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Social attention and scientific articles on stroke: Altmetric analysis of top-50 articles

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ABSTRACT

Objective: It is well known that social media influences politics and the economy. A new Web-based metric (Altmetrics) has recently been developed for use in scientific fields. The aim of this study was to determine which recent papers in the field of stroke have received the greatest amount of attention from the general public. The Altmetric Attention Score is an automatically calculated metric for monitoring social media.
Patients and methods: An Altmetric Explorer search was performed on May 25, 2018 to extract the following information: (i) journal name, (ii) journal impact factor (IF), (iii) year of publication, (iv) article topic, (v) article type, and (vi) stroke subtype.
Results: The journal that published articles that received the most attention on social media was *Stroke* (*n* = 16). Articles with higher IFs are not expected to receive greater attention on social media. Twenty-one of the identified articles related to the subtypes of ischemic stroke. Regarding contents, approximately half of the top-10 ranked articles were about modifiable risk factors, especially diet and physical activities. Two recent articles on the extension of mechanical thrombectomy after 6 h were included on this list.
Conclusions: There are some discrepancies in perspectives between scientific articles and general social media, and the Altmetric Attention Score is considered to more dynamically reflect the interests of the general public. We therefore suggest that physicians can use Altmetric analysis to identify what the general public actually wants to know about in the real world, while they should also have a critical view of the social media that attracts the public with a stimulating theme rather than a worthy subject.

1. Introduction

The number of times that published articles are cited is generally used to measure the impact of a journal and to evaluate the competence of authors. A citation is a reference to a published or unpublished source, and is based on the bibliometrics that explored these associations. This analysis is used to rank articles, with the citation rank used to identify published output that has had the greatest intellectual impact. Many medical specialists use bibliometric analysis to identify the most significant papers in their field, such as general surgery [1], emergency surgery [2], and neurology [3]. However, citations take a long time to accumulate, and the total number of citations may be affected by the time that has elapsed since publication.

A new Web-based metric (Altmetrics) has led to fast and dynamic

analyses of the influence on social media platforms such as Facebook and Twitter. Social media is well known to influence politics and the economy, and has also received considerable attention from different perspectives in various medical fields. The aim of this study was to determine which recent papers in the field of stroke have received the highest Altmetric Attention Scores (AASs).

2. Patients and methods

2.1. Search engine

Altmetric Explorer (Altmetric, London, UK) is a Web-based application that can be used to search the following sources of research output, to yield the most-relevant and up-to-date picture of the

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following types of online activity and discussion: [4]

1 Public policy documents.
2 Blogs. There are > 9000 academic and nonacademic blogs.
3 Mainstream media. There are > 2000 media outlets worldwide.
4 Citations.
5 Online reference managers.
6 Research highlights from F1000.
7 Postpublication peer-review platforms.
8 Social media platforms, such as Facebook, Twitter, Google+, Linked In, Sina Weibo, and Pinterest.
9 Wikipedia.
10 Open Syllabus Project, which involves > 4000 institutions worldwide.
11 Multimedia and other online platforms such as YouTube, Reddit, and Q&A.
12 Patents, using data from IIFI CLAIMS®.

The AAS and the Almetric donut are designed to make it easy to identify how much and what type of attention a particular research output has received [5]. The AAS is automatically calculated using an automated algorithm created by the company Altmetric, based on the weighted count of all the attention a research output has received. It is based on three main factors: volume, sources, and authors. Each color of the Altmetric donut represents a different source of attention (Fig. 1) [5].

2.2. Search strategy

An Altmetric Explorer search was performed on May 25, 2018 for articles published in the 91 journals included in the 2015 InCites™ Journal Citation Report® grouped under the subject categories of clinical neurology, neuroimaging, neurosciences, radiology, nuclear medicine & medical imaging, surgery, and general and internal medicine.

Two researchers (Y. Kim and J.S. Bae) read the full papers of the top-50 articles and extracted the following information by consensus: (i) journal name, (ii) journal impact factor (IF), (iii) year of publication, (iv) article topic, (v) article type, and (vi) stroke subtype.

To clarify the AAS for the stroke field, we excluded articles that suggested composite outcomes including myocardial infarction, peripheral arterial disease, and stroke. If the outcomes were suggested separately, the article was included in this study.

