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SHORT COMMUNICATION

The Top 100 Cited Articles Published in *Translational Stroke Research*

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Stroke, consisting of ischemic stroke and hemorrhagic stroke, is considered a serious public health issue globally, and more resources are required for allocation to stroke research and treatment [1]. However, effective treatment and management strategies and interventions are still lacking [2]. *Translational Stroke Research (Transl Stroke Res)*, which was found 10 years ago, contains basic, translational, and clinical studies [3]. By focusing on translating scientific discoveries from basic stroke research into clinical applications, it provides both basic scientists and physicians with contemporary and important reference points for stroke prevention, assessment, treatment, etc. The purpose of this study was to identify and summarize the characteristics of the 100 most cited articles from *Transl Stroke Res* through bibliometrics, and to provide readers a more comprehensive view of this journal for the past decade, and therapeutic targets for translation to clinical applications related to stroke research.

We conducted the citation analysis of all papers published in *Transl Stroke Res* by using the Clarivate™ Web of Science Core Collection (WOS, Boston, MA, USA), and we identified the top 100 papers through citation list. After arranging the shortlisted articles, several important bibliometric parameters were extracted. Data were double-checked for accuracy, and any discrepancy was resolved through the re-examination of the original paper. In addition, VOSviewer (version 1.6.15, Leiden University, Netherlands) was used for graphical mapping of collaboration network maps, and statistical analysis was performed using GraphPad Prism 9 (version 9.2.0, GraphPad Software LLC, USA).

Top 100 articles and their bibliometric results regarding *Transl Stroke Res*, according to the most citation counts received, are listed in the Supplemental Table. These articles received a total of 6,788 citations, which ranged from 41 to 330 (median 55.00, interquartile range [IQR] 74.75–46.25), with average citations per year ranging from 4.27 to 76.50 (median 7.34, IQR 6–9.96). Among them, the article reviewed the major pathophysiological factors associated with traumatic brain injury (TBI), which was published in 2011 by *Chodobski* et al., which has accrued the most citation counts [4]. Moreover, the letter discussed the relationship between SARS-CoV-2 virus, angiotensin-converting enzyme 2 (ACE2), and stroke, which was published in 2020 by *Hess* et al., which has received considerable scholarly attention in a relatively short period [5]. In addition, we observed that the top 10 had a wide range of citations from

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96 to 330, suggesting that the intervals in the top-ranked articles are large and should be paid more attention.

We found that the counts of article ($n = 22$) and citations ($N_{total} = 1{,}380$) reached a peak in 2014 (Fig. 1a), which may be attributed to the focus on blood–brain barrier (BBB) and neurovascular unit (NVU) laying important foundation for subsequent researches. Strong positive correlation existed between publication year and average citations ($r = 0.5386$, 95% CI: 0.3776 to 0.6680, $p < 0.0001$). Although the overall citations trend in the next 5 years was declining, the average counts of citations had steadily increased, indicating that the influence of old articles may diminish with later studies over time, but these studies still need sufficient time to accumulate citations [6].

The top 100 cited articles were contributed by a total of 454 authors from 17 different countries. *Richard F Keep* has contributed the most articles. *John H Zhang* has obtained the most citations and average citations. *Xi Guohua* and *Simard J. Marc* both contributed more than three articles and were featured as the most or second-most published articles as corresponding author. The number of co-authors of articles was growing over the years ($r = 0.2151$, 95% CI: 0.01366–0.3998, $p = 0.0316$), and the collaboration network displays the major co-authorship clusters (Fig. 1b). The results of contributing countries and institutions showed that the USA and its main research organizations have held the top position in the terms of high-impact articles ($n = 72$, $N_{total=}5{,}187$), outstanding scientists (as mentioned above), or huge financial supports ($312.34 million), which were outpacing 16 other countries (Fig. 1c). The dual marked dominance of the USA in translational medicine and stroke continue to play a steady role in translational stroke research.

