BMJ Open

The 100 Top-cited Articles Focusing on Acute Kidney Injury: a bibliometric analysis

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2016-011630
Article Type:	Research
Date Submitted by the Author:	22-Feb-2016
Complete List of Authors:	Liu, Yuan-hui; Department of Cardiology, Guangdong Cardiovascular Institute, Guangdong General Hospital, Guangdong Academy of Medical Sciences, Guangzhou 510100, China, Wang, Sheng-qi; Department of Pharmacy, Nanfang Hospital, Southern Medical University, Guangzhou, 510515, China, Xue, Jin-hua; Department of Physiology, School of Basic Medical Sciences, Gannan Medical University, Ganzhou, 341000, China, Liu, Yong; Department of Cardiology, Guangdong Cardiovascular Institute, Guangdong General Hospital, Guangdong Academy of Medical Sciences, Guangzhou 510100, China, Chen, Ji-yan; Department of Cardiology, Guangdong Cardiovascular Institute, Guangdong General Hospital, Guangdong Academy of Medical Sciences, Guangzhou 510100, China, Li, Guo-feng; Department of Pharmacy, Nanfang Hospital, Southern Medical University, Guangzhou, 510515, China, He, Peng-cheng; Department of Cardiology, Guangdong Cardiovascular Institute, Guangdong General Hospital, Guangdong Academy of Medical Sciences, Guangzhou 510100, China, Tan, Ning; Department of Cardiology, Guangdong Cardiovascular Institute, Guangdong General Hospital, Guangdong Academy of Medical Sciences, Guangzhou 510100, China,
Primary Subject Heading:	Renal medicine
Secondary Subject Heading:	Renal medicine
Keywords:	Bibliometric analysis, Acute kidney injury, Top 100 cited articles

The 100 Top-cited Articles Focusing on Acute Kidney Injury: a bibliometric analysis

Yuan-hui Liu MD [1#], Sheng-qi Wang MD [2#], Jin-hua Xue MD [3, 4#], Yong Liu MD [1], Ji-yan Chen MD, FACC,FESC[1], Guo-feng Li MD[2], Peng-cheng He MD[1*], Ning Tan MD, FACC,FESC,FAPSIC[1*]

[#]Equal contributors

[*]Corresponding author

[1]Department of Cardiology, Guangdong Cardiovascular Institute, Guangdong General Hospital, Guangdong Academy of Medical Sciences, Guangzhou 510100, China

[2]Department of Pharmacy, Nanfang Hospital, Southern Medical University, Guangzhou, 510515, China

[3]Department of Pathophysiology, School of Basic Medical Sciences, Southern Medical University, Guangzhou, 510515, China

[4]Department of Physiology, School of Basic Medical Sciences, Gannan Medical University, Ganzhou, 341000, China

Correspondence: Ning Tan, MD, FACC, FESC, FAPSIC. Department of Cardiology, Guangdong Cardiovascular Institute, Guangdong General Hospital, Guangdong Academy of Medical Sciences, Guangzhou 510100, China. E-mail: gdtanning@126.com; Telephone: +86-20-83819161; Fax: +86-20-83824369;

Abstract

Background: Acute kidney injury (AKI) is a major global health issue, associated with poor short- and long-term outcomes. Research on AKI is increasing with numerous articles published. However, the quantity and quality of research production in the field of AKI is unclear.

Methods and analysis: To analyze the characteristics of the most cited articles on AKI and to provide information about achievements and developments in AKI, we searched the Science Citation Index Expanded for citations of AKI articles. For the top 100 most frequently cited articles (T100), we evaluated the number of citations, publication time, province of origin, journal, impact factor, topic or subspecialty of the research, and publication type.

Results: The T100 articles ranged from a maximum of 1971 citations to a minimum of 215 citations (median 302 citations). T100 articles were published from 1951 to 2011, with most articles published in the 2000s (n=77), especially the 5-year period from 2002 to 2006 (n=51). The publications appeared in 30 journals, predominantly in the general medical journals, led by New England Journal of Medicine (n=17), followed by expert medical journals, led by the Journal of the American Society of Nephrology (n=16) and Kidney International (n=16). The great majority (83.7%) of T100 articles were published by teams involving ≥3 authors. T100 articles originated from 15 countries, led by the USA (n = 81) followed by Italy (n = 9). Among the T100 articles, 69 were clinical research, 25 were basic science, 21 were reviews, 5 were meta-analyses and 3 were clinical guidelines. Most clinical articles (55%) included patients with any cause of AKI, followed by the specific causes of contrast-induced AKI (25%) and cardiac surgery-induced AKI (15%).

Conclusions: This study provides a historical perspective on the scientific progress on AKI, and highlights areas of research requiring further investigations and developments.

Key words: Citation analysis; Acute kidney injury; Top 100 cited articles.

Strengths and limitations of this study

Two meticulous searches were performed in the Web of Science and consistent results were demonstrated in Scopus data.

Since some articles were cited more frequently than others because of the differences in time since publication, and this error was adjusted by a citation index determined for each article.

The language of publication was restricted to English, which would have failed to capture landmark articles published in other languages.

Findings of the present study would provide a historical perspective on the scientific progress on acute kidney injury.

Findings of the present study would highlights areas of research requiring further investigations and developments.

Introduction

Acute kidney injury (AKI) is a major global health issue and its incidence is markedly increasing in both developed and developing nations. The reported incidence ranges from 5% to 30-50% in patients under various conditions, such as coronary intervention, cardiac surgery, and intensive care unit admission. The development of AKI not only increases hospital stay and health care costs, but also results in poor short- and long-term outcomes[1-4]. Considering the importance of AKI, researches in this field has been increasing, and numerous articles have been published annually, giving new insights into the mechanism, early recognition, prevention or treatment of AKI. However, little is known regarding the quality of scientific achievements in this area.

Citation analysis is a bibliometric process that determines the influence of an article in the scientific community and evaluates the impact factor (IF) of a journal. The number of citations received by an article is a measure of its recognition and influence within the scientific community. A paper with greater citation history may be more valuable in its field[5]. Furthermore, citation analysis of the scientific literature may help to identify articles, research topics, and authors of influence. Therefore, academic institutions, funding agencies, and the public become increasingly interested in using citation analysis to assess the research quality and productivity of individual researchers [6]. Numerous attempts have been made to identify the most cited articles in various medical disciplines, including traumatic brain injury [7], radiology [8], hypospadiology [9], hypertension [10] and cardiac surgery [11]. However, no citation analysis of AKI has been published to date. Therefore, we aimed to analyze the characteristics of the 100 top-cited articles focused on AKI, and to determine achievements and advances in this field during the past century.

Methods

We conducted a citation search of the Science Citation Index Expanded of the ISI Web of Science (Thomson Reuters, Philadelphia, PA, USA) from 1945 to 15 July 2015. The search topic terms included “acute kidney injury” or “AKI” or “acute renal failure” or “ARF”. All electronic searches were conducted on one day, 15 July 2015, to avoid changes in citation rate as much as possible. After all identified articles were retrieved, and the results were sorted using the option “Times cited”, which yielded a list of all the articles published in a specific journal ranked by citation number. Articles on the list were then reviewed by two independent reviewers (Y.H.L and S.Q.W) by reading the abstracts or full-texts acquired from PubMed, Embase and ScienceDirect. Only studies focusing on AKI were selected for further analysis. Any disagreement between the two

reviewers was resolved through re-review or discussion with a third reviewer (J.H.X). There was a restriction on language (only English), but not on study type.

The top 100 (T100) identified articles were further analyzed by the two reviewers (Y.H.L and S.Q.W) independently according to the following parameters: citation number, authorship(first, second and corresponding authors), journal name and IF, title, number of authors, country of origin (defined by the address of the corresponding author), publication year, funding source, type of article，and level of evidence for clinical studies (evaluated based on the levels of evidence introductory document from the Oxford Centre for Evidence-based Medicine)[12]. The journals IFs were cross-referenced with the 2015 edition of Journal Citation Reports (JCR): Science Edition (1945-2014). Based on their study design, research setting and goals, the selected articles were grouped into 5 categories: clinical guidelines, review, meta-analysis, basic research, and clinical research (including observational and randomized control trials, RCTs). Prospective, retrospective, and case series were all categorized as observational studies. RCTs include both single- and double-blind studies. According to the causes of AKI, the topics were divided into (1) any cause, (2) contrast, (3) cardiac surgery, and (4) others. In addition, since some articles were cited more frequently than others because of the difference in time since publication, this error was adjusted by a citation index determined for each article. The citation index was defined as the mean number of citations per year. For comparison, we searched Scopus (http://www.scopus.com/ search/form.url; retrieved on July 15th, 2015) for total citation counts of the T100 articles.

Statistical analysis

Data are represented as median or interquartile range. The differences between groups were evaluated by the Wilcoxon rank sum test. The Spearman test was used to evaluate the strength and direction of the linear relationship between journal IF and the number of T100 cited articles or citations, and the correlation of article citations between different databases (Web of Science and Scopus). All data analyses were performed with SPSS 17 software (SPSS Inc., Chicago, IL, USA). All probability values were two-tailed, and the threshold for significance was set at $P < 0.05$.

Results

Citation count and publication year

A total of 56,830 papers were identified after the initial search in the period from 1945 to present. Among them, articles that focused solely on AKI and were among the top 100 most cited were included. Ultimately, 123 articles (including some duplicate citations) were included in the analysis

(Table1 and 1S). The median number of citations was 302 (range 215 to 1,971), with only three papers cited over 1000 times. The citation index (median 216, range 5 to 184) was correlated with number of the citations (r=0.581, P<0.001) per article. In addition, the number of citation and citations index per article were positively correlated between the Web of Science and Scopus database (r=0.770, P < 0.001; r=0.791, P < 0.001, respectively).

The selected T100 articles were published from 1951 to 2011, with most articles published in the 2000s (n=77), and particularly the 5-year period from 2002 to 2006 (n=51), followed by the 1990s (n=22) **(Figure 1)**. The single years with the most cited articles were 2004 and 2006 (each n=13). The number of citations was also the highest in the 2000s (30, 537) followed by the 1990s (9510). Spearman test indicated an uptrend between the citation index and time (r=0.315, P < 0.001). There is no correlation between time and number of citations(r=-0.003, P=0.975), but a positive correlation between time and citation index(r=0.347, P < 0.001).

Publishing journals of T100 articles

The T100 articles were published in 30 journals **(Table 2)**, predominantly in general medical journals, led by the New England Journal of Medicine (n=17), followed by expert medical journals, led by the Journal of the American Society of Nephrology (n=16) and Kidney International (n=16) (Table 2). In addition, Journal of Clinical Investigation, Lancet, Journal of the American Medical Association, American Journal of Medicine, and Critical Care Medicine contributed 11, 7, 5, 5, and 5 top cited articles, respectively. The journal' IFs of T100 articles ranged from 2.1 to 55.9. Many of the T100 articles were published in high-IF journals, while the journal IF was significantly correlated with the number of T100 articles (r=0.439, p=0.017), and the number of citations (r=0.476, p=0.009).

Authorship, Origins, and Institutions

The great majority (83.7%) of T100 articles were produced by teams involving ≥3 authors. A list of the most frequently-appearing authors is presented in Table 5. It is clearly dominated by JV Bonventre, who authored 10 T100 articles (first author: 5; corresponding author: 9) with a total of 4,527 citations, and P Devarajan, who authored 8 T100 articles with 3428 citations (**Table 3**).

The T100 articles originated from 15 countries, led by the USA (n = 81) followed by Italy (n = 9), Germany (n=7), France (n=5), and the United Kingdom (n=5), with all other counties having less than five publications, as shown in **Figure 2**. Articles originating from the USA also had the highest mean number of citations (mean 384 citations per article). Of the T100 articles, the leading

institutions with the most productive articles were Brigham and Women's Hospital (Boston, USA), Cincinnati Children's Hospital Medical Center (Cincinnati, USA) and the University of California, San Francisco (San Francisco, USA), with five articles each. The two institutions ranking next is the Yale University (West Haven, USA) **(Table 4)**.

Publication type and areas of study

The T100 articles included 69 clinical studies, 25 basic science studies, 21 reviews, 5 meta analyses and 3 clinical guidelines **(Figure 3)**. The number of total citations per article ranged from 218 to 1652 (median, 303) for clinical research, and from 215 to 814 (median, 257) for basic science. Of the 69 clinical articles, the most common type was prospective observational study (n=35), followed by RCT (n=16), retrospective study (n=16), and case report (n=2).

The primary purpose of these clinical studies included evaluation of a therapy strategy (n=16), description of biomarkers or risk model to prevent AKI (n=9, and n=3, respectively), description of epidemiology (n=27), evaluation of a diagnostic modality (n=5), and others (n=9). With regard to the causes of AKI in clinical researches, most articles (55%) included patients with any cause of AKI, followed by specific contrast induced AKI (25%) and cardiac surgery induced AKI (15%). Only 1 study reported on drug induced AKI, and the rest were nontraumatic rhabdomyolysis induced AKI (n=3). In addition, ischemic induced AKI was the most common type of AKI (64%) assessed in basic science studies, followed by drug induced AKI models (32%) and only 1 basic research study concerned surgery induced AKI.

Funding source and level of evidence

Among T100 articles (original articles), 60 were funded by public foundations, 3 received support from commercial companies, 8 were supported by both, and the remaining 52 did not specify the funding source (**Figure 4)**. More than half of studies that disclosed funding (95.8%) were supported by the public, and pharmaceutical companies only supported 15.5%. Funding supported most of the basic science T100 studies (96%, 24/25), but only 43.5% of clinical articles.

All of the clinical articles were assigned a level of evidence from 1 to 5 (**Figure 5**). Level 2b (47.3%) was the most frequent level of evidence, with a median of 298 citations per article. There were 16 studies each at level 1b and 3b. Only 1 and 4 T100 cited articles were assigned to level 1a and 2a, respectively. There was no significant association between citation index and level of evidence (P = 0.847). In addition, the evidence level was not strongly correlated with overall

number of citations (r=-0.11, p=0.345), citation index (r=-0.08, p=0.500), or year of publication (r=-0.16, p=0.174).

Discussion

The present study is the first to identify, rank and characterize the T100 articles in the field of AKI. The results reveal important advances and prevalent areas of interest in research about AKI, and may help physicians and scientists understand and design future research. The present study also provides quantitative information about authors, institutions, and journals that helps to identify classic works and high-impact journals.

Bibliometric analysis is a tool that quantifies the characteristics and scholarly impact of citation classics. Citation analysis, one common bibliometric method, can help authors to recognize important advances, and add a useful perspective on historical developments in a specific field. Understanding the characteristics inherent to highly cited works could help researchers who wish to publish effectively[13]. Despite some disadvantages in the assessment of article quality based simply on citation rating, it remains the most widely-accepted method currently available to judge the merits of a paper or journal[14]. Citation analysis is often used by journals to attract manuscripts with high citation potential. Currently, citation analysis of top cited articles is widespread and reported in various medical disciplines. However, there has been no citation analysis of AKI, which is a major global health issue associated with increased medical cost, and poor short- and long- term outcomes. In addition, the prevention, diagnosis, and treatment of AKI has become a rapidly developing specialty in recent years. This development is evidenced by the increasing number of related studies in the scientific literature. Identifying the classic articles that have contributed to progress in AKI research will help to understand the history and development of AKI and design future studies. However, little work has been conducted to recognize these important papers. The present study is the first to analyze the top article citations in AKI, and will help readers or authors to recognize the quality of the research, discoveries, and the trends steering AKI.

