

Measuring Excellence in Clinical Translation: What Are the Top Works in the Field of Neurosurgery?

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Excellence in clinical translation may be found in those studies that have had a particularly large impact in how neurosurgery is currently practiced. Although there are various ways to identify such studies, we used the number of times an article has been cited as an indicator of the impact that article has had in our field. Here, we highlight some of the findings from our study of 106 articles that have been cited at least 400 times, the cutoff for a so-called “citation classic.” Most studies concerned cerebrovascular disease, tumors, trauma, and functional neurosurgery, although there were relatively few articles on spinal surgery. Although 35% of the articles we identified were published in the neurosurgical literature, 37% of the articles, including most of the randomized trials, were published in the highest-impact general medical journals. In addition to presenting the results from randomized trials, the top articles described a novel surgical technique or classified neurosurgical disease or injury. The study of these citation classics can be instructive in understanding how we got to where we are and what is required to move the field forward.

How do we measure clinical translation excellence in neurosurgery? A small number of works have had a large impact in clinical neurosurgery and serve as the foundation for the way neurosurgery is practiced. These studies embody “clinical excellence.” How do we assess what has an impact in neurosurgery? Which concepts change our practice? Which new operations are adopted? What is fuzzy, what is definitive? What is a gimmick, what is a godsend? Although there may be several ways to explore these questions, we have used the number of times a particular work is cited as a measure of its importance in the field of neurosurgery and as a proxy for excellence in clinical translation in neurosurgery.

We identified the most cited works in the discipline of neurosurgery. The focus of this study is restricted to most “elite” articles. These are articles considered to be “citation classics” if, as defined by *Current Contents*, they have accumulated a minimum of 400 citations. More detailed accounts of this work have been recently published.^{1,2}

METHODS

Our study started by characterizing the top 100 cited articles in 14 neurosurgical journals. This provided a point from which to build a list of key words pertinent to clinical neurosurgery. This catalog of phrases was used to search both neurosurgical and nonneurosurgical journals in the Web-based bibliometric database Thomson’s ISI Web of Science. The data reflect the citation counts as of August 2009. The studies were limited to clinical studies and review articles; laboratory studies and animal models were omitted.

RESULTS

We identified 106 articles in the field that were cited at least 400 times. The topics, sources, and years of publication are summarized here. There were 38 articles on cerebrovascular disease, 21 on functional neurosurgery, 21 on tumors, and 19 on trauma. Overall, these articles made up 93% of the articles identified. In addition, there were 4 articles on spine, 2 on hydrocephalus, and 1 on infection. These findings were similar to the breakdown seen in our initial analysis of the 100 top cited works in journals dedicated to neurosurgery: 43 studies on cerebrovascular disease, 27 on trauma, 13 on functional neurosurgery, 12 on tumor, and 5 articles covering spinal surgery, syringomyelia, hydrocephalus, and infection.

What Types of Studies and Where Were They Published?

There were 29 randomized trials, 16 prospective studies, 15 grading systems or classifications, and 7 review articles. In addition, 39 studies were case series detailing natural history or early/pioneering experience with a technique or pathology. The sources of the classics were split roughly evenly between 3 categories of journals: 37% in general medical journals, which included the *New England Journal of Medicine*, *The Lancet*, and the *Journal of the American Medical Association*; 35% in journals dedicated to neurosurgery, which included the *Journal of Neurosurgery*, *Neurosurgery*, and the *Journal of Neurology, Neurosurgery, and Psychiatry*, and 28% in 22 other journals. The latter category included such high-impact journals as *Science*, *Nature Medicine*, *Annals of Internal Medicine*, the *Journal of Clinical Oncology*, the *Journal of the*

National Cancer Institute, *Circulation*, and the *British Medical Journal*, and were the source of between 1 and 3 classic articles each (mean, 1.4).

When Were They Published?

We limited our review to publications after 1950 because of the limited tracking of citations of older articles. More than 50% of articles were published after 1990, and >80% were published since 1980. Only 1 article since 2000 was identified, likely because not enough time has elapsed for recent articles to have accumulated citations.

