

## Review article

# The 100 most influential publications pertaining to intracranial aneurysms and aneurysmal subarachnoid hemorrhage



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## ARTICLE INFO

## Article history:

Received 27 January 2017

Accepted 13 February 2017

## Keywords:

Aneurysm

Subarachnoid hemorrhage

Influential

Top 100

Citation analysis

## ABSTRACT

The study of intracranial aneurysms has grown at an astounding rate since Sir Charles Symond's association of hemorrhage within the subarachnoid space to intracranial aneurysms in 1923. These associations led to the first surgical treatment of an intracranial aneurysm with wrapping by Norman Dott in 1931, and shortly thereafter, clip ligation by Walter Dandy in 1938. Surgical outcomes were improved by the introduction of the operative microscope in the 1960s and perioperative care utilizing induced hypertension, hypovolemia, and hemodilution ("HHH therapy"). Recent monumental advancements, such as coil embolization in 1990 by Guglielmi, have continued to advance the field forward. The authors hope to highlight some of the most seminal and influential works. Herein, we utilize the technique of citation analysis to assemble a list of the 100 most influential works pertaining to aneurysmal subarachnoid hemorrhage published between the years 1900 and 2015 to honor these individuals and to provide guidance to current and future researchers in the field. We additionally calculate the effects of author, journal, topic, and study design on the overall influence of publications in this field.

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## 1. Introduction

The first planned surgery on an intracranial aneurysm occurred in 1931, when Norman Dott wrapped a bleeding intracranial aneurysm as part of a case series that pioneered the diagnosis and management of aneurysmal subarachnoid hemorrhage [6,36]. Since then, the field of study dedicated to the understanding and management of intracranial aneurysms has grown and evolved at an explosive pace [24]. Countless publications have been devoted to exploring and elucidating the epidemiology, pathophysiology, diagnosis, and management of intracranial aneurysms and aneurysmal subarachnoid hemorrhage. In the process, many researchers have devoted their lives and careers to improving and expanding this field of knowledge. Given the rapid pace at which this field has expanded and changed, many of the seminal papers in the field are at risk of being lost amidst the massive proliferation of new studies. We believe that those physicians and researchers who contributed the most to developing and expanding this field of study deserve to have their work recognized. We also hope to shed light on the trajectory that the field has taken

over the past century, thus allowing current and future researchers to see the impact of other works in the field that may broaden and contribute to their ongoing work.

In previous studies, citation analyses have been performed in order to identify and recognize the most influential papers within various fields of study [3,8,14,20,30,32,35]. A citation analysis is a statistical methodology that involves ranking articles published in a field by the number of times they have been cited – an indirect measurement of each article's overall impact on the field itself. Citation analysis has, increasingly, become an established and accepted method for identifying the most impactful papers in a particular field.

In this study, we perform a citation analysis of the Thomson Reuters Web of Science in order to enumerate and recognize the 100 most influential articles that have furthered the understanding and management of intracranial aneurysms and aneurysmal subarachnoid hemorrhage.

## 2. Methods

### 2.1. Objective

To identify and analyze the 100 most cited articles studying intracranial aneurysms and aneurysmal subarachnoid hemorrhage published between the years 1900 and 2015 in any journal.

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## 2.2. Inclusion criteria

A number of criteria were set in order to determine which studies were included in the final list of 100 articles. First, studies were required to have focused predominantly on the pathophysiology, natural history, epidemiology, sequelae, diagnosis, or management of either intracranial aneurysms or aneurysmal subarachnoid hemorrhage. Studies that also included discussion of other forms of intracranial vascular anomalies or hemorrhage were included as long as more than half of the studied patients were diagnosed with intracranial aneurysm(s) or aneurysmal subarachnoid hemorrhage. Papers that focused solely or predominantly on the study of arteriovenous (AV) malformations, perimesencephalic hemorrhage, and non-aneurysmal subarachnoid hemorrhage were excluded.

## 2.3. Material

We utilized all journals and databases contained within the Thomson Reuter's Web of Science in order to identify eligible studies

## 2.4. Data collection

The literature query of the Thomson Reuters Web of Science was conducted in a two-step fashion (Fig. 1).