An article has more time to be cited with increasing age, and "older" articles are more likely to attain more citations, purely because of their longer citable period. However, in this analysis, most of the T100 articles (67%) were published between 2001 and 2009. This result is not consistent with most other citation analyses, in which the peak period for citation is from 1980 to 1995. However, it is consistent with recent research in the field of cardiovascular diseases[15]. In addition, to overcome the effect of publication time on citations, we also assessed the citation index as a measure of the

true impact of an article independent of short-lived trends. The results remained consistent indicating that the number of AKI articles increased, and this field attracted more resources and materials in the past 10 years, with the growing incidence of AKI, because of increasing exposure to contrast media or cardiothoracic surgery.

Some previous studies have demonstrated that high IF journals are attractive to authors, which in turn preferentially attract more submissions from the authors. Therefore, the IF of a journal is the strongest indicator for citations, and most top cited articles are published in high IF journals [16-18]. The present study also demonstrated that IF was positively correlated with the number of T100 articles, and the number of citations. However, other than the high-IF general medical journal the-New England Journal of Medicine, which published 17 T100 articles, the most productive journals were the Journal of the American Society of Nephrology and Kidney International, which have relatively low IFs. This result indicates an increasing trend of publishing highly influential articles in specialty journals dedicated solely to research into renal diseases such as AKI rather than general medical journals (e.g. Lancet or JAMA). These results are consistent agree with previous studies focusing on other diseases[10 15]. Our results also revealed that no T100 basic research study focusing on AKI was published in Nature, Cell, or Science, the highest influent journals on basic research. This result is in contrast to hypertension studies, among which highly cited basic research was published more frequently in Nature (6 articles) and Cell (4 articles) [10].

Fifteen countries contributed to the T100 cited articles, led by the USA, which is similar to the T100 articles in the fields of cardiac surgery[11], sepsis[19], and others[15 20 21]. This finding confirms the influence of the USA in relation to AKI research worldwide and may be related to the large population and abundant financial resources available to the scientific community in the USA. In addition, among the top 13 institutions, 9 (69%) are in USA. The leading institution is Brigham and Women's Hospital, which published 9 T100 cited articles with total citations number of 4263. Furthermore, American authors tend to cite local papers and European authors tend to publish in American journals and USA reviewers prefer USA papers[22 23]. In addition, European countries, like Italy and the UK, also demonstrated higher productivity. However, despite the rapid development of scientific research in recent years, Asian authors have not played a dominant role in AKI research since their contribution to research productivity is relatively low. This finding seems to conform to the phenomenon that “a country with better economic ranking has the higher quantity and quality of biomedical publications” [24]. A number of first or corresponding authors were represented more than

once on the list. This list of frequently-cited authors highlights some of the world's best-recognized experts in the field of AKI research. The most frequently-cited authors JV Bonventre and P Devarajan, with 5 and 6 articles, respectively, were associated with clinical articles.

Financial support from public foundations or commercial companies has greatly contributed to medical and public health research. In our study, more than half (57.7%) of T100 articles reported a source of funding support. Among them, 84.5% received funding from public institutions or national foundations, 4.2% from industry and 11.3% from both. Although, industry-funded research has been widely debated because of susceptibility to various biases, it has played and will continue to play a critical role in the research process[25]. In another recent study, 24% of funding was from industry, which is higher than in the present study. However, 30% of reported funding was from public agencies, which is lower than ours[19]. This comparison indicates that government-funded entities have prioritized AKI, a global health issue impacting medical costs. The cost per 6-month AKI survivor was calculated to be $80 000[26]. Another reason for this discrepancy might be the lack of new drug development research in the present T100 articles, resulting in little funding from pharmaceutical companies. In addition, only 44% of clinical research received funding, while 96% of basic research received funding. These results confirm the key role of public funding in the generation of influential basic research. However, clinical research has bridged the gap between basic science and human health improvement, is heavily weighted towards biomedical science, and plays a special role in the fight against AKI by providing evidence for its treatment and diagnosis. High-quality clinical research is expensive, and in the future, it should receive more funding support.

Based on the advantages of clinical research mentioned above, more clinical studies have been performed to provide new insights into the prevention, biomarkers, diagnosis or treatment of AKI. In addition, a recent detailed bibliometric analysis suggests the rapid dissemination of clinical findings [27]. Thus, it is not surprising that most of the T100 articles (58%) in the present study are clinical research, consistent with analyses in other fields[28-30]. The mean citation number per clinical research article was higher than that of basic research articles (404 vs. 328). Among clinical studies, the most frequent type was prospective observational study (n=35), followed by RCT (n=16). Our limited survey, based on the analysis to identify the citation source for the top 3 T100 clinical studies, revealed that most of their citations (2/3) came from other original articles (both clinical and pre-clinical studies), with the rest of citations (1/3) in subsequent reviews, editorials, or

meta-analyses. This distribution suggests that the conclusions of these highly cited clinical studies have stimulated much subsequent original research. Guidelines, reviews and meta-analyses (with 852, 362, and 267 mean citations per article, respectively) accounted for a high proportion (22%) of the list, which is a common finding in top citation assessments for any medical specialty. Authors frequently cite such publications as they convey outcome generalities of many single site studies. It is well recognized that levels of evidence will vary depending on the study designs. The goal of rating study designs and levels of evidence is to indicate the best available evidence for use in patient care. Among various study designs, RCTs provide the highest quality evidence for most clinical or interventional trials. The T100 articles included 16 RCTs, a lower proportion than other top medical articles, such as hypertension (24 RCTs).

A large majority of clinical research studies in the T100 cited articles included patients with AKI from any cause admitted to an intensive care unit. Among the research on specific causes of AKI, contrast-induced AKI in patients after cardiac catherization was the most common. It is not surprising that researchers have been increasingly interested in the field of biomarkers[31], or therapy for contrast induced AKI[32], with a large number of papers published, in parallel with the increasing use of cardiac catherization. Additionally, previous studies demonstrated that contrast-induced AKI is a common complication after procedures requiring contrast media, responsible for 11% of in-hospital AKI cases, and also associated with poor short- and long-term outcomes[3 33]. In our T100 RCT studies, 50% focused on the therapy of contrast-induced AKI. However, more high-quality RCTs for other causes of AKI, such as cardiac surgery, are needed in the future.

This study also has some limitations. First, despite a meticulous search of Web of Science and consistent results also demonstrated in Scopus data, some studies might have been missed. Second, this type of study usually favors older published articles, but excludes some recently published high quality studies, a limitation related to the effect of time on citations. Third, using the number of citations alone can not quantify the value of contributions to the field. Therefore, papers that are important and influential, but have a lower citation frequency, might be missed. Fourth, the minimal effect of self-citation was also not considered in our study. Finally, the language of publication was restricted to English, which would have failed to capture landmark articles published in other languages.

Conclusions

Our analysis summarized of the most influential studies on AKI, and highlights research areas that require further investigation and development. Our analysis also provides an insight into the citation frequencies of the top cited articles on AKI and sheds light on the quality of the works, discoveries, and trends steering AKI research globally.

Contributors

Conception/Design: NT, YHL, PCH.

Collection and/or assembly of data: YHL, SQW, JHX, YL, JYC, PCH.

Data analysis and interpretation: YHL, SQW, JHX, YL, JYC.

Manuscript writing: YHL.

Manuscript revising: NT, YHL, SQW, GFL.

Final approval of the version to be published: All authors.

Funding

This study was supported by a grant from the National Natural Science Foundation of China (Grant no. 81270286). The funders had no role in the study design, data collection and analysis, decision to publish, or preparation of the manuscript. This work was not funded by any industry sponsors.

Competing interests

The authors declare that they have no competing interests.

Ethical approval

Not required.

Data sharing

No additional data available.

References

1. Huber M, Ozrazgat-Baslanti T, Thottakkara P, et al. Mortality and cost of acute and chronic kidney disease after vascular surgery. *Ann Vasc Surg* 2016;30:72-81
2. Hoste EA, Bagshaw SM, Bellomo R, et al. Epidemiology of acute kidney injury in critically ill patients: the multinational AKI-EPI study. *Intensive Care Med* 2015;41:1411-23.
3. Giacoppo D, Madhavan MV, Baber U, et al. Impact of Contrast-Induced Acute Kidney Injury After Percutaneous Coronary Intervention on Short- and Long-Term Outcomes: Pooled Analysis From the HORIZONS-AMI and ACUITY Trials. *Circ Cardiovasc Interv* 2015;8:e002475.
4. Horkan CM, Purtle SW, Mendu ML, et al. The association of acute kidney injury in the critically ill and postdischarge outcomes: a cohort study. *Crit Care Med* 2015;43:354-64.
5. Eyre-Walker A, Stoletzki N. The assessment of science: the relative merits of post-publication review, the impact factor, and the number of citations. *PLoS Biol* 2013;11:e1001675.
6. E G. Citation analysis as a tool in journal evaluation. *Science* 1972;178:471-9.
7. Sharma B, Lawrence DW. Top-cited articles in traumatic brain injury. *Front Hum Neurosci* 2014;8:879.
8. Pagni M, Khan NR, Cohen HL, et al. Highly cited works in radiology: the top 100 cited articles in radiologic journals. *Acad Radiol* 2014;21:1056-66.
9. O'Kelly F, Nason GJ, McLoughlin LC, et al. A comparative bibliometric analysis of the top 150 cited papers in hypospadiology (1945-2013). *J Pediatr Urol* 2015;11:1-11
10. Oh YS, Galis ZS. Anatomy of success: the top 100 cited scientific reports focused on hypertension research. *Hypertension* 2014;63:641-7.
11. O'Sullivan KE, Kelly JC, Hurley JP. The 100 most cited publications in cardiac surgery: a bibliometric analysis. *Ir J Med Sci* 2015;184:91-9.
12. Phillips B, Ball C, Sackett D, et al. Levels of evidence. Available from URL: http://www.cebm. net/index.aspx?o=1025. Accessed on 1 October 2013.
13. Allen L, Jones C, Dolby K, et al. Looking for landmarks: the role of expert review and bibliometric analysis in evaluating scientific publication outputs. *PloS One* 2009;4:e5910.
14. D A. The counting house. *Nature* 2002;415:726-9.
15. Shuaib W, Khan MS, Shahid H, et al. Bibliometric analysis of the top 100 cited cardiovascular articles. *Am J Cardiol* 2015;115:972-81.
16. E G. The history and meaning of the journal impact factor. *JAMA* 2006;295:90-3.
17. Fendrich V, Rothmund M. Surgical research in Germany--an international comparison. *Chirurg* 2010;81:328-33.
18. FM C. National bias- a comparison of citation practices by health professionals. *Bull Med Libr Assoc* 1990;78:376-82.
19. Tao T, Zhao X, Lou J, et al. The top cited clinical research articles on sepsis: a bibliometric analysis. *Crit Care* 2012;16:R110.
20. Nason GJ, Tareen F, Mortell A. The top 100 cited articles in urology: An update. *Can Urol Assoc J* 2013;7:E16-24.
21. Gu W, Yuan Y, Yang H, et al. A bibliometric analysis of the 100 most influential papers on COPD. *Int J Chron Obstruct Pulmon Dis* 2015;10:667-76.
22. Campbell FM. National bias: a comparison of citation practices by health professionals. *Bull*

Med Libr Assoc 1990;78:376-82.

23. AM L. US and non-US submissions: an analysis of reviewer bias. *JAMA* 1998;280:246-7.
24. FE N. Publication outcome of research funding by the Danish Heart Foundation 1988-1990. *Ugeskr Laeger* 1998;160:4644-8.
25. Rowe S, Alexander N, Clydesdale FM, et al. Funding food science and nutrition research: financial conflicts and scientific integrity. *Am J Clin Nutr* 2009;89:1285-91.
26. Korkeila M RE, Takala J. Costs of care, long-term prognosis and quality of life in patients requiring renal replacement therapy during intensive care. *Intensive Care Med* 2000;26:1824-31.
27. Rosas SR, Schouten JT, Cope MT, et al. Modeling the dissemination and uptake of clinical trials results. *Res Eval* 2013;22:179-86.
28. Piolanti N, Nesti A, Andreani L, et al. The fifty most cited Italian articles in the orthopaedic literature. *Musculoskelet Surg* 2015;99:105-11.
29. Aminian A, Daigle CR, Brethauer SA, et al. Citation classics: top 50 cited articles in bariatric and metabolic surgery. *Surg Obes Relat Dis* 2014;10:898-905.
30. Cao F, Li J, Li A, et al. Citation classics in acute pancreatitis. Pancreatology 2012;12:325-30.
31. Liu YH, Liu Y, Chen JY, et al. LDL cholesterol as a novel risk factor for contrast-induced acute kidney injury in patients undergoing percutaneous coronary intervention. *Atherosclerosis* 2014;237:453-9.
32. Bei WJ, Duan CY, Chen JY, et al. Remote Ischemic Conditioning for Preventing Contrast-Induced Acute Kidney Injury in Patients Undergoing Percutaneous Coronary Interventions/Coronary Angiography: A Meta-Analysis of Randomized Controlled Trials. *J Cardiovasc Pharmacol Ther* 2016;21:53-63.
33. Nash K, Hafeez A, Hou S. Hospital-acquired renal insufficiency. *Am J Kidney Dis* 2002;39:930-6.

Table and Figure legends

Table 1. Bibliometric information associated with the Top 20 of the Top 100 cited articles on acute kidney injury.

Table 2. Journals in which the T100 articles were published.

Table 3. Authors with two or more top-cited articles.

Table 4. Institutions with two or more top cited articles on acute kidney injury.

Figure 1. Numbers of articles published and number of citations in 5 years periods.

Figure 2. Countries of origin of the top100 cited articles on acute kidney injury.

Figure 3. Distributions of research type of the top 100 cited articles on acute kidney injury.

Figure 4. Funding source of the top 100 cited research studies.

Figure 5. Levels of evidence of the top 100 cited clinical articles.

Table 1. Bibliometric information associated with the Top 20 of the Top 100 cited articles in acute kidney injury.

