



The Most-Cited Works in Severe Traumatic Brain Injury: A Bibliometric Analysis of the 100 Most-Cited Articles

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■ **BACKGROUND:** There is an abundance of works published on severe traumatic brain injury (sTBI). Bibliometric analyses aim to provide a macroscopic view of research activities regarding sTBI and are helpful in determining the most impactful studies within this field.

■ **METHODS:** We performed a generalized search using the database of Web of Science, organized the references by the number of citations, and reviewed full length-articles for the top-100 most-cited articles on sTBI. The articles were classified according to focus.

■ **RESULTS:** The top-100 articles were cited on average 326.4 times per paper. The *Journal of Neurosurgery* published the greatest number of top-100 cited articles (9 of 100). Authors from the United States published the majority (67%) of the most-cited articles. The most popular categories were “reviews and guidelines” and “etiology and epidemiology.”

■ **CONCLUSIONS:** The present study provides a cross-sectional summary of the 100 most-cited articles on sTBI, highlighting areas of research needing further investigation and development.

understanding of sTBI, decreasing the morbidity and improving the management of sTBI.^{3,4}

It is not easy to quantify the importance of a given published study. Recently, we often regard the number of published articles and citations as important indicators. And selected articles that have been cited more than 400 times generally are termed “Citation Classics”.⁵ Bibliometric analysis is usually used to understand the changing landscape of a specific field over time, as well as describing the importance of published articles.⁶

Bibliometrics has become an established method to analyze scientific literature in information science, which is based on a number of quantitative laws.⁷ It is being increasingly applied in various clinical specialties, including cardiovascular,⁸ hematology,⁹ endocrinology,¹⁰ neurology,¹¹ gastroenterology,¹² obstetrics and gynecology,¹³ ophthalmology,¹⁴ anesthesiology,¹⁵ orthopedic surgery,¹⁶ and radiology.¹⁷ Recently, similar methods have been applied to subspecialties within neurosurgery.^{18,19}

However, as we know, bibliometric analysis has not yet been applied to the field of sTBI. Thus, in the present study, we aimed to provide insight into the most widely cited works in this field. To some degree, the bibliometrics of sTBI concerning the distributions of countries could help to promote generalized development worldwide in this field, and the changing trends in highly cited publications could provide investigators with vital information about essential citation classics in the field.

METHODS

Search Strategy

To identify highly cited works in sTBI, we performed a generalized search using the database of Web of Science (WoS) (Thomson Reuters, New York, New York, USA), the world’s leading database collecting citation and other academic impact information. The search was performed in September 2017 with the restriction of publications within the last 2 decades. The

INTRODUCTION

Traumatic brain injury (TBI) is a major cause of death and disability worldwide without effective treatment, especially severe TBI (sTBI).¹ In Europe alone, a quarter to a third of patients with sTBI will die.² As a result, the heavy burden of disability and mortality highlights the urgent need for further

Key words

- Bibliometric analysis
- Citation classics
- Severe traumatic brain injury

Abbreviations and Acronyms

sTBI: Severe traumatic brain injury
TBI: Traumatic brain injury
WoS: Web of Science