3. Results

Altmetric Explorer identified 43,410 articles as being referred to online. The AAS, journal name, IF ranking, publication year, numbers of citations, and numbers of annual citations of the top-50 articles are summarized in Table 1. Because Altmetrics started collecting data only during the second half of 2011, none of the articles before 2010 were listed. The number of papers on this list peaked in 2016 (Supplementary Fig. I). Sixteen articles originated from the Stroke journal, accounting for one-third of the total, followed by the New England Journal of Medicine with eight articles. All but two of the articles were published

in journals in the highest IF quartile (Table 2). Regarding stroke subtypes, 21 articles were on ischemic stroke (IS), 8 were on hemorrhagic stroke (HS), 2 were on cerebral amyloid angiopathy, and 19 articles were on any type of stroke (Table 3). Regarding article types, 32 articles were original scientific papers, 8 were related to systematic reviews and meta-analyses, and 6 were related to guidelines and advisory documents (Table 4). The most-common topic was treatment and management (n = 23), followed by risk factors for stroke (n = 18) (Table 5).

It is noteworthy that half of the top-10 articles were about risk factors, especially diet and physical activities. The top-ranked article (#1 in Table 1) reported that sugar-sweetened beverages were not associated with stroke, whereas consuming artificially sweetened soft drinks was associated with a higher risk of stroke [6]. The third article (#3) reported that consuming up to one egg per day is not related to an increased risk of stroke. However, a higher egg consumption reduced the risk of HS in subgroup analyses [7]. A systematic review (#2) found that subjects with longer working hours have a higher risk of stroke [8]. The risk of IS is significant lower in people with higher levels of physical activity (#6) [9]. The tenth article (#10) reported that sauna bathing reduces the risk of stroke among Finnish subjects [10]. Furthermore, alcohol consumption (#14) [11] and cigarette consumption (#18) [12] attracted the attention of people on social media. Two meta-analyses found that light-to-moderate alcohol drinking was inversely associated only with IS, whereas heavy drinking was related to an increased risk of all strokes [11,12]. The meta-analysis of 55 studies found that smoking only one cigarette per day was associated with a risk of developing stroke that was higher than expected [12].

The most-common treatment and management topics covered were endovascular thrombectomy (#4, #5, #11, #15, #22, #25, and #48) [13,14] and drug therapy (#13, #27, #29, and #39) [15,16] in acute ischemic stroke (AIS). Two recent successful trials (#4 and #5) have expanded the availability of intra-arterial thrombectomy, thereby increasing the probability of treating acute-stroke patients [13,14]. The drugs for managing AIS in this list were aspirin, clopidogrel with aspirin, ticagrelor, and tenecteplase [15,16]. Although ticagrelor may be a stronger antiplatelet agent than aspirin, an international double-blind controlled trial involving 13,199 patients with nonsevere AIS or high-risk transient ischemic attack found that ticagrelor was not superior to aspirin in preventing stroke, myocardial infarction, or death at 3 months [17]. Tenecteplase is more specific than alteplase to fibrin, and works for a longer time. Administering tenecteplase before endovascular thrombectomy was associated with better reperfusion and a better 90-day functional outcome than alteplase among patients with AIS treated within 4.5 h [16].

4. Discussion

To the authors' knowledge, this is the first study to evaluate the online attention received by articles published in the stroke field. The journals that published articles receiving the most attraction on social media were *Stroke* (n = 16) and the *New England Journal of Medicine* (n = 8). Twenty-one articles were on the subtypes of IS. Regarding contents, treatment and management and risk factors for stroke received the most attention. It is noteworthy that about half of the top-10

Fig. 1. Altmetric donuts.

Table 1
Top-50 articles with the highest Altmetric Attention Scores (AASs).