Rank	Authors	Title	Journals	Years	Times Cited (Web)	Citation Index (Web)	Times Cited (Scopus)	Citation Index (Scopus)	PMID
1	Bellomo, R et al	Acute renal failure-definition, outcome measures, animal models, fluid therapy and information technology needs: the Second International Consensus Conference of the Acute Dialysis Quality Initiative (ADQI) Group	Critical Care	2004	1971	164.25	2219	184.92	15312219
2	Mehta, RL et al	Acute Kidney Injury Network: report of an initiative to improve outcomes in acute kidney injury	Critical Care	2007	1652	183.56	1725	191.67	17331245
3	Uchino, S et al	Acute renal failure in critically ill patients-A multinational, multicenter study	JAMA-Journal of the American Medical Association	2005	1297	117.91	1489	135.36	16106006
4	Thadhani, R et al	Medical progress - Acute renal failure	New England Journal of Medicine	1996	963	48.15	1139	56.95	8618585
5	Mishra, J et al	Neutrophil gelatinase-associated lipocalin (NGAL) as a biomarker for acute renal injury	Lancet	2005	949	86.27	1079	98.09	15811456

		after cardiac surgery							
6	Chertow, GM et al	Acute kidney injury, mortality, length of stay, and costs in hospitalized patients	Journal of the American Society of Nephrology	2005	893	81.18	1035	94.09	16177006
7	Ronco, C et al	Effects of different doses in continuous veno-venous haemofiltration on outcomes of acute renal failure: a prospective randomised trial	Lancet	2000	816	51.00	1032	64.5	10892761
8	Paller, MS et al	Oxygen free radicals in ischemic acute renal failure in the rat	Journal of Clinical Investigation	1984	814	25.44	575	17.97	6434591
9	McCullough, PA et al	Acute renal failure after coronary intervention: Incidence, risk factors, and relationship to mortality	American Journal of Medicine	1997	799	42.05	1016	53.47	9375704
10	Levy, EM et al	The effect of acute renal failure on mortality - A cohort analysis	JAMA- Journal of the American Medical Association	1996	793	39.65	998	49.9	8622223
11	Rihal, CS et al	Incidence and prognostic importance of acute renal failure after percutaneous coronary intervention	Circulation	2002	691	49.36	877	62.64	12010907
12	Solomon, R et al	Effects of saline, mannitol, and furosemide to	New England Journal of	1994	684	31.09	905	41.14	7969280

		prevent acute decreases in renal function induced by radiocontrast agents	Medicine						
13	Mehran, R et al	A simple risk score for prediction of contrast-induced nephropathy after percutaneous coronary intervention- Development and initial validation	Journal of the American College of Cardiology	2004	677	56.42	844	70.33	15464318
14	Mishra, J et al	Identification of neutrophil gelatinase-associated lipocalin as a novel early urinary biomarker for ischemic renal injury	Journal of the American Society of Nephrology	2003	645	49.62	735	56.54	14514731
15	Chertow, GM et al	Independent association between acute renal failure and mortality following cardiac surgery	American Journal of Medicine	1998	630	35.00	747	41.5	9576407
16	Parfrey, PS et al	Contrast material-induced renal failure in patients with diabetes mellitus, renal insufficiency, or both. A prospective controlled study	New England Journal of Medicine	1989	618	22.89	635	23.52	2643041
17	Aspelin, P et al	Nephrotoxic effects in high-risk patients undergoing angiography.	New England Journal of Medicine	2003	575	44.23	758	58.31	12571256
18	Brivet, FG et al	Acute renal failure in intensive care units - Causes, outcome, and prognostic factors of	Critical Care Medicine	1996	538	26.90	632	31.6	8605788

		hospital mortality: A prospective, multicenter study							
19	Togel, F et al	Administered mesenchymal stem cells protect against ischemic acute renal failure through differentiation-independent mechanisms	American Journal of Physiology-Renal Physiology	2005	524	47.64	625	56.82	15713913
20	Merten, GJ et al	Prevention of contrast-induced nephropathy with sodium bicarbonate - A randomized controlled trial	JAMA- Journal of the American Medical Association	2004	513	42.75	714	59.5	15150204

See Table S1 for a complete list of T100.

Table 2. Journals in which the T100 articles were published

Journal	No. of Articles (Citations)	Impact Factor	5-Year Impact Factor
New England Journal of Medicine	17 (7249)	55.87	54.39
Journal of the American Society of Nephrology	16 (5470)	9.34	5.47
Kidney International	16 (5157)	8.56	7.89
Journal of Clinical Investigation	11 (3930)	13.22	14.05
Lancet	7 (3194)	45.22	42.72
JAMA- Journal of the American Medical Association	5 (3095)	35.29	31.03
American Journal of Medicine	5 (2138)	5.00	5.26
Critical Care Medicine	5 (1935)	6.31	6.29
American Journal of Physiology-Renal Physiology	4 (1252)	3.25	3.51
Critical Care	4 (4379)	4.48	5.14
Archives of Internal Medicine	4 (1079)	17.33	13.10
Journal of the American College of Cardiology	3 (1238)	16.50	14.10
Medicine	3 (971)	5.72	5.29
Annals of Internal Medicine	3 (864)	17.8	17.47
Proceedings of the National Academy of Sciences of the United States of America	2 (683)	9.67	10.56
American Journal of Kidney Diseases	2 (627)	5.90	5.56
Clinical Journal of the American Society of Nephrology	2 (604)	4.61	5.47
American Journal of Cardiology	2 (482)	3.28	3.35

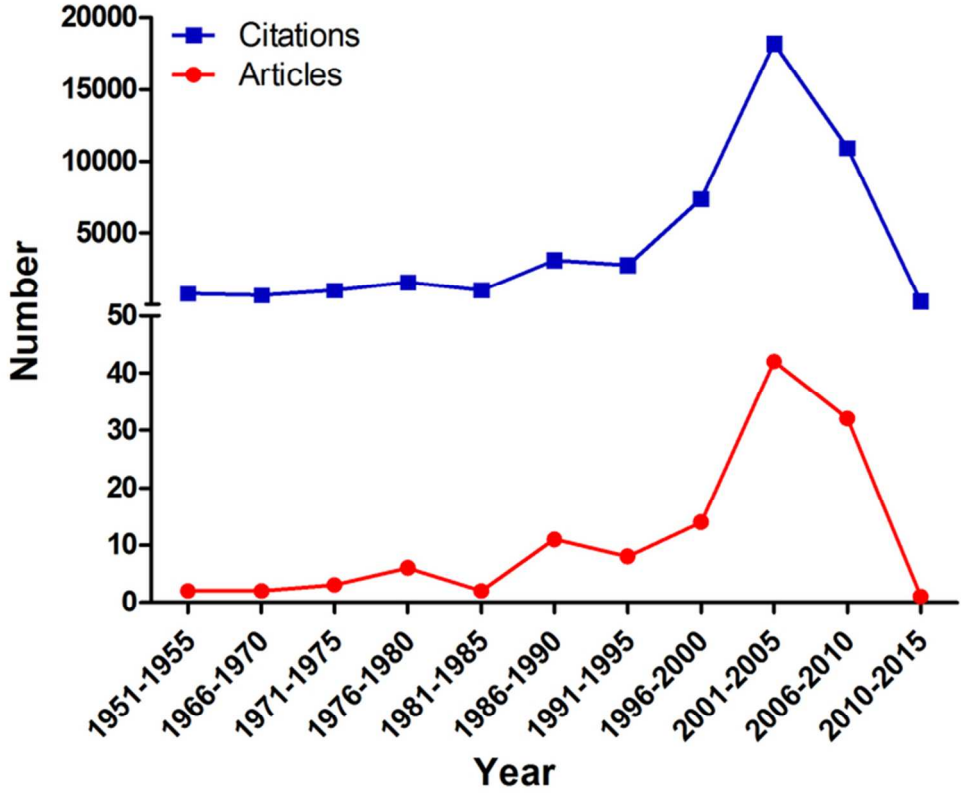
Notes: The journals that only published one of the T100 articles were shown below. Values given in parentheses were number of articles, impact factors and the corresponding citations, respectively. Circulation (1, 14.43, 691); Intensive Care Medicine (1, 7.21, 349); Nephrology Dialysis Transplantation (1, 3.58, 304); Anesthesiology (1, 5.88, 263); Circulation Research (1, 11.02, 243); Journal of Thoracic and Cardiovascular Surgery (1, 4.17, 229); International Journal of Molecular Medicine (1, 2.09, 228); American Journal of Physiology (1, NA, 227); Clinical Infectious Diseases (1, 8.89, 226); Annals of Surgery (1, 8.33, 226); Annals of Thoracic Surgery (1, 3.85, 221); European Radiology (1, 4.01, 220).

Table.3. Authors with two or more top-cited articles

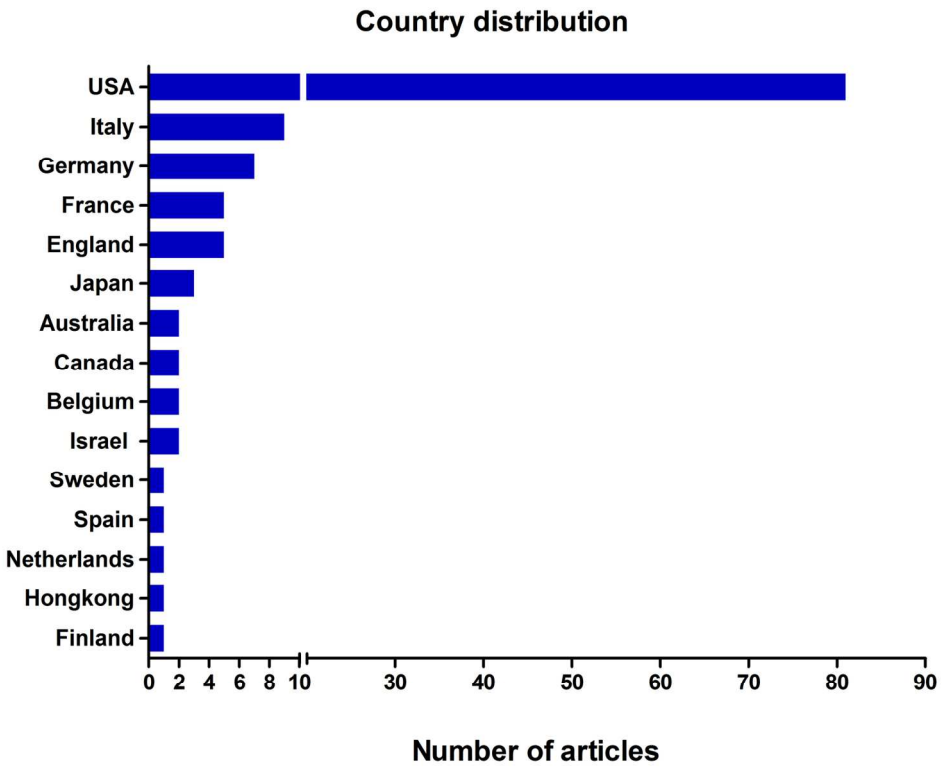
Rank	Author	No. of articles	First	Correspond	Other	Citations (First and Correspond)	Total citations
1	Bonventre, JV	10	5	9	1	4263	4527
2	Devarajan, P	8	1	5	3	2464	3428
3	Chertow, GM	6	3	5	1	2353	2579
4	Mehta, RL	6	4	3	1	2757	4728
5	Parikh, CR	4	2	4		996	813
6	Marenzi, G	3	3	3		813	1095
7	Schrier, RW	3	2	3		1095	1634
8	Camussi, G	2		2		452	452
9	Dangas, G	2	1	2		934	934
10	Kellum, JA	2				1788	1788
11	McCullough, PA	2	2	2		1101	1101
12	Schiffl, H	2	2	2		677	677
13	Westenfelder, C	2		2		761	761
14	Parfrey, PS	2	1	2	1	892	892
15	Bates, DW	2	1	1	1	226	1119
16	Coca, S. G	2	2			486	486

Table 4. Institutions with two or more top cited articles on acute kidney injury

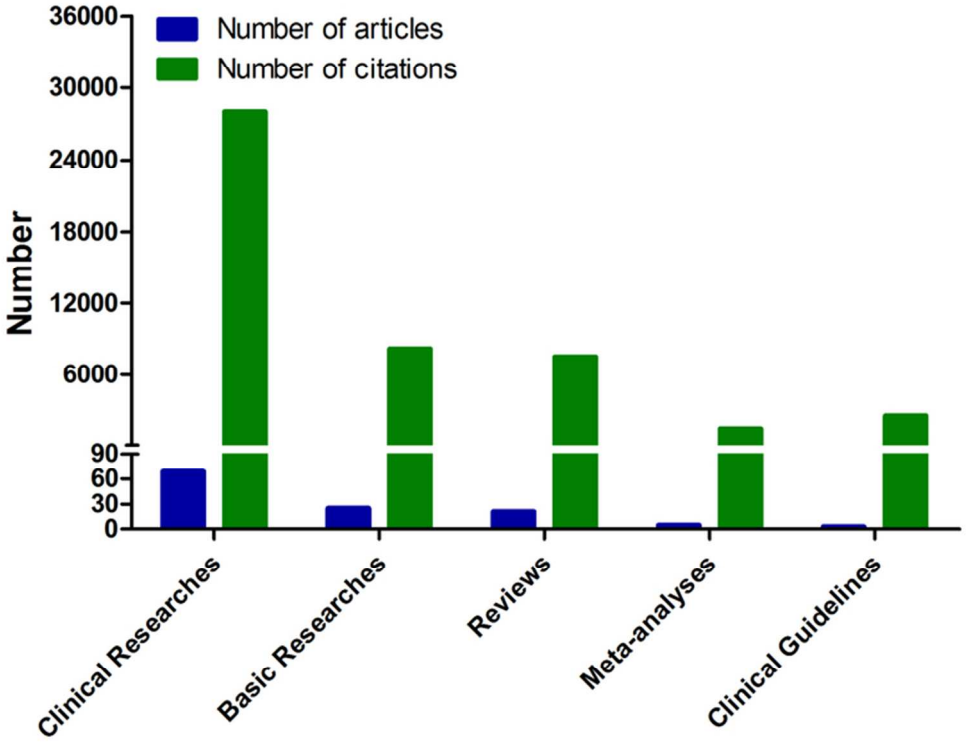
Rank	Institution	No. of Articles	Citations
1	Brigham and Women's Hospital, Boston, USA	9	4263
2	Cincinnati Children's Hospital Medical Center, Cincinnati, USA	5	2464
3	University of California, San Francisco, USA.	5	2353
4	Yale University, West Haven, USA	4	996
5	University of California, San Diego, USA	3	2757
6	The University of Milan, Milan, Italy	3	813
7	University of Colorado, Denver, USA	3	1095
8	University of Torino, Torino, Italy	2	452
9	Columbia University, New York, USA	2	934
10	William Beaumont Hospital, Royal Oak, USA	2	1101
11	University of Munich, Munich, Germany	2	677
12	Veterans Affairs medical center, Salt Lake City, USA	2	761
13	Memorial University of Newfoundland, City of Saint John, Canada	2	892



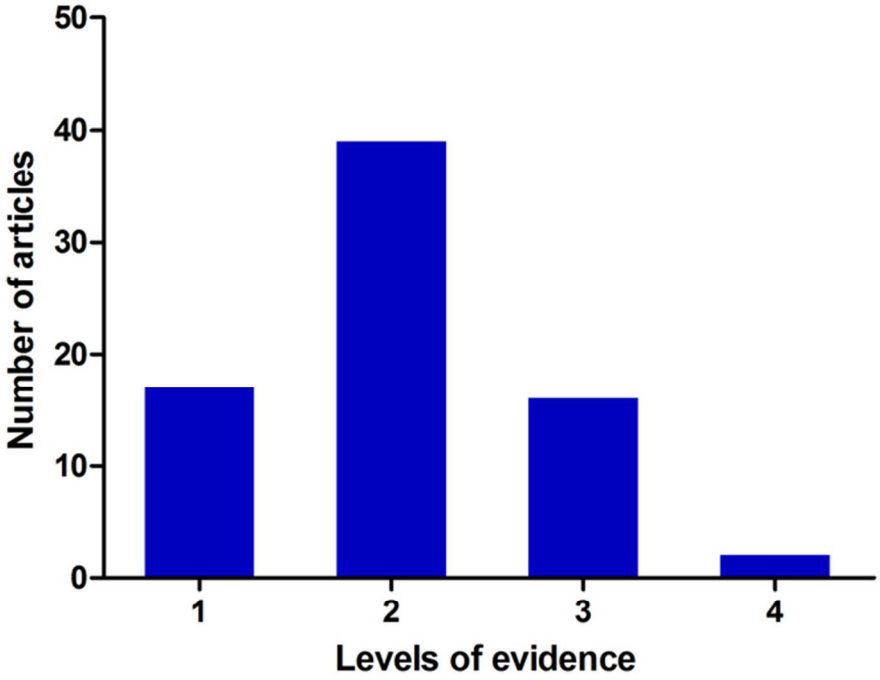
66x56mm (300 x 300 DPI)



