazzo AE, Machado FS, Ikeoka DT, De Bernoche C, Monachini MC, Puech-Leão P, et al Source: *Journal of Vascular Surgery* Published: May 2004	255	28.3
34	Predictors of cardiac events after major vascular surgery: role of clinical characteristics, dobutamine echocardiography, and beta-blocker therapy Authors: Boersma E, Poldermans D, Bax JJ, Steyerberg EW, Thomson IR, Banga JD, et al Source: *JAMA-Journal of the American Medical Association* Published: April 11, 2001	302	25.2
37	Combining clinical and thallium data optimizes preoperative assessment of cardiac risk before major vascular surgery Authors: Eagle KA, Coley CM, Newell JB, Brewster DC, Darling RC, Strauss HW, et al Source: *Annals of Internal Medicine* Published: June 1, 1989	515	21.5
42	Calcification of the aortic arch: risk factors and association with coronary heart disease, stroke, and peripheral vascular disease Authors: Iribarren C, Sidney S, Sternfeld B, Browner WS Source: *JAMA-Journal of the American Medical Association* Published: June 7, 2000	224	17.2
44	Treatment of thromboangiitis obliterans (Buerger's disease) by intramuscular gene transfer of vascular endothelial growth factor: preliminary clinical results Authors: Isner JM, Baumgartner I, Rauh G, Schainfeld R, Blair R, Manor O, et al Source: *Journal of Vascular Surgery* Published: December 1998	236	15.7

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Table. Continued.

Rank	*Publication information*	*Total*	*Average/year*
47	Dipyridamole-thallium scintigraphy and gated radionuclide angiography to assess cardiac risk before abdominal aortic surgery Authors: Baron JF, Mundler O, Bertrand M, Vicaut E, Barré E, Godet G, et al Source: *New England Journal of Medicine* Published: March 10, 1994	236	12.4
50	Dobutamine stress echocardiography for assessment of perioperative cardiac risk in patients undergoing major vascular surgery Authors: Poldermans D, Fioretti PM, Forster T, Thomson IR, Boersma E, el-Said EM, et al Source: *Circulation* Published: May 1993	226	11.3
Peripheral vascular disease			
23	Predictive value of noninvasively determined endothelial dysfunction for long-term cardiovascular events in patients with peripheral vascular disease Authors: Gokce N, Keaney JF Jr, Hunter LM, Watkins MT, Nedeljkovic ZS, Menzoian JO, et al Source: *Journal of the American College of Cardiology* Published: May 21, 2003	382	38.2
35	Endothelial dysfunction and cardiovascular risk prediction in peripheral arterial disease: additive value of flow-mediated dilation to ankle-brachial pressure index Authors: Brevetti G, Silvestro A, Schiano V, Chiariello M Source: *Circulation* Published: October 28, 2003	219	21.9
46	Correlation between preoperative ischemia and major cardiac events after peripheral vascular surgery Authors: Raby KE, Goldman L, Creager MA, Cook EF, Weisberg MC, Whittemore AD, et al Source: *New England Journal of Medicine* Published: November 9, 1989	299	12.5
Venous disease			
25	Chronic venous disease Authors: Bergan JJ, Schmid-Schönbein GW, Smith PD, Nicolaides AN, Boisseau MR, Eklof B Source: *New England Journal of Medicine* Published: August 3, 2006	219	31.3
Vascular radiology			
33	Echolucent plaques are associated with high risk of ischemic cerebrovascular events in carotid stenosis: the tromsø study Authors: Mathiesen EB, Bønaa KH, Joakimsen O Source: *Circulation* Published: May 1, 2001	303	25.3
45	Correlation of North American Symptomatic Carotid Endarterectomy Trial (NASCET) angiographic definition of 70% to 99% internal carotid artery stenosis with duplex scanning Authors: Moneta GL, Edwards JM, Chitwood RW, Taylor LM Jr, Lee RW, Cummings CA, et al Source: *Journal of Vascular Surgery* Published: January 1993	293	14.7
Vascular access			
49	Percutaneous transvenous angioplasty in the treatment of vascular access stenosis Author: Beathard GA Source: *Kidney International* Published: December 1992	238	11.3

its publication. We excluded review articles, consensus statements, meta-analyses, recommended practice patterns, and all other works not representing primary research. Because this report was focused toward the clinical practice of vascular surgery, articles dealing with cardiac surgery, interventional cardiology, and cardiovascular biology were excluded. Finally, the works were ranked in order of decreasing citation density and grouped into specific categories according to the clinical subject to which each pertained (Table).