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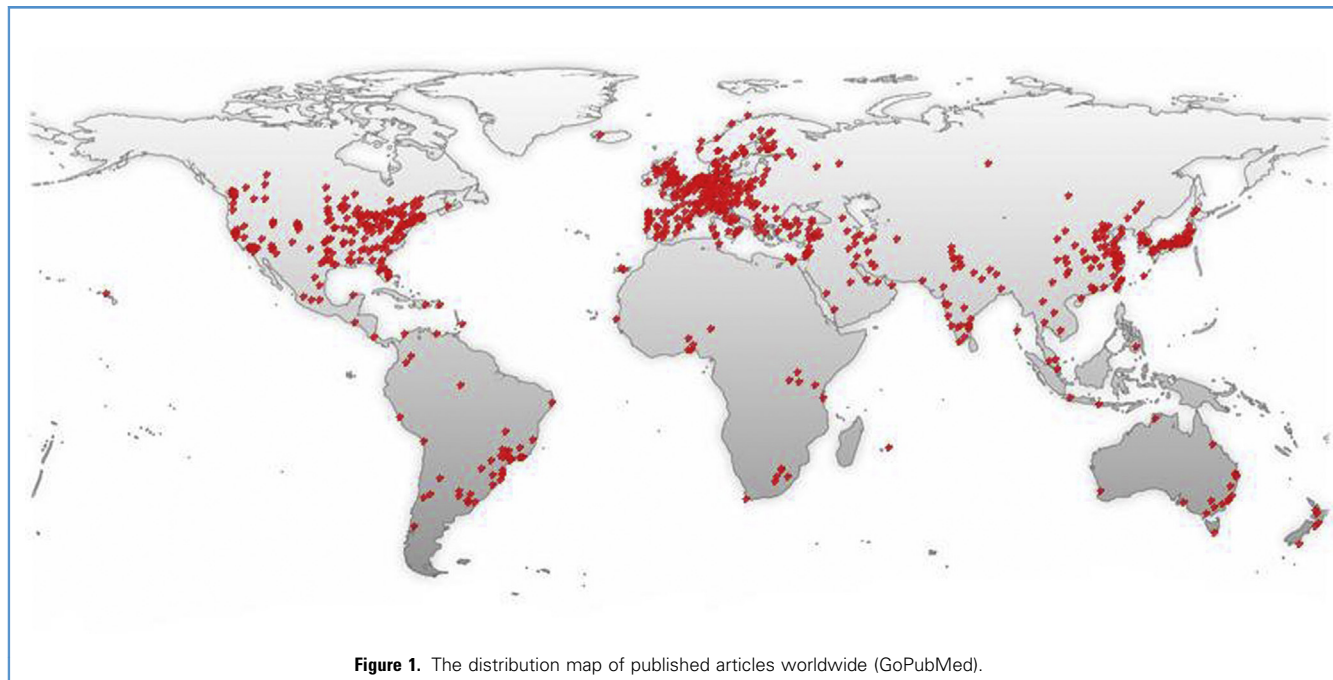


Figure 1. The distribution map of published articles worldwide (GoPubMed).

database was searched using the keywords “severe traumatic brain injury” or “sTBI” or “severe TBI”; that is, the articles that we identified were specific to sTBI. The document type was not restricted. We identified and reviewed the top-100 most-cited works in the field of sTBI.

Bibliometric Analysis

We recorded the basic information, such as article and journal titles, authors, and country using the WoS analysis tool. After collecting the top-100 cited articles, we collected all variables in our analysis, including number of citations, year of publication,

Table 1. The Top 10 Cited Articles on sTBI

Title	First Author	Journal (IF 2016)	Year	Country	Citations
Treatment of traumatic brain injury with moderate hypothermia	Marion	<i>New England Journal of Medicine</i> (72.406)	1997	USA	843
Traumatic brain injury in the United States: A public health perspective	Thurman	<i>Journal of Head Trauma Rehabilitation</i> (3.214)	1999	USA	760
Structured interviews for the Glasgow Outcome Scale and the extended Glasgow Outcome Scale: Guidelines for their use	Wilson	<i>Journal of Neurotrauma</i> (5.19)	1998	Scotland	759
Acute effects and recovery time following concussion in collegiate football players: the NCAA Concussion Study	McCrea	<i>Journal of the American Medical Association</i> (44.405)	2003	USA	680
The Patient Health Questionnaire Somatic, Anxiety, and Depressive Symptom Scales: a systematic review	Kroenke	<i>General Hospital Psychiatry</i> (2.279)	2010	USA	670
Moderate and severe traumatic brain injury in adults	Maas	<i>Lancet Neurology</i> (26.284)	2008	Belgium	631
The spectrum of disease in chronic traumatic encephalopathy	McKee	<i>Brain</i> (10.292)	2013	USA	498
Immune modulation of learning, memory, neural plasticity, and neurogenesis	Yirmiya	<i>Brain Behavior and Immunity</i> (5.964)	2011	Israel	498
White matter integrity and cognition in chronic traumatic brain injury: a diffusion tensor imaging study	Kraus	<i>Brain</i> (10.292)	2007	USA	494
A systematic review of brain injury epidemiology in Europe	Tagliaferri	<i>Acta Neurochirurgica</i> (1.881)	2006	USA	490

IF, impact factor.