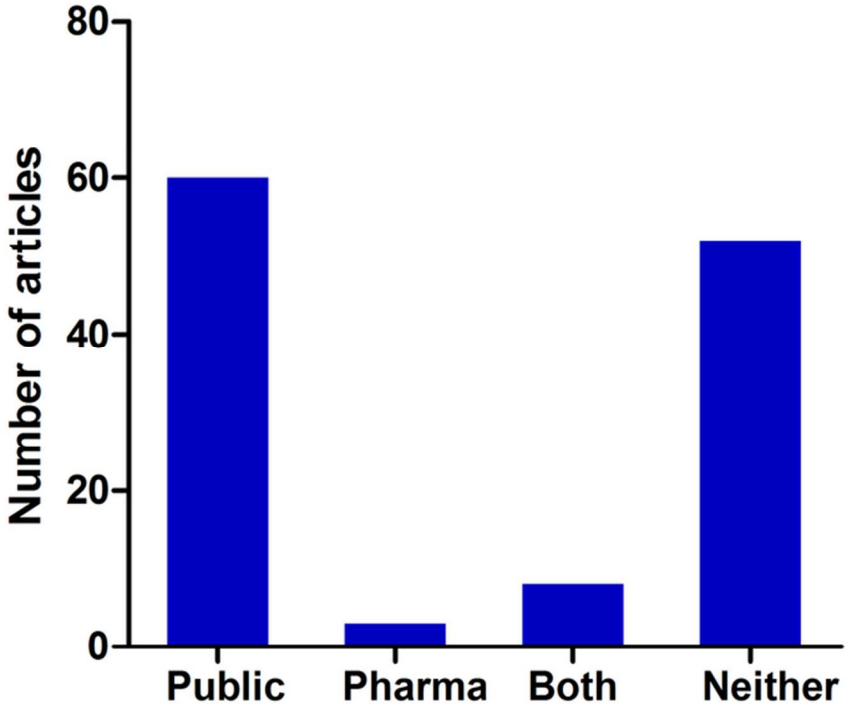
148x123mm (300 x 300 DPI)



68x54mm (300 x 300 DPI)



64x48mm (300 x 300 DPI)



68x54mm (300 x 300 DPI)

Table S1. Bibliometric information of the other T100 articles in acute kidney injury which were not shown in Table 1

Rank	Authors	Title	Journal	Year	Times Cited (Web)	Citation Index (Web)	Times Cited (Scoups)	Citation Index (Scoups)	PMID
21	Palevsky, PM et al	Intensity of renal support in critically ill patients with acute kidney injury	New England Journal of Medicine	2008	510	63.75	607	75.88	18492867
22	Oliver, J et al	The pathogenesis of acute renal failure associated with traumatic and toxic injury; renal ischemia, nephrotoxic damage and the ischemic episode	Journal of Clinical Investigation	1951	498	7.66	NA	NA	14897900
23	Hoste, EA et al	RIFLE criteria for acute kidney injury are associated with hospital mortality in critically ill patients: a cohort analysis	Critical Care	2006	491	49.10	652	65.2	16696865
24	Kelly, KJ et al	Intercellular adhesion molecule-1-deficient mice are protected against ischemic renal injury	Journal of Clinical Investigation	1996	471	23.55	501	25.05	8613529
25	Schrier, RW et al	Mechanisms of disease: Acute renal failure and sepsis	New England Journal of Medicine	2004	465	38.75	251	20.92	15247356

26	Liano, F et al	Epidemiology of acute renal failure: A prospective, multicenter, community-based study	Kidney International	1996	464	23.20	563	28.15	8872955
27	Lameire, N et al	Acute renal failure	Lancet	2005	439	39.91	569	51.73	15680458
28	Metnitz, PGH et al	Effect of acute renal failure requiring renal replacement therapy on outcome in critically ill patients	Critical Care Medicine	2002	438	31.29	534	38.14	12352040
29	Grossman, RA et al	Nontraumatic rhabdomyolysis and acute renal failure	New England Journal of Medicine	1974	433	10.31	215	5.12	4423658
30	Star, RA et al	Treatment of acute renal failure	Kidney International	1998	428	23.78	501	27.83	9853246
31	Schiffl, H et al	Daily hemodialysis and the outcome of acute renal failure	New England Journal of Medicine	2002	415	29.64	549	39.21	11821506
32	Hollenbe.NK et al	Acute oliguric renal failure in man: evidence for preferential renal cortical ischemia	Medicine	1968	409	8.52	105	2.19	5715692
33	Uchino, S et al	An assessment of the RIFLE criteria for acute renal failure in hospitalized patients	Critical Care Medicine	2006	407	40.70	475	47.5	16715038

34	Bonventre, JV et al	Recent advances in the pathophysiology of ischemic acute renal failure	Journalof the American Society of Nephrology	2003	401	30.85	448	34.46	12874476
35	Haase, M et al	Accuracy of Neutrophil Gelatinase-Associated Lipocalin (NGAL) in Diagnosis and Prognosis in Acute Kidney Injury: A Systematic Review and Meta-analysis	American Journal of Kidney Diseases	2009	394	56.29	479	68.43	19850388
36	Fouque, D et al	A proposed nomenclature and diagnostic criteria for protein-energy wasting in acute and chronic kidney disease	Kidney International	2008	392	49.00	454	56.75	18094682
37	Herget-Rosenthal, S et al	Early detection of acute renal failure by serum cystatin C	Kidney International	2004	384	32.00	488	40.67	15327406
38	Mueller, C et al	Prevention of contrast media-associated nephropathy - Randomized comparison of 2 hydration regimens in 1620 patients undergoing coronary angioplasty	Archives of Internal Medicine	2002	372	26.57	541	38.64	11822926
39	Morigi, M et al	Mesenchymal stem cells are renotropic,	Journal of the American	2004	369	30.75	433	36.08	15213267

		helping to repair the kidney and improve function in acute renal failure	Society of Nephrology						
40	Bonventre, JV et al	Mechanisms of ischemic acute renal failure	Kidney International	1993	366	15.91	359	15.61	8510397
41	Kelly, KJ et al	Antibody to intercellular adhesion molecule 1 protects the kidney against ischemic injury	Proceedings of the National Academy of Sciences of the United States of America	1994	354	16.09	345	15.68	7904759
42	Devarajan, P et al	Update on mechanisms of ischemic acute kidney injury	Journal of the American Society of Nephrology	2006	351	35.10	370	37	16707563
43	de Mendonca, A et al	Acute renal failure in the ICU: risk factors and outcome evaluated by the SOFA score	Intensive Care Medicine	2000	349	21.81	436	27.25	10990106
44	Abel, RM et al	Improved survival from acute renal failure after treatment with intravenous essential L-amino acids and glucose. Results of a prospective, double-blind study	New England Journal of Medicine	1973	345	8.02	133	3.09	4631743
45	Humes, HD et al	Epidermal growth factor enhances renal tubule cell regeneration and repair and accelerates the recovery of renal function	Journal of Clinical Investigation	1989	336	12.44	217	8.04	2592559

		in postischemic acute renal failure							
46	Bonventre, JV et al	Ischemic acute renal failure: An inflammatory disease?	Kidney International	2004	335	27.92	368	30.67	15253693
47	Schrier, RW et al	Acute renal failure: definitions, diagnosis, pathogenesis, and therapy	Journal of Clinical Investigation	2004	332	27.67	376	31.33	15232604
48	Kawaida, K et al	Hepatocyte growth factor prevents acute renal failure and accelerates renal regeneration in mice	Proceedings of the National Academy of Sciences of the United States of America	1994	329	14.95	309	14.05	8183913
49	Ricci, Z. et al	The RIFLE criteria and mortality in acute kidney injury: A systematic review	Kidney International	2008	325	40.63	374	46.75	18160961
50	Marenzi, G et al	N-acetylcysteine and contrast-induced nephropathy in primary angioplasty	New England Journal of Medicine	2006	323	32.30	402	40.2	16807414
51	Akcan-Arikan, A et al	Modified RIFLE criteria in critically ill children with acute kidney injury	Kidney International	2007	320	35.56	368	40.89	17396113
52	Ishani, Areef et al	Acute Kidney Injury Increases Risk of ESRD among Elderly	Journal of the American Society of Nephrology	2009	319	45.57	364	52	19020007
53	Mehta, RL et al	Spectrum of acute renal failure in the	Kidney International	2004	315	26.25	368	30.67	15458458

		intensive care unit: The PICARD experience							
54	Rosner, Mitchell H et al	Acute kidney injury associated with cardiac surgery	Clinical Journal of the American Society of Nephrology	2006	310	31.00	341	34.1	17699187
55	Mehta, RL et al	A randomized clinical trial of continuous versus intermittent dialysis for acute renal failure	Kidney International	2001	309	20.60	401	26.73	11532112
56	Hakim, RM et al	Effect of the dialysis membrane in the treatment of patients with acute renal failure	New England Journal of Medicine	1994	307	13.95	287	13.05	7935703
57	Conlon, PJ et al	Acute renal failure following cardiac surgery	Nephrology Dialysis Transplantation	1999	304	17.88	395	23.24	10344355
58a	Nickolas, Thomas L et al	Sensitivity and specificity of a single emergency department measurement of urinary neutrophil gelatinase-associated lipocalin for diagnosing acute kidney injury	Annals of Internal Medicine	2008	303	37.88	344	8.82	18519927

58b	Anderson, RJ et al	Nonoliguric acute renal failure	New England Journal of Medicine	1977	303	7.77	157	19.63	854045
59a	McCullough, Peter A et al	Contrast-induced acute kidney injury	Journal of the American College of Cardiology	2008	302	37.75	366	5.81	18402894
59b	Zager, RA et al	Rhabdomyolysis and myohemoglobinuric acute renal failure	Kidney International	1996	302	15.10	372	18.6	8821813
59c	Swann, RC et al	The clinical course of acute renal failure	Medicine	1953	302	4.79	2	0.25	13054209
60	Better, OS et al	Early management of shock and prophylaxis of acute renal failure in traumatic rhabdomyolysis	New England Journal of Medicine	1990	301	11.58	331	12.73	2407958
61	Miller, TR et al	Urinary diagnostic indices in acute renal failure: a prospective study	Annals of Internal Medicine	1978	298	7.84	163	4.29	666184
62	Xue, Jay L et al	Incidence and mortality of acute renal failure in Medicare beneficiaries, 1992 to 2001	Journal of the American Society of Nephrology	2006	296	29.60	326	32.6	16495381
63	Bennett, Michael et al	Urine NGAL predicts severity of acute kidney injury after cardiac surgery: A	Clinical Journal of the American Society of Nephrology	2008	294	36.75	344	43	18337554

		prospective study							
64	Ostermann, Marlies et al	Acute kidney injury in the intensive care unit according to RIFLE	Critical Care Medicine	2007	288	32.00	324	36	17581483
65	Noiri, E et al	In vivo targeting of inducible NO synthase with oligodeoxynucleotides protects rat kidney against ischemia	Journal of Clinical Investigation	1996	277	13.85	272	13.6	8636419
66	Oken, DE et al	Glycerol-induced hemoglobinuric acute renal failure in the rat. I. Micropuncture study of the development of oliguria	Journal of Clinical Investigation	1966	275	5.50	65	1.3	5935360
67	Barrett, BJ et al	Preventing nephropathy induced by contrast medium	New England Journal of Medicine	2006	274	27.40	347	34.7	16436769
68	Parikh, C. R. et al	Urinary IL-18 is an early predictive biomarker of acute kidney injury after cardiac surgery	Kidney International	2006	267	26.70	309	30.9	16710348
69	Payen, Didier et al	A positive fluid balance is associated with a worse outcome in patients with acute renal failure	Critical Care	2008	265	33.13	309	38.63	18533029

70a	Ichimura, T et al	Kidney injury molecule-1: a tissue and urinary biomarker for nephrotoxicant-induced renal injury	American Journal of Physiology-Renal Physiology	2004	264	22.00	330	27.5	14600030
70b	Bouman, CSC et al	Effects of early high-volume continuous venovenous hemofiltration on survival and recovery of renal function in intensive care patients with acute renal failure: A prospective, randomized trial	Critical Care Medicine	2002	264	18.86	303	21.64	12394945
71a	Wagener, Gebhard et al	Association between increases in urinary neutrophil gelatinase-associated lipocalin and acute renal dysfunction after adult cardiac surgery	Anesthesiology	2006	263	26.30	312	7.8	16931980
71b	Koffler, A et al	Acute renal failure due to nontraumatic rhabdomyolysis	Annals of Internal Medicine	1976	263	6.58	117	11.7	937919
72a	Chertow, GM et al	Prognostic stratification in critically ill patients with acute renal failure requiring dialysis	Archives of Internal Medicine	1995	262	12.48	282	12.82	7605152

72b	Schiffl, H et al	Biocompatible membranes in acute renal failure: prospective case-controlled study	Lancet	1994	262	11.91	242	11.52	7914959
73a	Birck, R et al	Acetylcysteine for prevention of contrast nephropathy: meta-analysis	Lancet	2003	260	20.00	388	10.49	12944058
73b	Byrd, L et al	Radiocontrast-induced acute renal failure: a clinical and pathophysiologic review	Medicine	1979	260	7.03	123	9.46	449662
74a	Marenzi, G et al	Contrast-induced nephropathy in patients undergoing primary angioplasty for acute myocardial infarction	Journal of the American College of Cardiology	2004	259	21.58	297	33	15519007
74b	Ali, Tariq et al	Incidence and outcomes in acute kidney injury: A comprehensive population-based study	Journal of the American Society of Nephrology	2007	259	28.78	297	24.75	17314324
75a	Sharples, EJ et al	Erythropoietin protects the kidney against the injury and dysfunction caused by ischemia-reperfusion	Journal of the American Society of Nephrology	2004	257	21.42	287	26.09	15284297
75b	Dangas, G et al	Contrast-induced nephropathy after percutaneous coronary interventions in	American Journal of Cardiology	2005	257	23.36	309	25.75	15619387

		relation to chronic kidney disease and hemodynamic variables							
76	Thakar, CV et al	A clinical score to predict acute renal failure after cardiac surgery	Journal of the American Society of Nephrology	2005	254	23.09	304	27.64	15563569
77a	Mehta, RL et al	Diuretics, mortality, and nonrecovery of renal function in acute renal failure	JAMA- Journal of the American Medical Association	2002	253	18.07	290	20.71	12444861
77b	Coca, S. G et al	Biomarkers for the diagnosis and risk stratification of acute kidney injury: A systematic review	Kidney International	2008	253	31.63	351	43.88	18094679
77c	Bonventre, JV et al	Dedifferentiation and proliferation of surviving epithelial cells in acute renal failure	Journal of the American Society of Nephrology	2003	253	19.46	300	23.08	12761240
78	Norman, DJ et al	Myolysis and acute renal failure in a heart-transplant recipient receiving lovastatin	New England Journal of Medicine	1988	252	9.00	162	5.79	3275891
79	Tomita, K et al	Plasma endothelin levels in patients with acute renal failure	New England Journal of Medicine	1989	250	9.26	140	5.19	2677723