RESULTS

The search returned 80,379 publications, which was further pared by the methods described above. Each was then formatted to reflect the title of the document and the journal in which it was published. The total number of citations for the chosen articles ranged from 218 to 3593. The median citation density was 50.2 citations per year (range, 11.3-201.3). Most of the articles (33 of 50 [66%]) were published after the year 2000, and the remaining 34% were published before 2000. *The New England Journal of Medicine* was responsible for 32% (16 of 50) of the publications, followed by the *Journal of Vascular Surgery* with 22% and *The Lancet* with 18%. An examination of the clinical categories showed aortic and aneurysmal disease accounted for the greatest percentage of articles, at 34% (17 of 50), trailed closely by carotid stenosis/stroke prevention, at 32% (16 of 50).

DISCUSSION

The field of vascular surgery, like many others in modern medicine, is constantly evolving. New pharmacotherapies, treatment modalities, and technologic advancements have emerged and significantly changed its clinical practice. Many of these advances have occurred in the last two decades, and the data reviewed during this period highlight many of those developments.

There has been a considerable shift from open procedures to a less invasive endovascular approach in addressing the same clinical problem. Not surprisingly, this trend was reflected within the literature reviewed here. Of the 17 articles published before 2000, only two (12%) examined results of endovascular data. This is in stark contrast to 16 of the 33 publications since 2000 that involve consideration of data from endovascular approaches, equating to nearly 49%. Of these articles, 70% focusing on aortic and aneurysmal disease centered on endovascular therapies or complications thereof, or both. All articles, save two, concerning carotid disease and stroke prevention published after 2000 involve data from minimally invasive stenting. That endovascular technologies have revolutionized the field of vascular surgery in the past 25 years can thus be concluded based on the growing number of publications that focus on its widespread utility in clinical therapies.

This type of article certainly has strengths and weaknesses. Its strength as a concise source of highly influential articles within the field of clinical vascular surgery is clear. It is also unique in its categorization of works into groups according to clinical disease categories, facilitating the search for the inquisitive trainee. The ability to electronically access each of these 50 articles by the hyperlinks contained within the Table makes each instantly available for review from any computer.

This article does have weaknesses, one of which is presupposed into our argument. Our assumption was that those articles most referenced in other scholarly works would be the most influential in alteration of clinical practice. This seems a relatively safe assumption, but it should not be deemed infallible.

Another potential problem is the limitation of our initial search. Although a large list of journals is contained within the Web of Knowledge Citation Search Index, we did limit our search only to works found there. We ranked the selected works by their citation density in an attempt to ameliorate bias toward older publications; however, those published within the last few years could potentially be under-represented. Although each may have significant importance to the field of vascular surgery, the extent of their influence on others' work may not have had sufficient time to appear in citations.

CONCLUSIONS

Vascular surgery is a diverse and rapidly evolving discipline, and new developments in technology and understanding disease processes have changed practice patterns significantly during the last 25 years. This report's intent is to highlight some of the most formative publications within that period to serve as a guide for current and future practice patterns within the field as well as to provide a concise list made readily accessible to today's surgical trainee.

AUTHOR CONTRIBUTIONS

Conception and design: MC
Analysis and interpretation: FS
Data collection: FS
Writing the article: FS
Critical revision of the article: MC
Final approval of the article: JD
Statistical analysis: Not applicable
Obtained funding: Not applicable
Overall responsibility: FS

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Submitted Apr 5, 2013; accepted May 6, 2014.