Rank	Article title	AAS	Journal name	Impact factor ranking	Date of publication (YYMMDD)	Number of citations	Number of annual citations
1	Sugar- and artificially sweetened beverages and the risks of incident stroke and dementia	3215	Stroke	Q1	2017-01-01	14	9.9
2	Long working hours and risk of coronary heart disease and stroke: a systematic review and meta-analysis of published and unpublished data for 603,838 individuals	2016	The Lancet	Q1	2015-08-01	114	40.2
3	Egg consumption and risk of coronary heart disease and stroke: dose-response meta-analysis of prospective cohort studies	1710	British Medical Journal	Q1	2013-01-07	136	25.1
4	Thrombectomy 6 to 24 hours after stroke with a mismatch between deficit and infarct	1591	New England Journal of Medicine	Q1	2017-11-11	120	N/A[a]
5	Thrombectomy for stroke at 6 to 16 hours with selection by perfusion imaging	1426	New England Journal of Medicine	Q1	2018-01-24	27	N/A[a]
6	Physical activity and risk of breast cancer, colon cancer, diabetes, ischemic heart disease, and ischemic stroke events: systematic review and dose-response meta-analysis for the Global Burden of Disease Study 2013	1158	British Medical Journal	Q1	2016-08-09	95	51.8
7	Evidence of amyloid-β cerebral amyloid angiopathy transmission through neurosurgery	1097	Acta Neuropathologica	Q1	2018-02-15	0	0
8	2018 Guidelines for the Early Management of Patients With Acute Ischemic Stroke: a guideline for healthcare professionals from the American Heart Association/American Stroke Association	1061	Stroke	Q1	2018-01-01	67	N/A[a]
9	Incidence of subarachnoid hemorrhage is decreasing together with decreasing smoking rates	913	Neurology	Q1	2016-08-12	17	9.3
10	Sauna bathing reduces the risk of stroke in Finnish men and women: a prospective cohort study	911	Neurology	Q1	2018-05-02	1	N/A[a]
11	Time to treatment with endovascular thrombectomy and outcomes from ischemic stroke: a meta-analysis	888	JAMA: Journal of the American Medical Association	Q1	2016-09-27	193	110.3
12	Global burden of stroke and risk factors in 188 countries, during 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013	855	Lancet Neurology	Q1	2016-06-09	144	72
13	Effects of aspirin on risk and severity of early recurrent stroke after transient ischaemic attack and ischaemic stroke: time-course analysis of randomised trials	801	The Lancet	Q1	2016-05-18	50	26.1
14	Differing association of alcohol consumption with different stroke types: a systematic review and meta-analysis	782	BMC Medicine	Q1	2016-11-24	14	8.8
15	Endovascular thrombectomy after large-vessel ischaemic stroke: a meta-analysis of individual patient data from five randomised trials	754	The Lancet	Q1	2016-02-18	543	232.7
16	Guidelines for the prevention of stroke in women	748	Stroke	Q1	2014-02-06	260	58.9
17	Efficacy of folic acid therapy in primary prevention of stroke among adults with hypertension in China: the CSPPT randomized clinical trial	707	JAMA: Journal of the American Medical Association	Q1	2015-03-15	180	55.4
18	Low cigarette consumption and risk of coronary heart disease and stroke: meta-analysis of 141 cohort studies in 55 study reports	665	British Medical Journal	Q1	2018-01-24	16	N/A[a]
19	Global and regional effects of potentially modifiable risk factors associated with acute stroke in 32 countries (INTERSTROKE): a case-control study	615	The Lancet	Q1	2016-07-01	158	75.8
20	Changes in the employment status and risk of stroke and stroke types	611	Stroke	Q1	2017-04-09	0	0
21	MIDAS (Modafinil in Debilitating Fatigue After Stroke): a randomized, double-blind, placebo-controlled cross-over trial	593	Stroke	Q1	2017-01-01	6	4.2
22	2015 American Heart Association/American Stroke Association Focused Update of the 2013 Guidelines for the Early Management of Patients With Acute Ischemic Stroke Regarding Endovascular Treatment: a guideline for healthcare professionals from the American Heart Association/American Stroke Association	568	Stroke	Q1	2015-07-01	554	189.9
23	Role of sleep-disordered breathing and sleep-wake disturbances for stroke and stroke recovery	566	Neurology	Q1	2016-08-03	17	8.9
24	Subarachnoid hemorrhage	562	New England Journal of Medicine	Q1	2017-07-20	9	9.8
25	Analysis of workflow and time to treatment and the effects on outcome in endovascular treatment of acute ischemic stroke: results from the SWIFT PRIME randomized controlled trial	561	Radiology	Q1	2016-04-19	46	21.2
26	Stroke in Indigenous Africans, African Americans, and European Americans: interplay of racial and geographic factors	555	Stroke	Q1	2017-01-01	6	4.2
27	Clopidogrel with aspirin in acute minor stroke or transient ischemic attack	553	New England Journal of Medicine	Q1	2013-06-26	339	67.8
28	The most affected health domains after ischemic stroke	546	Neurology	Q1	2018-03-28	1	N/A[a]
29	Ticagrelor versus aspirin in acute stroke or transient ischemic attack	542	New England Journal of Medicine	Q1	2016-05-10	67	32.2
29	Ten-year temporal trends in medical complications after acute intracerebral hemorrhage in the United States	542	Stroke	Q1	2017-01-01	6	4.2
31	Therapeutic outcomes of transplantation of amniotic fluid-derived stem cells in experimental ischemic stroke	513	Frontiers in Cellular Neuroscience	Q1	2014-08-13	12	3.1
32	Air pollution is associated with ischemic stroke via cardiogenic embolism	508	Stroke	Q1	2016-01-01	8	3.3