80	Lin, FM et al	Hematopoietic stem cells contribute to the regeneration of renal tubules after renal ischemia-reperfusion injury in mice	Journal of the American Society of Nephrology	2003	247	19.00	304	23.38	12707389
81	Sutton, TA et al	Microvascular endothelial injury and dysfunction during ischemic acute renal failure	Kidney International	2002	244	17.43	271	19.36	12371954
82a	Arendshorst, WJ et al	Pathogenesis of acute renal failure following temporary renal ischemia in the rat	Circulation Research	1975	243	5.93	285	6.95	1192555
82b	Parikh, CR et al	Urine IL-18 is an early diagnostic marker for acute kidney injury and predicts mortality in the intensive care unit	Journal of the American Society of Nephrology	2005	243	22.09	83	7.55	16148039
83a	Kay, J et al	Acetylcysteine for prevention of acute deterioration of renal function following elective coronary angiography and intervention - A randomized controlled trial	JAMA- Journal of the American Medical Association	2003	239	18.38	327	25.15	12578487
83b	Shusterman, N et al	Risk factors and outcome of	American Journal of Medicine	1987	239	8.24	254	8.76	3605183

		hospital-acquired acute renal failure. Clinical epidemiologic study							
83c	Bonventre, Joseph V et al	Cellular pathophysiology of ischemic acute kidney injury	Journal of Clinical Investigation	2011	239	47.80	228	45.6	22045571
84a	Togel, Florian et al	Vasculotropic, paracrine actions of infused mesenchymal stem cells are important to the recovery from acute kidney injury	American Journal of Physiology-Renal Physiology	2007	237	26.33	284	18.93	17213465
84b	Burne, MJ et al	Identification of the CD4(+) T cell as a major pathogenic factor in ischemic acute renal failure	Journal of Clinical Investigation	2001	237	15.80	267	26.7	11696572
84c	Waikar, Sushrut S et al	Declining mortality in patients with acute renal failure, 1988 to 2002	Journal of the American Society of Nephrology	2006	237	23.70	254	28.22	16495376
85a	Melnikov, VY et al	Impaired IL-18 processing protects caspase-1-deficient mice from ischemic acute renal failure	Journal of Clinical Investigation	2001	236	15.73	253	9.37	11342578
85b	Cigarroa, RG et al	Dosing of contrast material to prevent contrast nephropathy in patients with renal	American Journal of Medicine	1989	236	8.74	282	18.8	2729314

		disease							
86	Vinsonneau,Christophe et al	Continuous venovenous haemodiafiltration versus intermittent haemodialysis for acute renal failure in patients with multiple-organ dysfunction syndrome: a multicentre randomised trial	Lancet	2006	235	23.50	312	31.2	16876666
87	Thurau, K et al	Acute renal success. The unexpected logic of oliguria in acute renal failure	American Journal of Medicine	1976	234	5.85	121	3.03	961698
88a	Firth, JD et al	Endothelin: an important factor in acute renal failure?	Lancet	1988	233	8.32	276	9.86	2903385
88b	Coca, Steven G et al	Long-term Risk of Mortality and Other Adverse Outcomes After Acute Kidney Injury: A Systematic Review and Meta-analysis	American Journal of Kidney Diseases	2009	233	33.29	110	15.71	19346042
89	Marenzi, G et al	The prevention of radiocontrast-agent-induced nephropathy by hemofiltration	New England Journal of Medicine	2003	231	17.77	355	27.31	14523141

90	Zanardo, G et al	Acute renal failure in the patient undergoing cardiac operation. Prevalence, mortality rate, and main risk factors	Journal of Thoracic and Cardiovascular Surgery	1994	229	10.41	275	12.5	8196394
91a	Herrera, MB et al	Mesenchymal stem cells contribute to the renal repair of acute tubular epithelial injury	International Journal of Molecular Medicine	2004	228	19.00	273	39	15547670
91b	Bouchard, Josee et al	Fluid accumulation, survival and recovery of kidney function in critically ill patients with acute kidney injury	Kidney International	2009	228	32.57	264	22	19436332
92a	Vaidya, VS et al	Urinary kidney injury molecule-1: a sensitive quantitative biomarker for early detection of kidney tubular injury	American Journal of Physiology-Renal Physiology	2006	227	22.70	294	7.74	16174863
92b	Rich, MW et al	Incidence, risk factors, and clinical course of acute renal insufficiency after cardiac catheterization in patients 70 years of age or older. A prospective study	Archives of Internal Medicine	1990	227	8.73	283	10.88	2353856
92c	Stein, JH et al	Current concepts on the pathophysiology	American Journal of Physiology	1978	227	5.97	64	6.4	343602

		of acute renal failure							
93a	Bates, DW et al	Mortality and costs of acute renal failure associated with amphotericin B therapy	Clinical Infectious Diseases	2001	226	15.07	285	8.64	11229835
93b	Richards, WO et al	Acute renal failure associated with increased intra-abdominal pressure	Annals of Surgery	1983	226	6.85	213	14.2	6600601
94a	Supavekin, S et al	Differential gene expression following early renal ischemia/reperfusion	Kidney International	2003	225	17.31	242	17.29	12675847
94b	Diaz-Sandoval, LJ et al	Acetylcysteine to prevent angiography-related renal tissue injury (the APART Trial)	American Journal of Cardiology	2002	225	16.07	296	22.77	11809444
95	Bruno, Stefania et al	Mesenchymal Stem Cell-Derived Microvesicles Protect Against Acute Tubular Injury	Journal of the American Society of Nephrology	2009	224	32.00	230	32.86	19389847
96	Liangos, Orfeas et al	Urinary N-acetyl-beta-(D) -glucosaminidase activity and kidney injury molecule-1 level are associated with adverse outcomes in acute renal failure	Journal of the American Society of Nephrology	2007	222	24.67	260	28.89	17267747

97	Kuitunen, A et al	Acute renal failure after cardiac surgery: Evaluation of the RIFLE classification	Annals of Thoracic Surgery	2006	221	22.10	255	25.5	16427848
98	Morcos, SK et al	Contrast-media-induced nephrotoxicity: a consensus report	European Radiology	1999	220	12.94	290	17.06	10525875
99	Ward, MM et al	Factors predictive of acute renal failure in rhabdomyolysis	Archives of Internal Medicine	1988	218	7.79	242	8.64	3382301
100	Heyman, SN et al	Acute renal failure with selective medullary injury in the rat	Journal of Clinical Investigation	1988	215	7.68	156	5.57	3403711

BMJ Open

The 100 Top-cited Articles Focusing on Acute Kidney Injury: a bibliometric analysis

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2016-011630.R1
Article Type:	Research
Date Submitted by the Author:	n/a
Complete List of Authors:	Liu, Yuan-hui; Department of Cardiology, Guangdong Cardiovascular Institute, Guangdong General Hospital, Guangdong Academy of Medical Sciences, Guangzhou 510100, China, Wang, Sheng-qi; Department of Pharmacy, Nanfang Hospital, Southern Medical University, Guangzhou, 510515, China, Xue, Jin-hua; Department of Physiology, School of Basic Medical Sciences, Gannan Medical University, Ganzhou, 341000, China, Liu, Yong; Department of Cardiology, Guangdong Cardiovascular Institute, Guangdong General Hospital, Guangdong Academy of Medical Sciences, Guangzhou 510100, China, Chen, Ji-yan; Department of Cardiology, Guangdong Cardiovascular Institute, Guangdong General Hospital, Guangdong Academy of Medical Sciences, Guangzhou 510100, China, Li, Guo-feng; Department of Pharmacy, Nanfang Hospital, Southern Medical University, Guangzhou, 510515, China, He, Peng-cheng; Department of Cardiology, Guangdong Cardiovascular Institute, Guangdong General Hospital, Guangdong Academy of Medical Sciences, Guangzhou 510100, China, Tan, Ning; Department of Cardiology, Guangdong Cardiovascular Institute, Guangdong General Hospital, Guangdong Academy of Medical Sciences, Guangzhou 510100, China,
Primary Subject Heading:	Renal medicine
Secondary Subject Heading:	Renal medicine
Keywords:	Bibliometric analysis, Acute kidney injury, Top 100 cited articles

The 100 Top-cited Articles Focusing on Acute Kidney Injury: a bibliometric analysis

Yuan-hui Liu MD[1#], Sheng-qi Wang MD[2#], Jin-hua Xue MD[3, 4#], Yong Liu MD[1], Ji-yan Chen MD, FACC,FESC[1], Guo-feng Li MD[2], Peng-cheng He MD[1*], Ning Tan MD, FACC,FESC,FAPSIC[1*]

[#]Equal contributors

[*]Corresponding author

[1]Department of Cardiology, Guangdong Cardiovascular Institute, Guangdong Provincial Key Laboratory of Coronary Heart Disease Prevention, Guangdong General Hospital, Guangdong Academy of Medical Sciences, Guangzhou 510100, Guangdong, China

[2]Department of Pharmacy, Nanfang Hospital, Southern Medical University, Guangzhou, 510515, China

[3]Department of Pathophysiology, School of Basic Medical Sciences, Southern Medical University, Guangzhou, 510515, China

[4]Department of Physiology, School of Basic Medical Sciences, Gannan Medical University, Ganzhou, 341000, China

Correspondence: Ning Tan MD, FACC, FESC, FAPSIC; Peng-cheng He MD. Department of Cardiology, Guangdong Cardiovascular Institute, Guangdong Provincial Key Laboratory of Coronary Heart Disease Prevention, Guangdong General Hospital, Guangdong Academy of Medical Sciences, Guangzhou 510100, Guangdong, China E-mail: gdtanning@126.com; Telephone: +86-20-83819161; Fax: +86-20-83824369;

Abstract

Background: Acute kidney injury (AKI) is a major global health issue, associated with poor short- and long-term outcomes. Research on AKI is increasing with numerous articles published. However, the quantity and quality of research production in the field of AKI is unclear.

Methods and analysis: To analyze the characteristics of the most cited articles on AKI and to provide information about achievements and developments in AKI, we searched the Science Citation Index Expanded for citations of AKI articles. For the top 100 most frequently cited articles (T100), we evaluated the number of citations, publication time, province of origin, journal, impact factor, topic or subspecialty of the research, and publication type.

Results: The T100 articles ranged from a maximum of 1971 citations to a minimum of 215 citations (median 302 citations). T100 articles were published from 1951 to 2011, with most articles published in the 2000s (n=77), especially the 5-year period from 2002 to 2006 (n=51). The publications appeared in 30 journals, predominantly in the general medical journals, led by New England Journal of Medicine (n=17), followed by expert medical journals, led by the Journal of the American Society of Nephrology (n=16) and Kidney International (n=16). The great majority (83.7%) of T100 articles were published by teams involving ≥3 authors. T100 articles originated from 15 countries, led by the USA (n = 81) followed by Italy (n = 9). Among the T100 articles, 69 were clinical research, 25 were basic science, 21 were reviews, 5 were meta-analyses and 3 were clinical guidelines. Most clinical articles (55%) included patients with any cause of AKI, followed by the specific causes of contrast-induced AKI (25%) and cardiac surgery-induced AKI (15%).

Conclusions: This study provides a historical perspective on the scientific progress on AKI, and highlights areas of research requiring further investigations and developments.

Key words: Citation analysis; Acute kidney injury; Top 100 cited articles.

Strengths and limitations of this study

Two meticulous searches were performed in the Web of Science and consistent results were demonstrated in Scopus data.

Since some articles were cited more frequently than others because of the differences in time since publication, and this error was adjusted by a citation index determined for each article.

The language of publication was restricted to English, which would have failed to capture landmark articles published in other languages.

Findings of the present study would provide a historical perspective on the scientific progress on acute kidney injury.

Findings of the present study would highlights areas of research requiring further investigations and developments.

Introduction

Acute kidney injury (AKI) is a major global health issue and its incidence is markedly increasing in both developed and developing nations.[1] The reported incidence ranges from 5% to 30-50% in patients under various conditions, such as coronary intervention,[2] cardiac surgery,[3] and intensive care unit admission.[4] The development of AKI not only increases hospital stay and health care costs, but also results in poor short- and long-term outcomes.[4] Considering the importance of AKI, researches in this field has been increasing, and numerous articles have been published annually, giving new insights into the mechanism, early recognition, prevention or treatment of AKI.[5 6] However, little is known regarding the quality of scientific achievements in this area.

Citation analysis is a bibliometric process that determines the influence of an article in the scientific community and evaluates the impact factor (IF) of a journal.[7] The number of citations received by an article is a measure of its recognition and influence within the scientific community. A paper with greater citation history may be more valuable in its field.[8 9] Furthermore, citation analysis of the scientific literature may help to identify articles, research topics, and authors of influence.[10] Therefore, academic institutions, funding agencies, and the public become increasingly interested in using citation analysis to assess the research quality and productivity of individual researchers.[11] Numerous attempts have been made to identify the most cited articles in various medical disciplines, including psychology,[12] radiology,[13] hypospadiology,[14] hypertension,[15] surgery[16] and cardiac surgery.[17] However, no citation analysis of AKI has been published to date. Therefore, we aimed to analyze the characteristics of the 100 top-cited articles focused on AKI, and to determine achievements and advances in this field during the past century.

Methods

Search strategy

We conducted a citation search of the Science Citation Index Expanded database of the Thomson Reuters Web of Science Core Collection (Philadelphia, PA, USA) from 1945 to 15 July 2015. The following search key words were used: “acute kidney injury” or “AKI” or “acute renal failure” or “ARF”. All electronic searches were conducted on one day, 15 July 2015, to avoid changes in citation rate as much as possible. After all identified articles were retrieved, and the results were sorted using the option “Times cited”, which yielded a list of all the articles published in a specific journal ranked by citation number. The papers that had a higher citation density were ranked higher.

Study selection

Articles on the list were then reviewed by two independent reviewers (Y.H.L and S.Q.W) by reading the abstracts acquired from Web of Science. When it is necessary, the full-texts were acquired from PubMed, Embase or ScienceDirect. Only studies focusing on AKI as the main topic and in the English language were included. The exclusion criteria were: (1) articles in languages other than English, (2) articles focused on other topics other than about AKI. Any disagreement between the two reviewers was resolved through discussion with a third reviewer (J.H.X).

Assessing the articles and Journals

Using the modified approach of the methods by Lim and Azer et al,[18 19] two reviewers (Y.H.L and S.Q.W) reviewed the top 100 cited (T100) articles and the following data were compiled: (1) citation number, (2) number of authors and authorship (first, second and corresponding authors), (3) title, (4) publication year, (5) country of origin. If there were authors from multiple countries, country of origin was determined using the country that the corresponding author belonged to. Those from the same country were classified into those from one institute and those from more than one institute. Articles that received funding source were identified. Level of evidence for clinical studies was also identified, and was evaluated based on the levels of evidence introductory document from the Oxford Centre for Evidence-based Medicine.[20] In addition, journal name and IF were also extracted. The journals IFs were cross-referenced with the 2014 edition of Journal Citation Reports (JCR): Science Edition (1945-2014).

Evaluating the included studies

Based on included study design, research setting and goals, the selected articles were grouped into 5 categories: clinical guidelines, review, meta-analysis, basic research, and clinical research (including observational and randomized control trials, RCTs). Prospective, retrospective, and case series were all categorized as observational studies. RCTs include both single- and double-blind studies.

In addition, according to the causes of AKI, the topics were divided into (1) any cause, (2) contrast, (3) cardiac surgery, and (4) others. Since some articles were cited more frequently than others because of the difference in time since publication, this error was adjusted by a citation index determined for each article. The citation index was defined as the mean number of citations per year. For comparison, we searched Scopus (http://www.scopus.com/ search/form.url; retrieved on July 15th, 2015) for total citation counts of the T100 articles.