Table 2. Countries of the Top-100 Cited Articles on sTBI

Country	Record Count
United States	67
Germany	10
England	9
Canada	8
The Netherlands	8
Scotland	8
Australia	7
Israel	5
Italy	5
Sweden	5
France	4
Belgium	2
Denmark	2
Switzerland	2

sTBI, severe traumatic brain injury.

name of first author, title of article, journal of publication, and specialty and country of the corresponding author at the time of publication, for each article. We also ranked the 100 most-cited articles in descending order by number of citations.

We subsequently divided the articles into 5 categories: (1) etiology and epidemiology of sTBI; (2) review articles or guidelines on sTBI; (3) treatment of sTBI; (4) sequelae and prognosis of sTBI; and (5) diagnosis of sTBI. The first category included articles describing the mechanisms of sTBI, as well as epidemiologic studies for prevalence, clinical characteristics, and risk factors. The second category encompassed highly cited reviews and published guidelines. The third category included studies of surgical, endovascular, and other treatments for sTBI. The fourth category encompassed studies investigating the influence factors of prognosis or complications of sTBI, such as cognitive dysfunction, disability, psychiatric disability, loss of consciousness, anterograde amnesia, and confusion. Finally, the fifth category included

Table 3. Journals (with More Than 4 Articles) in Which the Top 100 Cited Articles on sTBI Were Published

Journal	Number of Articles
<i>Journal of Neurosurgery</i>	9
<i>Journal of the American Medical Association</i>	8
<i>Brain</i>	7
<i>Journal of Neurotrauma</i>	6
<i>New England Journal of Medicine</i>	6

sTBI, severe traumatic brain injury.

Table 4. The Most Common Authors (with More Than 3 Articles) of Top 100 Cited Articles on sTBI

First Author	Record Count
Hovda	6
Maas	6
Murray	5
Marmarou	4
Mcintosh	4
Steyerberg	4

sTBI, severe traumatic brain injury.

studies investigating the role of transcranial Doppler, computed tomography, magnetic resonance imaging, and other clinical and radiologic assessment instruments. Two reviewers (Xiaoye Ma and Sajan Pandey) independently read the title and abstract of each article (and full text, if necessary), and performed journal selection, article identification, and article analysis. Any disagreements between reviewers were resolved by a third reviewer (Lei Li).

RESULTS

General Information

The total number of literature extracted from the WoS was 11,618, among which 8987 were original articles and the others were papers without original data, such as reviews, editorials, comments, and so on. The world map revealed that the articles were focused on western Europe, eastern Asia, and the United States (Figure 1).