Table 1 (*continued*)

Rank	Article title	AAS	Journal name	Impact factor ranking	Date of publication (YYMMDD)	Number of citations	Number of annual citations
32	Intensive blood-pressure lowering in patients with acute cerebral hemorrhage	508	New England Journal of Medicine	Q1	2016-06-08	135	67.5
34	Prevalence of stroke in children admitted with sickle cell anaemia to Mulago Hospital	506	BMC Neurology	Q3	2016-09-17	4	2.3
34	Amyloid-β pathology and cerebral amyloid angiopathy are frequent in iatrogenic Creutzfeldt-Jakob disease after dural grafting	506	Swiss Medical Weekly	Q2	2016-01-27	38	15.7
35	Risk of intracranial haemorrhage in antidepressant users with concurrent use of non-steroidal anti-inflammatory drugs: nationwide propensity score matched study	498	British Medical Journal	Q1	2015-07-16	27	9.3
37	THSD1 (Thrombospondin Type 1 Domain Containing Protein 1) mutation in the pathogenesis of intracranial aneurysm and subarachnoid hemorrhage	496	Stroke	Q1	2016-12-01	6	4
37	Sex, smoking, and risk for subarachnoid hemorrhage	496	Stroke	Q1	2016-07-21	14	7.3
38	Tenecteplase versus alteplase before thrombectomy for ischemic stroke	494	New England Journal of Medicine	Q1	2018-04-26	4	N/A[a]
40	Telemedicine in prehospital stroke evaluation and thrombolysis: taking stroke treatment to the doorstep	492	JAMA Neurology	Q1	2015-12-07	33	13.2
41	Association between statin use and ischemic stroke or major hemorrhage in patients taking dabigatran for atrial fibrillation	490	CMAJ: Canadian Medical Association Journal	Q1	2016-11-21	6	3.8
42	In-transit telemedicine speeds ischemic stroke treatment: preliminary results	486	Stroke	Q1	2016-08-04	5	2.7
43	Guidelines for Adult Stroke Rehabilitation and Recovery: a guideline for healthcare professionals from the American Heart Association/American Stroke Association	483	Stroke	Q1	2016-05-04	156	74.9
44	Infarct pattern and collateral status in adult moyamoya disease: a multimodal magnetic resonance imaging study	478	Stroke	Q1	2016-01-01	2	0.8
45	The safety and feasibility of image-guided BrainPath-mediated transsulcul hematoma evacuation: a multicenter study	475	Neurosurgery	Q1	2016-06-01	18	9
46	Metrics for measuring quality of care in comprehensive stroke centers: detailed follow-up to Brain Attack Coalition Comprehensive Stroke Center Recommendations: a statement for healthcare professionals from the American Heart Association/American Stroke Association	469	Stroke	Q1	2011-03-01	126	17.4
47	Stroke prevention in atrial fibrillation: a systematic review	467	JAMA: Journal of the American Medical Association	Q1	2015-05-20	123	39.9
48	A randomized trial of intraarterial treatment for acute ischemic stroke	465	New England Journal of Medicine	Q1	2014-12-17	1734	495.4
49	Defining optimal brain health in adults: a presidential advisory from the American Heart Association/American Stroke Association	459	Stroke	Q1	2017-01-01	10	7.1
50		454	JAMA Internal Medicine	Q1	2016-10-03	87	52.2

Abbreviation: Q1, quartile 1; Q2, quartile 2; Q3, quartile 3; N/A, not available.