Statistical analysis

Data are represented as median or interquartile range. The differences between groups were evaluated by the Wilcoxon rank sum test. The Spearman test was used to evaluate the strength and direction of the linear relationship between journal IF and the number of T100 cited articles or citations, and the correlation of article citations between different databases (Web of Science Core Collection and Scopus). All data analyses were performed with SPSS 17 software (SPSS Inc., Chicago, IL, USA). All probability values were two-tailed, and the threshold for significance was set at $P < 0.05$.

Results

Citation count and publication year

A total of 56,830 papers were identified after the initial search in the period from 1945 to present. Among them, articles that focused solely on AKI and were among the top 100 most cited were included. Flow diagram representing the study selection process was presented in Supplementary Figure 1. Ultimately, 123 articles (including some duplicate citations) were included in the analysis **(Table1 and Supplementary Table 1)**. The median number of citations was 302 (range 215 to 1,971), with only three papers cited over 1000 times. The citation index (median 216, range 5 to 184) was correlated with number of the citations ($r=0.581$, $P<0.001$) per article. In addition, the number of citation and citations index per article were positively correlated between the Web of Science and Scopus database ($r=0.770$, $P < 0.001$; $r=0.791$, $P < 0.001$, respectively).

The selected T100 articles were published from 1951 to 2011, with most articles published in the 2000s (n=77), and particularly the 5-year period from 2002 to 2006 (n=51), followed by the 1990s (n=22) **(Figure 1)**. The single years with the most cited articles were 2004 and 2006 (each n=13). The number of citations was also the highest in the 2000s (30, 537) followed by the 1990s (9510). Spearman test indicated an uptrend between the citation index and time ($r=0.315$, $P < 0.001$). There is no correlation between time and number of citations($r=-0.003$, $P=0.975$), but a positive correlation between time and citation index($r=0.347$, $P < 0.001$).

Publishing journals of T100 articles

The T100 articles were published in 30 journals **(Table 2)**, predominantly in general medical journals, led by the New England Journal of Medicine (n=17), followed by expert medical journals, led by the Journal of the American Society of Nephrology (n=16) and Kidney International (n=16) (Table 2). In addition, Journal of Clinical Investigation, Lancet, Journal of the American Medical Association, American Journal of Medicine, and Critical Care Medicine contributed 11, 7, 5, 5, and 5

top cited articles, respectively. The journal' IFs of T100 articles ranged from 2.1 to 55.9. Many of the T100 articles were published in high-IF journals, while the journal IF was significantly correlated with the number of T100 articles (r=0.439, p=0.017), and the number of citations (r=0.476, p=0.009).

Authorship, Origins, and Institutions

The great majority (83.7%) of T100 articles were produced by teams involving ≥3 authors. A list of the most frequently-appearing authors is presented in **Table 3.** It is clearly dominated by JV Bonventre, who authored 10 T100 articles (first author: 5; corresponding author: 9) with a total of 4,527 citations, and P Devarajan, who authored 8 T100 articles with 3428 citations.

The T100 articles originated from 15 countries, led by the USA (n = 81) followed by Italy (n = 9), Germany (n=7), France (n=5), and the United Kingdom (n=5), with all other counties having less than five publications, as shown in **Figure 2**. Articles originating from the USA also had the highest mean number of citations (mean 384 citations per article). Of the T100 articles, the leading institutions with the most productive articles were Brigham and Women's Hospital (Boston, USA), Cincinnati Children's Hospital Medical Center (Cincinnati, USA) and the University of California, San Francisco (San Francisco, USA), with five articles each. The two institutions ranking next is the Yale University (West Haven, USA) **(Table 4)**.

Publication type and areas of study

The T100 articles included 69 clinical studies, 25 basic science studies, 21 reviews, 5 meta analyses and 3 clinical guidelines **(Figure 3)**. The number of total citations per article ranged from 218 to 1652 (median, 303) for clinical studies, and from 215 to 814 (median, 257) for basic science. Of the 69 clinical articles, the most common type was prospective observational studies (n=35), followed by RCTs (n=16), retrospective studies (n=16), and case reports (n=2). In addition, 75% of 16 RCTs were published in the journals with high IF, 8 in New England Journal of Medicine, 2 in Lancet and 2 in JAMA. Only 18% of 51 observational studies were published in the journals with high IF, and most of them (47%) presented open access options, and all of them came from prospective observational studies, including 4 in New England Journal of Medicine, 2 in Lancet and 3 in JAMA. Furthermore, prospective observational studies had the higher median citation of per article than the retrospective studies (median: 298 vs. 292)

The primary purpose of these clinical studies included evaluation of a therapy strategy (n=16), description of biomarkers or risk model to prevent AKI (n=9, and n=3, respectively), description of

epidemiology (n=27), evaluation of a diagnostic modality (n=5), and others (n=9). With regard to the causes of AKI in clinical researches, most articles (55%) included patients with any cause of AKI, followed by specific contrast induced AKI (25%) and cardiac surgery induced AKI (15%). Only 1 study reported on drug induced AKI, and the rest were nontraumatic rhabdomyolysis induced AKI (n=3). In addition, ischemic induced AKI was the most common type of AKI (64%) assessed in basic science studies, followed by drug induced AKI models (32%) and only 1 basic research study concerned surgery induced AKI.

Funding source and level of evidence

Among T100 articles (original articles), 60 were funded by public foundations, 3 received support from commercial companies, 8 were supported by both, and the remaining 52 did not specify the funding source (**Figure 4)**. More than half of studies that disclosed funding (95.8%) were supported by the public, and pharmaceutical companies only supported 15.5%. Funding supported most of the basic science T100 studies (96%, 24/25), but only 43.5% of clinical articles.

All of the clinical articles were assigned a level of evidence from 1 to 5 (**Figure 5**). Level 2b (47.3%) was the most frequent level of evidence, with a median of 298 citations per article. There were 16 studies each at level 1b and 3b. Only 1 and 4 T100 cited articles were assigned to level 1a and 2a, respectively. There was no significant association between citation index and level of evidence (P = 0.847). In addition, the evidence level was not strongly correlated with overall number of citations (r=-0.11, p=0.345), citation index (r=-0.08, p=0.500), or year of publication (r=-0.16, p=0.174).

Discussion

The present study is the first to identify, rank and characterize the T100 articles in the field of AKI. The results reveal important advances and prevalent areas of interest in research about AKI, and may help physicians and scientists understand and design future research. The present study also provides quantitative information about authors, institutions, and journals that helps to identify classic works and high-impact journals.

Bibliometric analysis is a tool that quantifies the characteristics and scholarly impact of citation classics. Citation analysis, one common bibliometric method, can help authors to recognize important advances, and add a useful perspective on historical developments in a specific field. Understanding the characteristics inherent to highly cited works could help researchers who wish to publish effectively.[21] However, we also should notice that the citations number might be poorly

related to merit, it is strongly affected by the journal in which the paper is published.[8 22] In addition, the number of citations would be influenced by factors such as the geographic origin of the authors, whether they are English speaking,[23] and the gender of the authors.[24] Despite some disadvantages in the assessment of article quality based simply on citation rating, it remains the most widely-accepted method currently available to judge the merits of a paper or journal.[25] Citation analysis is often used by journals to attract manuscripts with high citation potential. Currently, citation analysis of top cited articles is widespread and reported in various medical disciplines. However, there has been no citation analysis of AKI, which is a major global health issue associated with increased medical cost, and poor short- and long- term outcomes. In addition, the prevention, diagnosis, and treatment of AKI have become a rapidly developing specialty in recent years. This development is evidenced by the increasing number of related studies in the scientific literature. Identifying the classic articles that have contributed to progress in AKI research will help to understand the history and development of AKI and design future studies. However, little work has been conducted to recognize these important papers. The present study is the first to analyze the top article citations in AKI, and will help readers or authors to recognize the quality of the research, discoveries, and the trends steering AKI.

An article has more time to be cited with increasing age, and "older" articles are more likely to attain more citations, purely because of their longer citable period. However, in this analysis, most of the T100 articles (67%) were published between 2001 and 2009. This result is not consistent with most other citation analyses, in which the peak period for citation is from 1980 to 1995. However, it is consistent with recent research in the field of cardiovascular diseases.[26] In addition, to overcome the effect of publication time on citations, we also assessed the citation index as a measure of the true impact of an article independent of short-lived trends. The results remained consistent indicating that the number of AKI articles increased, and this field attracted more resources and materials in the past 10 years, with the growing incidence of AKI, because of increasing exposure to contrast media or cardiothoracic surgery.

Some previous studies have demonstrated that high IF journals are attractive to authors, which in turn preferentially attract more submissions from the authors. Therefore, the IF of a journal is the strongest indicator for citations, and most top cited articles are published in high IF journals.[27-29] The present study also demonstrated that IF was positively correlated with the number of T100 articles, and the number of citations. However, other than the high-IF general medical journal the-New

England Journal of Medicine, which published 17 T100 articles, the most productive journals were the Journal of the American Society of Nephrology and Kidney International, which have relatively low IFs. This result indicates an increasing trend of publishing highly influential articles in specialty journals dedicated solely to research into renal diseases such as AKI rather than general medical journals (e.g. Lancet or JAMA). These results are consistent agree with previous studies focusing on other diseases[15 26]. Our results also revealed that no T100 basic research study focusing on AKI was published in Nature, Cell, or Science, the highest influent journals on basic research. This result is in contrast to hypertension studies, among which highly cited basic research was published more frequently in Nature (6 articles) and Cell (4 articles).[15]

Fifteen countries contributed to the T100 cited articles, led by the USA, which is similar to the T100 articles in the fields of cardiac surgery,[17] sepsis,[30] and others.[26 31 32] This finding confirms the influence of the USA in relation to AKI research worldwide and may be related to the large population and abundant financial resources available to the scientific community in the USA. In addition, among the top 13 institutions, 9 (69%) are in USA. The leading institution is Brigham and Women's Hospital, which published 9 T100 cited articles with total citations number of 4263. Furthermore, American authors tend to cite local papers and European authors tend to publish in American journals and USA reviewers prefer USA papers.[29 33] In addition, European countries, like Italy and the UK, also demonstrated higher productivity. However, despite the rapid development of scientific research in recent years, Asian authors have not played a dominant role in AKI research since their contribution to research productivity is relatively low. This finding seems to conform to the phenomenon that "a country with better economic ranking has the higher quantity and quality of biomedical publications".[34] A number of first or corresponding authors were represented more than once on the list. This list of frequently-cited authors highlights some of the world's best-recognized experts in the field of AKI research. The most frequently-cited authors JV Bonventre and P Devarajan, with 5 and 6 articles, respectively, were associated with clinical articles.

Financial support from public foundations or commercial companies has greatly contributed to medical and public health research. In our study, more than half (57.7%) of T100 articles reported a source of funding support. Among them, 84.5% received funding from public institutions or national foundations, 4.2% from industry and 11.3% from both. Although, industry-funded research has been widely debated because of susceptibility to various biases, it has played and will continue to play a critical role in the research process.[35] In another recent study, 24% of funding was from

industry, which is higher than in the present study. However, 30% of reported funding was from public agencies, which is lower than ours.[30] This comparison indicates that government-funded entities have prioritized AKI, a global health issue impacting medical costs. The cost per 6-month AKI survivor was calculated to be $80 000.[36] Another reason for this discrepancy might be the lack of new drug development research in the present T100 articles, resulting in little funding from pharmaceutical companies. In addition, only 44% of clinical research received funding, while 96% of basic research received funding. These results confirm the key role of public funding in the generation of influential basic research. However, clinical research has bridged the gap between basic science and human health improvement, is heavily weighted towards biomedical science, and plays a special role in the fight against AKI by providing evidence for its treatment and diagnosis. High-quality clinical research is expensive, and in the future, it should receive more funding support.

Based on the advantages of clinical research mentioned above, more clinical studies have been performed to provide new insights into the prevention, biomarkers, diagnosis or treatment of AKI. In addition, a recent detailed bibliometric analysis suggests the rapid dissemination of clinical findings.[37] Thus, it is not surprising that most of the T100 articles (58%) in the present study are clinical research, consistent with analyses in other fields.[38-40] The mean citation number per clinical research article was higher than that of basic research articles (404 vs. 328). Among clinical studies, the most frequent type was prospective observational study (n=35), followed by RCT (n=16). Our limited survey, based on the analysis to identify the citation source for the top 3 T100 clinical studies, revealed that most of their citations (2/3) came from other original articles (both clinical and pre-clinical studies), with the rest of citations (1/3) in subsequent reviews, editorials, or meta-analyses. This distribution suggests that the conclusions of these highly cited clinical studies have stimulated much subsequent original research. Guidelines, reviews and meta-analyses (with 852, 362, and 267 mean citations per article, respectively) accounted for a high proportion (22%) of the list, which is a common finding in top citation assessments for any medical specialty. Authors frequently cite such publications as they convey outcome generalities of many single site studies. It is well recognized that levels of evidence will vary depending on the study designs. The goal of rating study designs and levels of evidence is to indicate the best available evidence for use in patient care. Among various study designs, RCTs provide the highest quality evidence for most

clinical or interventional trials. The T100 articles included 16 RCTs, a lower proportion than other top medical articles, such as hypertension (24 RCTs).

A large majority of clinical research studies in the T100 cited articles included patients with AKI from any cause admitted to an intensive care unit. Among the research on specific causes of AKI, contrast-induced AKI in patients after cardiac catherization was the most common. It is not surprising that researchers have been increasingly interested in the field of biomarkers,[41] or therapy for contrast induced AKI,[42] with a large number of papers published, in parallel with the increasing use of cardiac catherization. Additionally, previous studies demonstrated that contrast-induced AKI is a common complication after procedures requiring contrast media, responsible for 11% of in-hospital AKI cases, and also associated with poor short- and long-term outcomes.[2 43] In our T100 RCT studies, 50% focused on the therapy of contrast-induced AKI. However, more high-quality RCTs for other causes of AKI, such as cardiac surgery, are needed in the future.

This study also has some limitations. First, despite a meticulous search of Web of Science and consistent results also demonstrated in Scopus data, some studies might have been missed. Second, this type of study usually favors older published articles, but excludes some recently published high quality studies, a limitation related to the effect of time on citations. Third, using the number of citations alone can not quantify the value of contributions to the field. Therefore, papers that are important and influential, but have a lower citation frequency, might be missed. Fourth, the minimal effect of self-citation was also not considered in our study. Finally, the language of publication was restricted to English, which would have failed to capture landmark articles published in other languages.

Conclusions

Our analysis summarized of the most influential studies on AKI, and highlights research areas that require further investigation and development. Our analysis also provides an insight into the citation frequencies of the top cited articles on AKI and sheds light on the quality of the works, discoveries, and trends steering AKI research globally.

Contributors

Conception/Design: NT, YHL, PCH.

Collection and/or assembly of data: YHL, SQW, JHX, YL, JYC, PCH.

Data analysis and interpretation: YHL, SQW, JHX, YL, JYC.

Manuscript writing: YHL.

Manuscript revising: NT, YHL, SQW, GFL.

Final approval of the version to be published: All authors.

Funding

This study was supported by a grant from the National Natural Science Foundation of China (Grant no. 81270286). The funders had no role in the study design, data collection and analysis, decision to publish, or preparation of the manuscript. This work was not funded by any industry sponsors.

Competing interests

The authors declare that they have no competing interests.