In the first stage of the data collection process, a topic search of the Web of Science databases with the query *intracranial aneurysm*. This search yielded 49,706 results, which were then sorted in descending order by total number of citations. Within the first 285 studies, 200 papers involving research on topics related to unruptured and ruptured intracranial aneurysms were identified based on review of titles and abstracts. These papers were then carefully reviewed to create a list of keywords to be used in the second stage of data collection.

144 keywords and key phrases were derived from an analysis of the titles and abstracts of the initial 200 articles (Table 1). These keywords and phrases were then used to construct a title search of the Web of Science database (Table 1). This phase of the search yielded 333,642 articles, which were again sorted in descending order by total number of citations. Within the first 431 studies, the top 100 articles with the most citations that met the criteria outlined above were selected for final inclusion.

The following information was extracted from all 100 articles selected for final inclusion: title, author(s), journal of publication, year of publication, year of first citation, year of peak citations, total number of times cited, and number of times cited in 2015. Using this information, we were then able to calculate the average number of citations/year, the number of years until first citation, and the number of years until peak citation for each article. Finally, all articles selected for final inclusion were also categorized by topic and manuscript type.

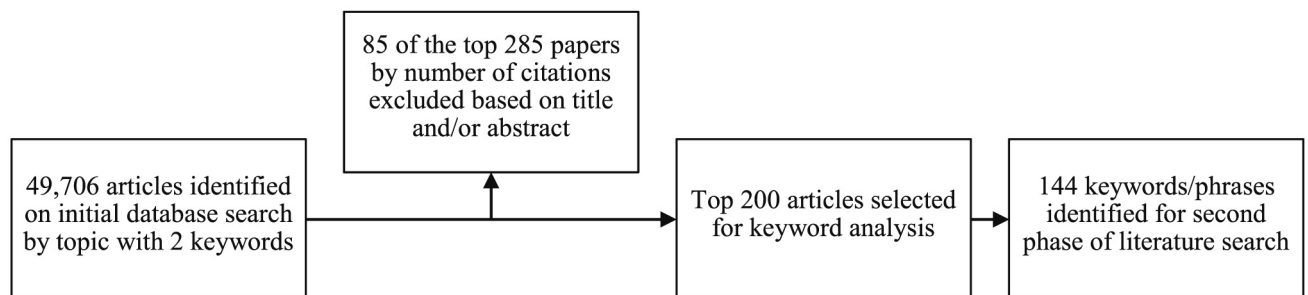
## 3. Results

### 3.1. Gross outcomes of citation analysis

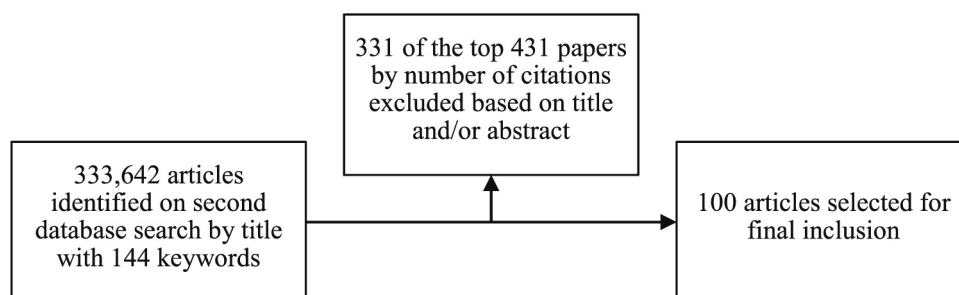
333,642 total articles matched the final search criteria outlined above. A detailed review of titles, abstracts, and full texts was conducted to select the 100 most cited articles within this group. The final list of the top 100 most influential papers in the field of intracranial aneurysms and aneurysmal subarachnoid hemorrhage is assembled in Table 6. The final list displayed also contains information regarding the year in which each article was most cited, the average number of citations per year each article received, and the number of times each article was cited in the year 2015.

On average, papers included in the top 100 list were cited a total of  $423.21 \pm 315.14$  times. The number of total citations ranged from 236 Piotin et al. [31] to 1947 Hunt et al. [13]. The oldest arti-

### Phase 1 – Topic search



### Phase 2 – Title search



**Fig. 1.** Literature search strategy. This is a flow chart illustrating the two-step search of the Thomson Reuters Web of Science that was performed to arrive at the final list of 100 articles.

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