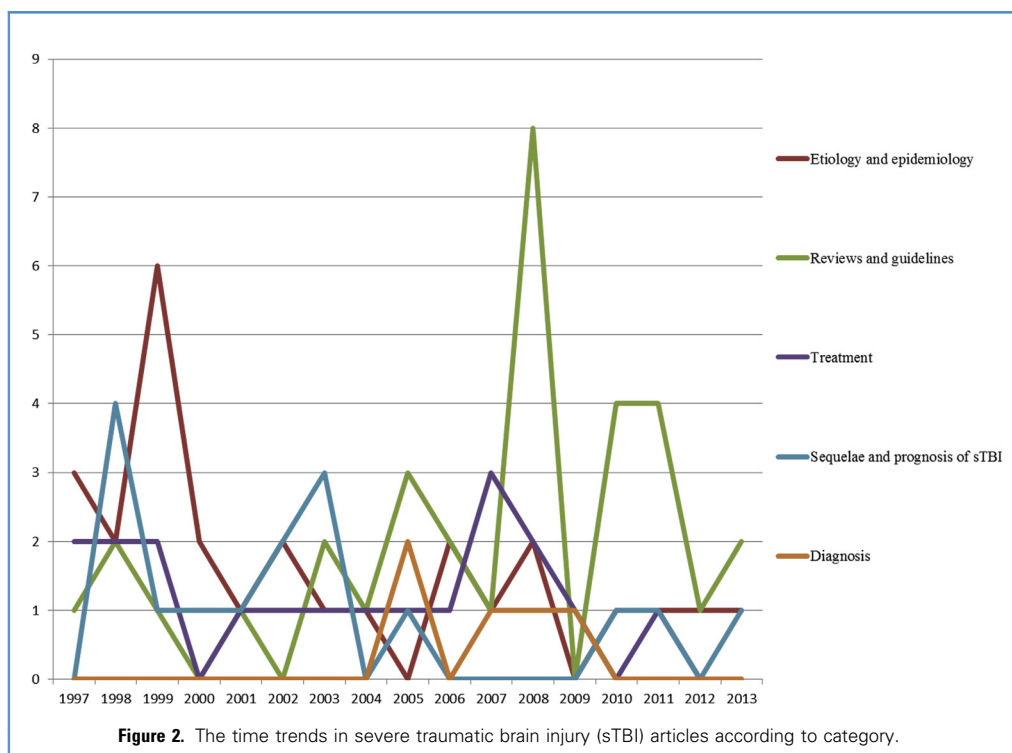
The Most Cited Works in sTBI

The top-10 most-cited articles on sTBI are presented in Table 1. The top-100 most-cited articles were cited 326.4 times on average (range, 206–843). The most frequently cited article, with 843 citations, was published by Marion et al in 1997 in the *New England Journal of Medicine* (“Treatment of traumatic brain injury with moderate hypothermia”), followed by Thurman et al. (“Traumatic brain injury in the United States: A public health perspective”), published in the *Journal of Head Trauma Rehabilitation* in 1999.

Table 5. Article Categories for the Top-100 Cited Works

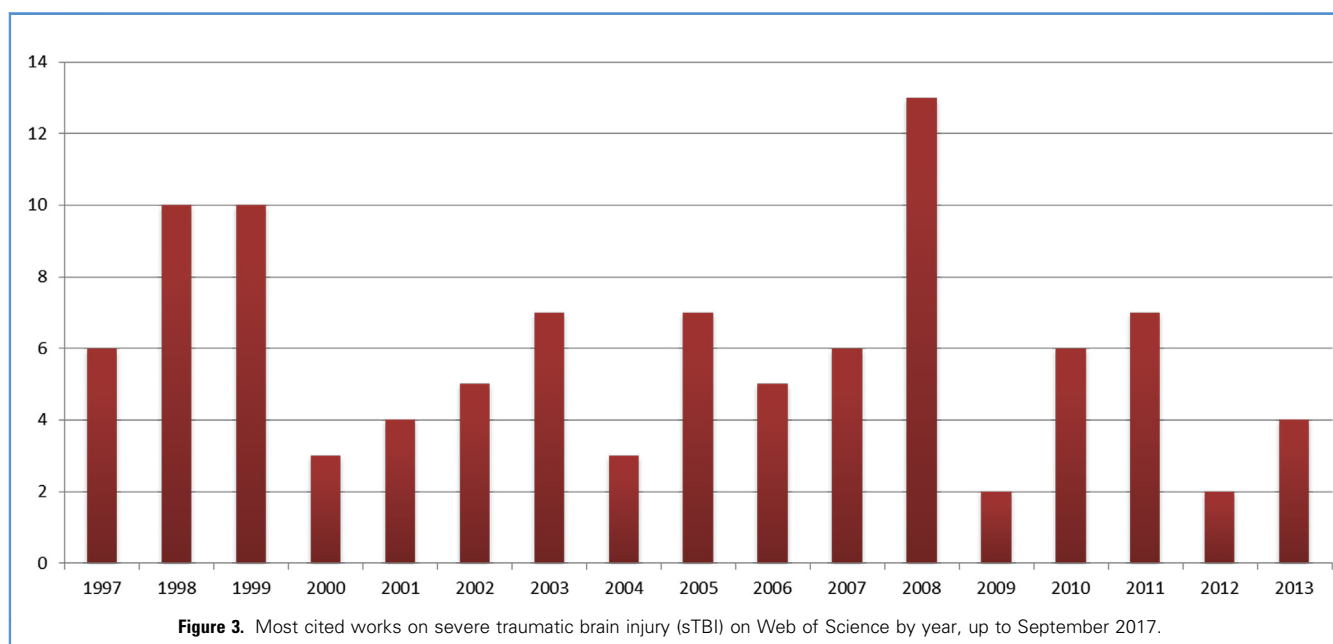
Category	Number of Articles
Etiology and epidemiology	27
Reviews and guidelines	33
Treatment	19
Sequelae and prognosis of sTBI	16
Diagnosis	5

sTBI, severe traumatic brain injury.