Ethical approval

Not required.

Data sharing

No additional data available.

References

1. Ad-hoc working group of E, Fliser D, Laville M, *et al*. A European Renal Best Practice (ERBP) position statement on the Kidney Disease Improving Global Outcomes (KDIGO) clinical practice guidelines on acute kidney injury: part 1: definitions, conservative management and contrast-induced nephropathy. *Nephrol Dial Transplant* 2012;27: 4263-72.
2. Giacoppo D, Madhavan MV, Baber U, *et al*. Impact of Contrast-Induced Acute Kidney Injury After Percutaneous Coronary Intervention on Short- and Long-Term Outcomes: Pooled Analysis From the HORIZONS-AMI and ACUITY Trials. *Circ Cardiovasc Interv* 2015; 8:e002475.
3. Huber M, Ozrazgat-Baslanti T, Thottakkara P, *et al*. Mortality and Cost of Acute and Chronic Kidney Disease after Vascular Surgery. *Ann Vasc Surg* 2016;30:72-81.
4. Hoste EA, Bagshaw SM, Bellomo R, *et al*. Epidemiology of acute kidney injury in critically ill patients: the multinational AKI-EPI study. *Intensive Care Med* 2015;41:1411-23.
5. Yang Y, Song M, Liu Y, *et al*. Renoprotective approaches and strategies in acute kidney injury. *Pharmacol Ther* 2016. . doi: 10.1016/j.pharmthera.2016.03.015. [Epub ahead of print]
6. Dellepiane S, Marengo M, Cantaluppi V. Detrimental cross-talk between sepsis and acute kidney injury: new pathogenic mechanisms, early biomarkers and targeted therapies. *Crit Care* 2016;20:61.
7. Moed HF. New developments in the use of citation analysis in research evaluation. *Arch Immunol Ther Exp* 2009;57:13-8.
8. Eyre-Walker A, Stoletzki N. The assessment of science: the relative merits of post-publication review, the impact factor, and the number of citations. *PLoS Biol* 2013; 11:e1001675.
9. Moed HF. The impact-factors debate: the ISI's uses and limits. *Nature* 2002;415:731-2.
10. Smith DR, Rivett DA. Bibliometrics, impact factors and manual therapy: balancing the science and the art. *Man Ther* 2009;14:456-9.
11. Moed HF. New developments in the use of citation analysis in research evaluation. Arch Immunol Ther Exp (Warsz).2009;57:13-18.
12. Ho YS, Hartley J. Classic articles in Psychology in the Science Citation Index Expanded: A bibliometric analysis. *Br J Psychol* 2015. doi: 10.1111/bjop.12163.[Epub ahead of print]
13. Pagni M, Khan NR, Cohen HL, *et al*. Highly cited works in radiology: the top 100 cited articles in radiologic journals. *Acad Radiol* 2014;21:1056-66.
14. O'Kelly F, Nason GJ, McLoughlin LC, *et al*. A comparative bibliometric analysis of the top 150 cited papers in hypospadiology (1945-2013). *J Pediatr Urol* 2015;11:85 e1-85.
15. Oh YS, Galis ZS. Anatomy of success: the top 100 cited scientific reports focused on hypertension research. Hypertension 2014;63:641-7.
16. Long X, Huang JZ, Ho YS. A historical review of classic articles in surgery field. *Am J Surg* 2014;208:841-9.
17. O'Sullivan KE, Kelly JC, Hurley JP. The 100 most cited publications in cardiac surgery: a bibliometric analysis. *Ir J Med Sci* 2015;184:91-9.
18. Lim KJ, Yoon DY, Yun EJ, *et al*. Characteristics and trends of radiology research: a survey of original articles published in AJR and Radiology between 2001 and 2010. Radiology 2012;264:796-802.
19. Azer SA, Azer S. Bibliometric analysis of the top-cited gastroenterology and hepatology

articles. BMJ Open 2016;6:e009889.
20. Phillips B, Ball C, Sackett D, *et al*. Levels of evidence. Available from URL: http://www.cebm.net/index.aspx?o=1025 Accessed on 1 October 2013.
21. Allen L, Jones C, Dolby K, *et al*. Looking for landmarks: the role of expert review and bibliometric analysis in evaluating scientific publication outputs. *PLoS One* 2009;4: e5910.
22. Lariviere V, Gingras Y. The Impact Factor's Matthew Effect: A Natural Experiment in Bibliometrics. *J Am Soc Inf Sci Tec* 2010;61:424-27.
23. Paris G, De Leo G, Menozzi P, *et al*. Region-based citation bias in science. *Nature* 1998; 396:210.
24. Stephane B. Normative versus social constructivist processes in the allocation of citations: anetwork-analytic model. *Am Sociol Rev* 1998;63:829-46.
25. Adam D. The counting house. *Nature* 2002;415:726-9.
26. Shuaib W, Khan MS, Shahid H, *et al*. Bibliometric analysis of the top 100 cited cardiovascular articles. *Am J Cardiol* 2015;115:972-81.
27. Garfield E. The history and meaning of the journal impact factor. *JAMA* 2006;295:90-3.
28. Fendrich V, Rothmund M. Surgical research in Germany--an international comparison. *Chirurg* 2010;81:328-33.
29. Campbell FM. National bias: a comparison of citation practices by health professionals. *Bull Med Libr Assoc* 1990;78:376-82.
30. Tao T, Zhao X, Lou J, *et al*. The top cited clinical research articles on sepsis: a bibliometric analysis. *Crit Care* 2012;16:R110.
31. Nason GJ, Tareen F, Mortell A. The top 100 cited articles in urology: An update. *Can Urol Assoc J* 2013;7:e16-24.
32. Gu W, Yuan Y, Yang H, *et al*. A bibliometric analysis of the 100 most influential papers on COPD. *Int J Chron Obstruct Pulmon Dis* 2015;10:667-76.
33. Link AM. US and non-US submissions: an analysis of reviewer bias. *JAMA* 1998;280:246-7.
34. Nielsen FE. [Publication outcome of research funding by the Danish Heart Foundation 1988-1990]. *Ugeskr Laeger* 1998;160:4644-8.
35. Rowe S, Alexander N, Clydesdale FM, *et al*. Funding food science and nutrition research: financial conflicts and scientific integrity. *Am J Clin Nutr* 2009;89:1285-91.
36. Korkeila M, Ruokonen E, Takala J. Costs of care, long-term prognosis and quality of life in patients requiring renal replacement therapy during intensive care. *Intensive Care Med* 2000;26:1824-31.
37. Rosas SR, Schouten JT, Cope MT, *et al*. Modeling the dissemination and uptake of clinical trials results. *Res Eval* 2013;22:179-86.
38. Piolanti N, Nesti A, Andreani L, *et al*. The fifty most cited Italian articles in the orthopaedic literature. *Musculoskelet Surg* 2015;99:105-11.
39. Aminian A, Daigle CR, Brethauer SA, *et al*. Citation classics: top 50 cited articles in bariatric and metabolic surgery. *Surg Obes Relat Dis* 2014;10:898-905.
40. Cao F, Li J, Li A, *et al*. Citation classics in acute pancreatitis. *Pancreatology* 2012;12:325-30.
41. Liu YH, Liu Y, Chen JY, *et al*. LDL cholesterol as a novel risk factor for contrast-induced acute kidney injury in patients undergoing percutaneous coronary intervention. *Atherosclerosis* 2014;237:453-9.
42. Bei WJ, Duan CY, Chen JY, *et al*. Remote Ischemic Conditioning for Preventing Contrast-Induced Acute Kidney Injury in Patients Undergoing Percutaneous Coronary

Interventions/Coronary Angiography: A Meta-Analysis of Randomized Controlled Trials. *J Cardiovasc Pharmacol Ther* 2016;21:53-63.

43. Nash K, Hafeez A, Hou S. Hospital-acquired renal insufficiency. *Am J Kidney Dis* 2002; 39:930-6.

Table and Figure legends

Table 1. Bibliometric information associated with the Top 20 of the Top 100 cited articles on acute kidney injury.

Table 2. Journals in which the T100 articles were published.

Table 3. Authors with two or more top-cited articles.

Table 4. Institutions with two or more top cited articles on acute kidney injury.

Figure 1. Numbers of articles published and number of citations in 5 years periods.

Figure 2. Countries of origin of the top100 cited articles on acute kidney injury.

Figure 3. Distributions of research type of the top 100 cited articles on acute kidney injury.

Figure 4. Funding source of the top 100 cited research studies.

Figure 5. Levels of evidence of the top 100 cited clinical articles.

Supplementary Figure 1: Flow diagram representing the study selection process

Table 1. Bibliometric information associated with the Top 20 of the Top 100 cited articles in acute kidney injury.

Rank	Authors	Title	Journals	Years	Times Cited (Web)	Citation Index (Web)	Times Cited (Scopus)	Citation Index (Scopus)	PMID
1	Bellomo, R et al	Acute renal failure-definition, outcome measures, animal models, fluid therapy and information technology needs: the Second International Consensus Conference of the Acute Dialysis Quality Initiative (ADQI) Group	Critical Care	2004	1971	164.25	2219	184.92	15312219
2	Mehta, RL et al	Acute Kidney Injury Network: report of an initiative to improve outcomes in acute kidney injury	Critical Care	2007	1652	183.56	1725	191.67	17331245
3	Uchino, S et al	Acute renal failure in critically ill patients-A multinational, multicenter study	JAMA-Journal of the American Medical Association	2005	1297	117.91	1489	135.36	16106006
4	Thadhani, R et al	Medical progress - Acute renal failure	New England Journal of Medicine	1996	963	48.15	1139	56.95	8618585
5	Mishra, J et al	Neutrophil gelatinase-associated lipocalin (NGAL) as a biomarker for acute renal injury	Lancet	2005	949	86.27	1079	98.09	15811456

		after cardiac surgery							
6	Chertow, GM et al	Acute kidney injury, mortality, length of stay, and costs in hospitalized patients	Journal of the American Society of Nephrology	2005	893	81.18	1035	94.09	16177006
7	Ronco, C et al	Effects of different doses in continuous veno-venous haemofiltration on outcomes of acute renal failure: a prospective randomised trial	Lancet	2000	816	51.00	1032	64.5	10892761
8	Paller, MS et al	Oxygen free radicals in ischemic acute renal failure in the rat	Journal of Clinical Investigation	1984	814	25.44	575	17.97	6434591
9	McCullough, PA et al	Acute renal failure after coronary intervention: Incidence, risk factors, and relationship to mortality	American Journal of Medicine	1997	799	42.05	1016	53.47	9375704
10	Levy, EM et al	The effect of acute renal failure on mortality - A cohort analysis	JAMA- Journal of the American Medical Association	1996	793	39.65	998	49.9	8622223
11	Rihal, CS et al	Incidence and prognostic importance of acute renal failure after percutaneous coronary intervention	Circulation	2002	691	49.36	877	62.64	12010907
12	Solomon, R et al	Effects of saline, mannitol, and furosemide to	New England Journal of	1994	684	31.09	905	41.14	7969280

		prevent acute decreases in renal function induced by radiocontrast agents	Medicine						
13	Mehran, R et al	A simple risk score for prediction of contrast-induced nephropathy after percutaneous coronary intervention- Development and initial validation	Journal of the American College of Cardiology	2004	677	56.42	844	70.33	15464318
14	Mishra, J et al	Identification of neutrophil gelatinase-associated lipocalin as a novel early urinary biomarker for ischemic renal injury	Journal of the American Society of Nephrology	2003	645	49.62	735	56.54	14514731
15	Chertow, GM et al	Independent association between acute renal failure and mortality following cardiac surgery	American Journal of Medicine	1998	630	35.00	747	41.5	9576407
16	Parfrey, PS et al	Contrast material-induced renal failure in patients with diabetes mellitus, renal insufficiency, or both. A prospective controlled study	New England Journal of Medicine	1989	618	22.89	635	23.52	2643041
17	Aspelin, P et al	Nephrotoxic effects in high-risk patients undergoing angiography.	New England Journal of Medicine	2003	575	44.23	758	58.31	12571256
18	Brivet, FG et al	Acute renal failure in intensive care units - Causes, outcome, and prognostic factors of	Critical Care Medicine	1996	538	26.90	632	31.6	8605788

		hospital mortality: A prospective, multicenter study							
19	Togel, F et al	Administered mesenchymal stem cells protect against ischemic acute renal failure through differentiation-independent mechanisms	American Journal of Physiology-Renal Physiology	2005	524	47.64	625	56.82	15713913
20	Merten, GJ et al	Prevention of contrast-induced nephropathy with sodium bicarbonate - A randomized controlled trial	JAMA- Journal of the American Medical Association	2004	513	42.75	714	59.5	15150204

See Supplementary Table 1 for a complete list of T100.

Table 2. Journals in which the T100 articles were published

Journal	No. of Articles (Citations)	Impact Factor	5-Year Impact Factor
New England Journal of Medicine	17 (7249)	55.87	54.39
Journal of the American Society of Nephrology	16 (5470)	9.34	5.47
Kidney International	16 (5157)	8.56	7.89
Journal of Clinical Investigation	11 (3930)	13.22	14.05
Lancet	7 (3194)	45.22	42.72
JAMA- Journal of the American Medical Association	5 (3095)	35.29	31.03
American Journal of Medicine	5 (2138)	5.00	5.26
Critical Care Medicine	5 (1935)	6.31	6.29
American Journal of Physiology-Renal Physiology	4 (1252)	3.25	3.51
Critical Care	4 (4379)	4.48	5.14
Archives of Internal Medicine	4 (1079)	17.33	13.10
Journal of the American College of Cardiology	3 (1238)	16.50	14.10
Medicine	3 (971)	5.72	5.29
Annals of Internal Medicine	3 (864)	17.8	17.47
Proceedings of the National Academy of Sciences of the United States of America	2 (683)	9.67	10.56
American Journal of Kidney Diseases	2 (627)	5.90	5.56
Clinical Journal of the American Society of Nephrology	2 (604)	4.61	5.47
American Journal of Cardiology	2 (482)	3.28	3.35

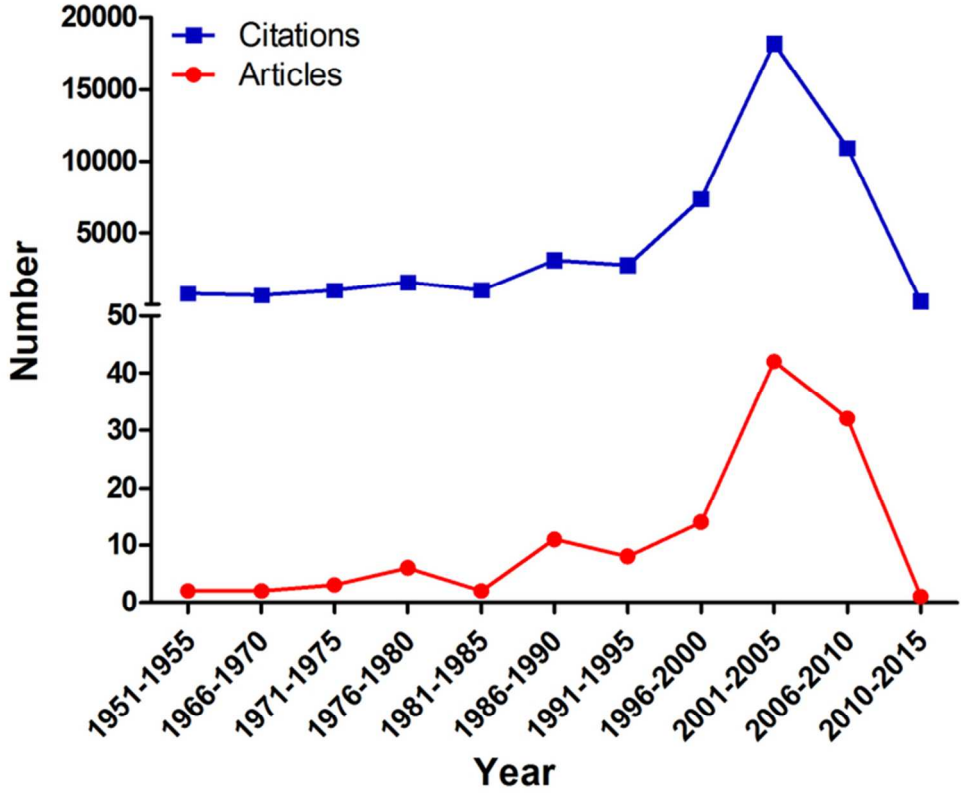
Notes: The journals that only published one of the T100 articles were shown below. Values given in parentheses were number of articles, impact factors and the corresponding citations, respectively. Circulation (1, 14.43, 691); Intensive Care Medicine (1, 7.21, 349); Nephrology Dialysis Transplantation (1, 3.58, 304); Anesthesiology (1, 5.88, 263); Circulation Research (1, 11.02, 243); Journal of Thoracic and Cardiovascular Surgery (1, 4.17, 229); International Journal of Molecular Medicine (1, 2.09, 228); American Journal of Physiology (1, NA, 227); Clinical Infectious Diseases (1, 8.89, 226); Annals of Surgery (1, 8.33, 226); Annals of Thoracic Surgery (1, 3.85, 221); European Radiology (1, 4.01, 220).