Top 10 Articles

Here, we highlight the 10 most cited studies³⁻¹² (Table). The 2 top cited articles were grading systems and were cowritten by Jennett (on the Glasgow Outcome Scale³ and the Glasgow Coma Scale,⁴ rank 1 and 2, respectively). Additional top cited grading systems included the Hunt-Hess (rank 5) and the Fisher systems (rank 8), both for subarachnoid hemorrhage. Four articles were the results of 3 randomized studies evaluating carotid endarterectomy, including 2 articles from the North American Symptomatic Carotid Endarterectomy Trial, the Asymptomatic Carotid Atherosclerosis Trial, and the European Carotid Surgery Trial (rank 3, 4, 7, and 10, respectively). There was 1 randomized trial of tumors, a study on temozolomide and radiotherapy for glioblastoma (rank 9). The introduction of transcranial Doppler ultrasound for measuring velocity of cerebral blood vessels was also one of the top cited articles (rank 6). In summary, among the top 10 articles, 4 were classification systems, 5 were randomized trials, and 1 was a new technique.

DISCUSSION

Want to Write a Classic?

We have compiled a list of the most highly cited papers in neurosurgery. These works are among the most important and influential in our specialty. There is no recipe to guarantee writing a classic or high-impact article, and to amass that number of citations, time is the ultimate judge, but we can glean some tips from the characteristics that the articles in this collection have in common. First, organize and conduct a randomized double-blind clinical trial because this is regarded as the gold standard for the evaluation of medical therapies and is indeed the format of 27% of these studies. Second, organize neurosurgical pathology through the introduction of a classification or grading system, as was done in 14% of the citation classics we identified. Third, invent and develop a new high impact operation.

Limitations

There are many grounds for omissions in this study. First, you often find only what you are looking for. The method for identifying the top cited papers in the neurosurgical journals is straightforward: One performs a search of all articles published by those journals and sorts them by the number of time they have been cited. However, in considering *any* article published in *any* journal, the method is less black and white. In this study, we relied on a catalog of search phrases that was developed on the basis of the topics found in the most highly cited works in the neurosurgical journals. However, there were, no doubt, omissions. Second, we omitted articles published before 1950 because the database used is less reliable for tracking citations of articles published before that date. Third, we did not include basic science articles; thus, we ignored a large subset of articles that have

TABLE. Ten Most Cited Articles Relating to Clinical Neurosurgery

Rank	Year	Authors	Topic	Citations ^a
1	1975	Jennett and Bond ³	Glasgow Outcome Scale	4199
2	1974	Teasdale and Jennet ⁴	Glasgow Coma Scale	3193
3	1991	North American Symptomatic Carotid Endarterectomy Trial Investigators ⁵	North American Symptomatic Carotid Endarterectomy Trial	2912
4	1995	Walker et al ⁶	Asymptomatic Carotid Atherosclerosis Study	2057
5	1968	Hunt and Hess ⁷	Grading for outcome after subarachnoid hemorrhage	1518
6	1982	Aaslid et al ⁸	Transcranial Doppler ultrasound	1434
7	1991	European Carotid Surgery Trial Investigators ⁹	European Carotid Surgery Trial	1361
8	1980	Fisher et al ¹⁰	Grading for risk of vasospasm	
9	2005	Stupp et al ¹¹	Radiotherapy and temozolomide for glioblastoma	1134
10	1998	Barnett et al ¹²	North American Symptomatic Carotid Endarterectomy Trial	1110

^aCitation counts from August 2009.

had a profound impact on our specialty. The rationale for this omission is that the breadth of such works is large and deserving of a more dedicated study.

CONCLUSION

The information collected in this study is useful on various fronts. First, these articles are among the most important and high-impact works in our field, and neurosurgeons should be familiar with them. Second, residency programs could consider including these works in the neurosurgical curriculum. The study of these articles not only is of historical interest but also identifies the foundations of modern neurosurgery and can be instructive in understanding how knowledge in our field is developed and what is required for our field to move forward. Third, both authors and editors may gain insight from the characteristics of these articles in what is required to make an impact in our field. This list is not fixed and will continue to change as our discipline continues to advance.

Disclosure

Dr Lozano is a Canada Research Chair (tier 1) in Neuroscience. The authors have no personal financial or institutional interest in any of the drugs, materials, or devices described in this article.

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