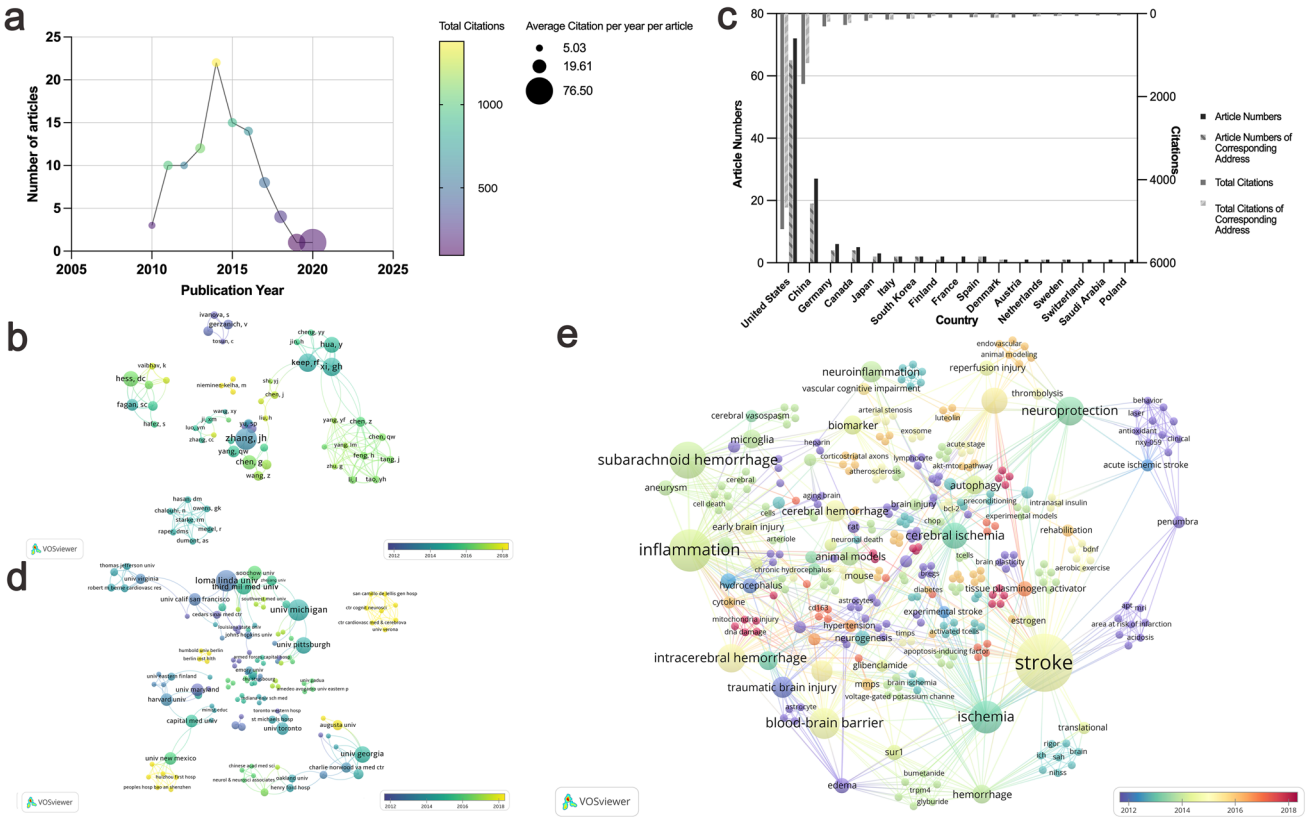

Fig. 1 **a** The trends of article numbers, total citations, and average citations vs. publication year of the 100 most cited articles in *Transl Stroke Res*. **b** The visualization map of major co-authorship clusters of the 100 most cited articles in *Transl Stroke Res*. Note: The network graph represents the main cooperation among the authors listed in the top 100 most cited articles. Size of the node is proportional to the citations of collaborations, the thickness of the line indicates the strength of the relationship, and the network is overlayed with the color gradient representing the time of collaboration as presented in the heat strip at the bottom right corner. **c** The distribution of article numbers and total citations among all countries of the 100 most cited articles in *Transl Stroke Res*. **d** The visualization map of major cooperative organizations of the 100 most cited articles in *Transl Stroke Res*. **e** The co-occurrence network of keywords of the 100 most cited articles in *Transl Stroke Res*. Note: The network graph represents the co-occurrence of keywords in the top 100 most-cited articles. Size of the node is proportional to the count of keyword, and the network is overlayed with the color gradient representing the time of usage of keyword as presented in the heat strip at the bottom right corner

With these advantages, the phenomenon of international cooperation led by the USA in *Transl Stroke Res* perhaps follows. We note that several outstanding contributors from the University of Michigan or Loma Linda University had conducted academic exchanges with influential universities in China, Japan, or Poland (Fig. 1d). Driven by outstanding researchers and leading institutions, construction and maintenance of strong international collaboration can not only promote the creating and spreading of knowledge [7], but also strengthen the capabilities of new research groups in other countries.[8] This would gradually expand the opportunities for translational stroke research.

We also investigated the main disease or pathology topics involved in the list. Cerebral ischemia ($n = 50$, $N_{total=}3{,}053$) was discussed more frequently than cerebral hemorrhage ($n = 36$, $N_{total=}2{,}477$) and the greatest support from funding projects. Co-occurrence map of keywords indicates that inflammation, neuroprotection and BBB are the most high-frequency keywords besides stroke and its classified subtypes (Fig. 1e). It was found that since 2018, the research area of cerebral ischemia has featured an increasing number of works on the therapeutic effect of natural compounds on hemorrhagic transformation of ischemic stroke (various natural compounds, baicalin, peroxynitrite, and hemorrhagic transformation were linked to tissue plasminogen activator activity and ischemic stroke) [9]. Simultaneously, the research area of cerebral hemorrhage tended over time to explore hormones and the blockade of interleukin to regulate cell mitochondrial membrane/endothelial cell permeability to reduce inflammation and BBB damage (mitochondrial injury, oxidative stress, melatonin, DNA damage, and secondary brain injury were linked to intracerebral hemorrhage, apoptosis, and inflammation; interleukin 6 was linked to SAH, BBB, and inflammation) [10, 11].

Development of stroke translational research has directly impacted the continuous growth of research productivity in the stroke field as a whole [12]. This study depicted the top 100 citation classics that had played a significant role in bolstering the progress in *Transl Stroke Res* since its initial publication in the past decade. These findings would provide historical insight into the landmark studies during the first decade, highlighting the importance of promoting combination of basic and clinical researches in stroke.

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