[a] It is not meaningful to obtain annual numbers because the period is less than one year.

Table 2
Journals with top-50 articles, ranked according to the AAS.

Rank	Journal name	Impact factor ranking	Number of articles
1	Stroke	Q1	16
2	New England Journal of Medicine	Q1	8
3	The Lancet	Q1	4
3	British Medical Journal	Q1	4
3	Neurology	Q1	4
6	JAMA: Journal of the American Medical Association	Q1	3
7	CMAJ: Canadian Medical Association Journal	Q1	1
7	Frontiers in Cellular Neuroscience	Q1	1
7	Acta Neuropathologica	Q1	1
7	BMC Medicine	Q1	1
7	Radiology	Q1	1
7	BMC Neurology	Q3	1
7	Swiss Medical Weekly	Q2	1
7	Lancet Neurology	Q1	1
7	JAMA Neurology	Q1	1
7	JAMA Internal Medicine	Q1	1
7	Neurosurgery	Q1	1

Table 3
Numbers of articles with top-50 AASs according to stroke subgroups.

Subgroup	Numbers of list
Ischemic stroke	21
All strokes	19
Hemorrhagic stroke	8
Intracerebral hemorrhage	(4)
Subarachnoid hemorrhage	(4)
Cerebral amyloid angiopathy	2

Table 4
Numbers of articles with top-50 AASs according to article types.

Subgroup	Number of articles
Original scientific papers	32
Systematic reviews and meta-analyses	8
Guidelines and advisory documents	6
Reviews	4

Table 5
Numbers of articles with top-50 AASs according to subject categories.

Subject category	Number of articles
Treatment and management	**23**
AIS thrombectomy	7
Intra-arterial thrombectomy	(6)
Early management regarding endovascular thrombectomy	(1)
AIS management	6
Telemedicine	(2)
Early management of AIS	(1)
Aspirin plus clopidogrel	(1)
Ticagrelor versus aspirin	(1)
Tenecteplase versus alteplase	(1)
Prevention	4
Atrial fibrillation prevention	(2)
Prevention of stroke in women	(1)
Primary prevention: folic acid	(1)
After-stroke treatment: aspirin, modafinil, and stem cells	3
Acute hemorrhage blood-pressure control	1
Image-guided BrainPath-mediated transsulcul hematoma evacuation	1
Rehabilitation	1
Risk factors for stroke	**18**
Drugs and diet	5
Sugar- and artificially sweetened beverages, eggs, and alcohol	(3)
Antidepressants/NSAIDs and statins	(2)
Working hours, employment status, physical activity, sleep, and sauna bathing	5
Smoking and sex	3
Global risk factors, modifiable risk factors, and racial/ geographic factors	3
Air pollution	1
Sickle-cell anemia	1
Pathomechanism or brain biopsy	**4**
Complications	**2**
Brain health	**1**
Quality of care	**1**
Disease review	**1**

Abbreviations: AIS, acute ischemic stroke; NSAIDs, non-steroidal anti-inflammatory drugs.

ranked articles were about risk factors, especially diet and physical activities.

There are several noteworthy aspects of this study. One of the most-interesting findings was that articles published in journals with the highest IFs did not receive more attention on social media than those published in journals with lower IFs. For example, although several high-IF journals such as the New England Journal of Medicine, JAMA, and The Lancet are included in this list, those journals did not receive the highest rankings or contained the largest numbers of published articles. These findings suggest that traditional metrics and the AAS measure different perspectives [18]. Furthermore, there are some discrepancies in attentions between scientists and general people.