Sixty-seven of the 100 articles were from the United States, 10 were from Germany, and 9 were from England (Table 2). These highly cited works were published in 18 unique journals. The journal publishing the greatest number of the top-100 highly

cited articles was the *Journal of Neurosurgery*, which published 9 articles with an average of 265.78 citations per paper. Journals publishing more than 4 highly cited works are listed in Table 3. Hovda and Maas were the most prolific authors in the top-100



cited articles (Table 4). Thirty-five of the top-100 cited articles are considered citation classics, accruing more than 400 citations.

Articles by Category

The categories in which of the 100 most-cited articles are listed in Table 5, and the trends in publication according to dates are shown in Figure 2. Review articles and guidelines on sTBI were the most common topics (33 articles), followed by etiology and epidemiology of sTBI (27 articles), treatment of sTBI (19 articles), and sequelae and prognosis of sTBI (16 papers). There were only 5 highly cited studies on the diagnosis of sTBI. In 2008, there was a surge in the publication of highly cited articles in sTBI (Figure 3). Articles with a focus on etiology and epidemiology were the most common in 1999, and the situation has remained stable since the 2000s. Interestingly, the most common category in 1998 was the sequelae and prognosis of sTBI, and this has shown a tendency toward a decline after 2003; however, the trends in treatment were not pronounced. Finally, there has been a steady increase in highly cited systematic reviews and guidelines, especially since 2008.

DISCUSSION

In this study, we have identified and reviewed the top 100 most-cited articles associated with sTBI. Bibliometric studies can provide a historical account of research and can reflect the changing landscape within a given field. With a citation index, it is possible to identify articles that have had significant influence in the area of sTBI, as well as articles that have been referenced recently. Therefore, we provide a general discussion of our findings, as well as a category-specific commentary.

Our bibliometric analysis demonstrated the average number of citations of the top-100 cited works over the last 20 years was 326.4, and identified 20 works as citation classics, suggesting they are of high quality with active research activity.

Over the last 20 years, far more of the most-cited articles originated from the United States compared with any other country, indicating that the articles published from the United States were of high quality and quantity. In addition, the distribution map of published articles shows that the worldwide productivity in sTBI is concentrated in western Europe, eastern Asia, and the United States. The *Journal of Neurosurgery* published the most sTBI research worldwide, followed by the *Journal of the American Medical Association*, demonstrating the importance of these 2 journals in this field.

Our findings show that studies on sTBI are currently accumulating the most cited works per year (Figure 2). This suggests that sTBI is a predominant topic of discussion in the field of brain injury, perhaps because rates of severe morbidity and mortality have not improved over the last 20 years,²⁰ which highlights the urgent need for researchers to improve the knowledge of sTBI.³

We also found that most of the articles were associated with reviews, guidelines, etiology, and epidemiology, given that the mechanism of sTBI is complex and covers a wide range of individuals.²¹ Therefore, the discovery of new biomarkers and risk factors will contribute to a deeper understanding of TBI.²² In view of the effectiveness of many of the currently available treatments and management programs for sTBI,²³ the discussion of new sTBI treatment methods is necessary in the future. Moreover, sustained research on predictors of outcome is needed to help clinicians identify patients at high risk of poor long-term outcomes and target these patients for a particular management strategy or therapeutic intervention.²⁴

Although only 5 works were associated with sTBI diagnosis, it also may be reasonable to expect an increase in research activity into the identification and evaluation of sTBI, given the push to identify brain injuries accurately and immediately.²⁵

We note that additional research activities in one subarea might affect activities in another subarea. For example, more attention to treatment and diagnosis may lead to updated guidelines or consensus statements, which is consistent with our results.

This study has some limitations that should be noted. First, articles not published in WoS-cited journals are not included. Furthermore, the citation metrics that were computed in the present study have likely changed since we completed our analyses, given that the sTBI literature is being continually cited. At the same time, we did not consider self-reference bias. Nonetheless, given this study's broad nature and vast citations, we believe that it can still be useful in describing the general trend of the most-cited works in this field. Moreover, we have not excluded reviews and guidelines for reviews and guidelines tend to portray the articles with widespread acknowledgment in the scientific community and represent the highest quality or greatest scientific merit in the literature. They all represent the latest achievements of sTBI development in their period and have had profound influence worldwide.^{6,26}

CONCLUSIONS

The present study provides a cross-sectional summary of the 100 cited studies in sTBI, highlighting areas of research that require further investigation and development.

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