Another significant finding is that modifiable risk factors such as diet (sugar- and artificially sweetened beverages, eggs, cigarettes, and alcohol) [6,7,11,12], physical activities (working hours, physical activity, sauna bathing, and sleep) [8–10], and environmental conditions (air pollution) [19] attract public attention on social media. This indicates the presence of certain discrepancies in perspectives between scientific articles and general social media. Clinicians are interested in various topics such as the pathomechanisms of disease, treatment guidelines, procedure or operative methods, and new drugs that members of the general public are not interested in. In addition, although individuals have an insignificant impact on modifiable risk factors, the impact on the whole of humankind will be tremendous. These findings provide new insight into what information clinicians should provide patients with.

Finally, extending the treatment time of intra-arterial thrombectomy is a remarkable subject. The current direction of treatment trends in hyperacute IS is faster treatment and treating more patients. The American Heart Association/American Stroke Association is promoting the FAST (Face drooping, Arm weakness, Speech difficulty, Time to call 911) campaign so that more patients can get treatment sooner (Supplementary Fig. IIA) [20]. Meanwhile, the Korean Stroke Society is implementing the Stroke Five campaign (Supplementary Fig. IIB). These attempts by health professionals to improve education levels and campaigns may contribute to improvements in stroke morbidity [21]. There was a report in 1995 on the National Institute of Neurological Disorders and Stroke (NINDS) tissue plasminogen activator (tPA) study that stated that despite a higher risk of symptomatic intracerebral hemorrhage, intravenous tPA within 3 h of the symptom onset of IS improved the clinical functional outcome at 3 months [22]. Additionally, the Canadian Alteplase for Stroke Effectiveness Study (CASES) [23], Standard Treatment with Alteplase to Reverse Stroke (STARS) [24], and Safe Implementation of Thrombolysis in Stroke-Monitoring Study (SITS-MOST) [25] confirmed that intravenous alteplase is safe and effective when used within 3 h of symptom onset. However, the time limitation of 3 h has prompted many studies to attempt to expand this. A meta-analysis of data from previous studies in which tPA was administered after 3 h revealed that intravenous tPA can be expected to be effective for up to 4.5 h [26]. In 2008, the European Cooperative Acute Stroke Study-3 (ECASS-3) [27] and the Safe

Implementation of Thrombolysis in Stroke-International Stroke Treatment Registry (SITS-ISTR) [28] demonstrated the effects of tPA in patients with AIS within 4.5 h. The International Stroke Trial-3 (IST-3) demonstrated the efficacy of tPA in patients older than 81 years [29]. The development of devices for mechanical thrombectomy has led to the emergence of new therapeutic areas. In 2015, the EXTEND-IA [30], ESCAPE trial [31], and MR CLEAN study (#48) [32] suggested that early mechanical thrombectomy improved stroke outcomes compared with tPA alone. However, because AASs only reflect recent online attention, only one of these novel studies was included in the present list. In addition, recent articles (#4 and #5) that extended mechanical thrombectomy after 6 h for stroke might become the milestone for hyperacute IS [13,14].

AASs appear to provide novel perspectives on attention in scientific scholarship. Because Altmetrics only started collecting data during the second half of 2011, this method is specifically sensitive to recent news. This means that more-recent articles may receive higher AASs, which may result in some misinterpretations. However, a traditional method (bibliometric analysis) was used to calculate the total number of citations, which depends on the time that has elapsed since an article was published in a journal [33]. The AAS can therefore be considered a more-accurate indicator of the public perceptions of dynamic science and the medical field. One strength of the present study is that Altmetric Explorer yields cleaned-up data for use in analyses. The AAS facilitates measuring the online activity arising from specific research in real time. A high level of interest on social media can help physicians to determine what the general public actually wants in the real world. On the other hand, they should also have a critical insight of the social media that attracts the public with a stimulating theme rather than a worthy subject.

Finally, we suggest that combining the AAS and traditional metrics could provide a more-comprehensive description of scientific research output.

Author contributions

YK and JSB conducted the search and content analysis and was a major contributor in writing the manuscript. D-YY assisted with the search and content analysis and was a major contributor in writing the manuscript. All reviewed and commented on multiple drafts of the manuscript. All authors read and approved the final manuscript.

Declaration of Competing Interest

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Appendix A. Supplementary data

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