Table.3. Authors with two or more top-cited articles

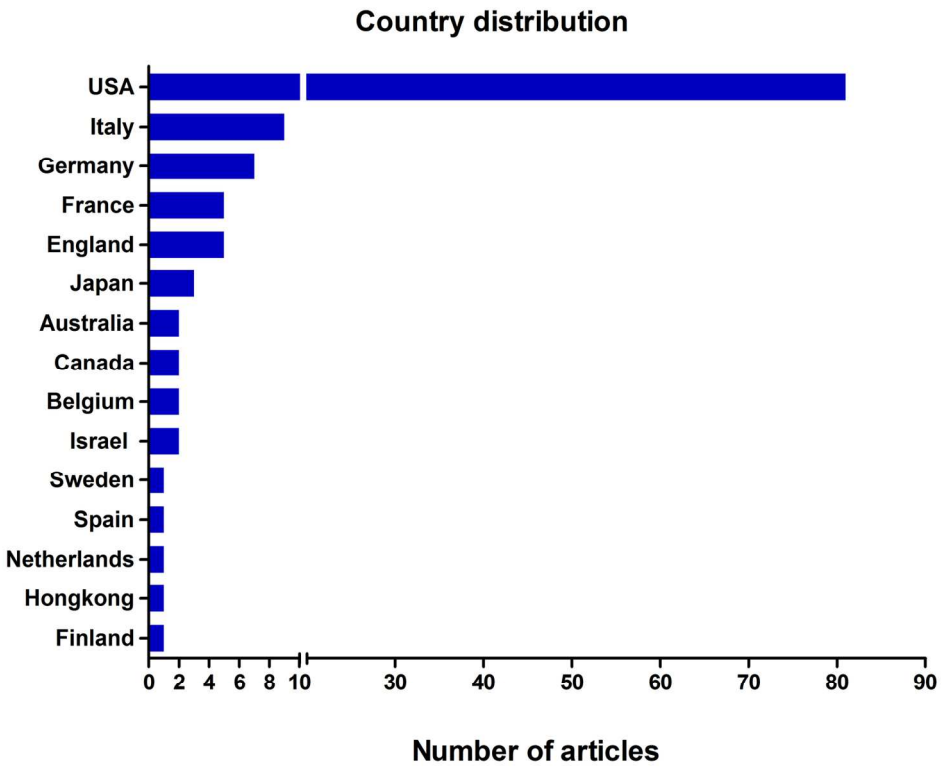
Rank	Author	No. of articles	First	Correspond	Other	Citations (First and Correspond)	Total citations
1	Bonventre, JV	10	5	9	1	4263	4527
2	Devarajan, P	8	1	5	3	2464	3428
3	Chertow, GM	6	3	5	1	2353	2579
4	Mehta, RL	6	4	3	1	2757	4728
5	Parikh, CR	4	2	4		996	813
6	Marenzi, G	3	3	3		813	1095
7	Schrier, RW	3	2	3		1095	1634
8	Camussi, G	2		2		452	452
9	Dangas, G	2	1	2		934	934
10	Kellum, JA	2				1788	1788
11	McCullough, PA	2	2	2		1101	1101
12	Schiffl, H	2	2	2		677	677
13	Westenfelder, C	2		2		761	761
14	Parfrey, PS	2	1	2	1	892	892
15	Bates, DW	2	1	1	1	226	1119
16	Coca, S. G	2	2			486	486

Table 4. Institutions with two or more top cited articles on acute kidney injury

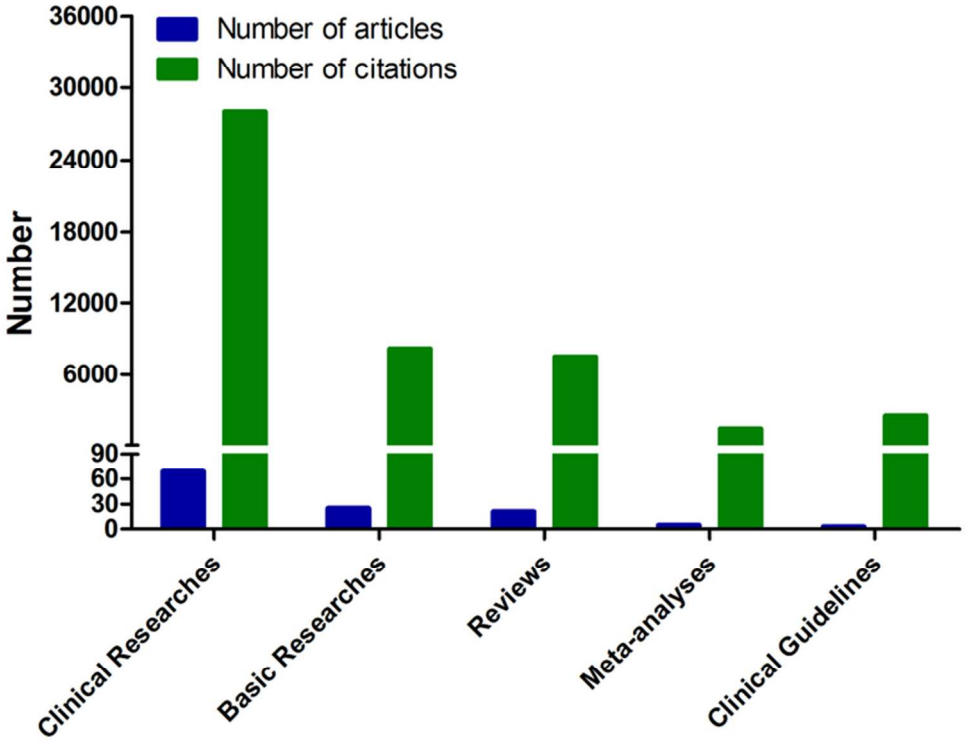
Rank	Institution	No. of Articles	Citations
1	Brigham and Women's Hospital, Boston, USA	9	4263
2	Cincinnati Children's Hospital Medical Center, Cincinnati, USA	5	2464
3	University of California, San Francisco, USA.	5	2353
4	Yale University, West Haven, USA	4	996
5	University of California, San Diego, USA	3	2757
6	The University of Milan, Milan, Italy	3	813
7	University of Colorado, Denver, USA	3	1095
8	University of Torino, Torino, Italy	2	452
9	Columbia University, New York, USA	2	934
10	William Beaumont Hospital, Royal Oak, USA	2	1101
11	University of Munich, Munich, Germany	2	677
12	Veterans Affairs medical center, Salt Lake City, USA	2	761
13	Memorial University of Newfoundland, City of Saint John, Canada	2	892



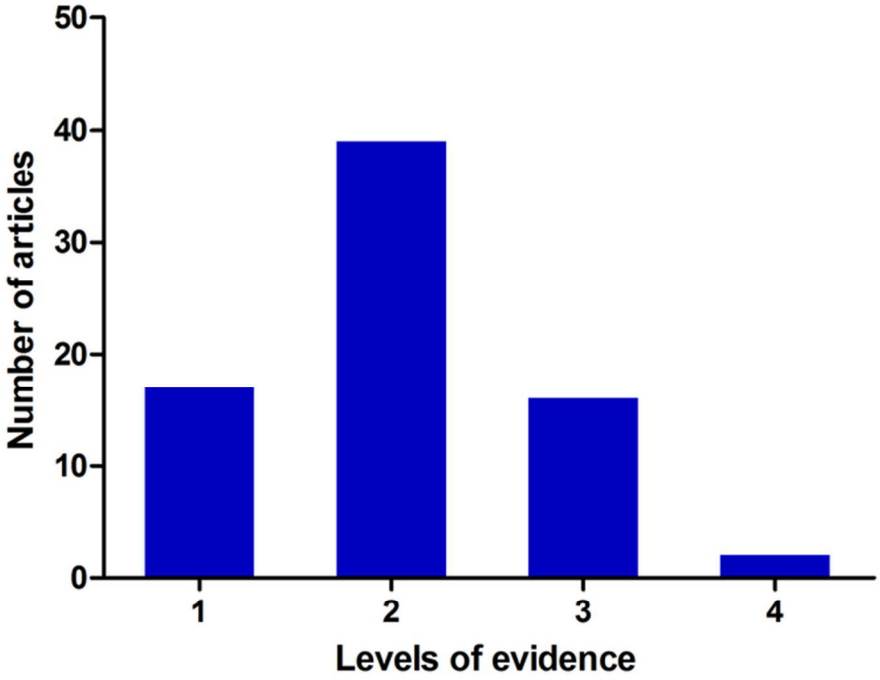
66x56mm (300 x 300 DPI)



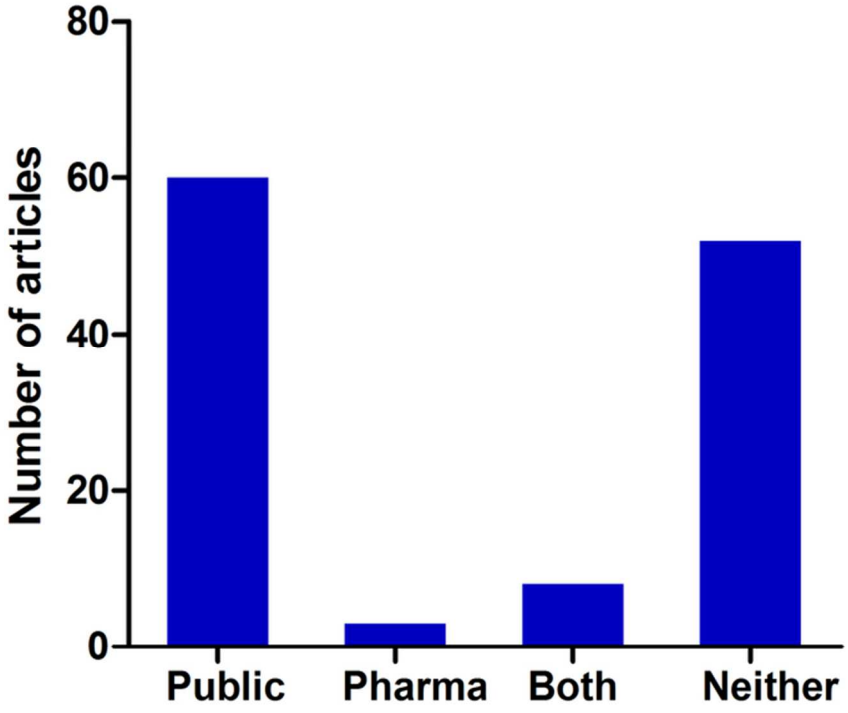
148x123mm (300 x 300 DPI)



68x54mm (300 x 300 DPI)



64x48mm (300 x 300 DPI)



68x54mm (300 x 300 DPI)

Table S1. Bibliometric information of the other T100 articles in acute kidney injury which were not shown in Table 1

Rank	Authors	Title	Journal	Year	Times Cited (Web)	Citation Index (Web)	Times Cited (Scoups)	(
21	Palevsky, PM et al	Intensity of renal support in critically ill patients with acute kidney injury	New England Journal of Medicine	2008	510	63.75	607	
22	Oliver, J et al	The pathogenesis of acute renal failure associated with traumatic and toxic injury; renal ischemia, nephrotoxic damage and the ischemic episode	Journal of Clinical Investigation	1951	498	7.66	NA	
23	Hoste, EA et al	RIFLE criteria for acute kidney injury are associated with hospital mortality in critically ill patients: a cohort analysis	Critical Care	2006	491	49.10	652	
24	Kelly, KJ et al	Intercellular adhesion molecule-1-deficient mice are protected against ischemic renal injury	Journal of Clinical Investigation	1996	471	23.55	501	
25	Schrier, RW et al	Mechanisms of disease: Acute renal failure and sepsis	New England Journal of Medicine	2004	465	38.75	251	

26	Liano, F et al	Epidemiology of acute renal failure: A prospective, multicenter, community-based study	Kidney International	1996	464	23.20	563
27	Lameire, N et al	Acute renal failure	Lancet	2005	439	39.91	569
28	Metnitz, PGH et al	Effect of acute renal failure requiring renal replacement therapy on outcome in critically ill patients	Critical Care Medicine	2002	438	31.29	534
29	Grossman, RA et al	Nontraumatic rhabdomyolysis and acute renal failure	New England Journal of Medicine	1973	433	10.31	215
30	Star, RA et al	Treatment of acute renal failure	Kidney International	1998	428	23.78	501
31	Schiffl, H et al	Daily hemodialysis and the outcome of acute renal failure	New England Journal of Medicine	2002	415	29.64	549
32	Hollenbe.NK et al	Acute oliguric renal failure in man: evidence for preferential renal cortical ischemia	Medicine	1968	409	8.52	105
33	Uchino, S et al	An assessment of the RIFLE criteria for acute renal failure in hospitalized patients	Critical Care Medicine	2006	407	40.70	475

34	Bonventre, JV et al	Recent advances in the pathophysiology of ischemic acute renal failure	Journalof the American Society of Nephrology	2003	401	30.85	448
35	Haase, M et al	Accuracy of Neutrophil Gelatinase-Associated Lipocalin (NGAL) in Diagnosis and Prognosis in Acute Kidney Injury: A Systematic Review and Meta-analysis	American Journal of Kidney Diseases	2008	394	56.29	479
36	Fouque, D et al	A proposed nomenclature and diagnostic criteria for protein-energy wasting in acute and chronic kidney disease	Kidney International	2008	392	49.00	454
37	Herget-Rosenthal, S et al	Early detection of acute renal failure by serum cystatin C	Kidney International	2004	384	32.00	488
38	Mueller, C et al	Prevention of contrast media-associated nephropathy - Randomized comparison of 2 hydration regimens in 1620 patients undergoing coronary angioplasty	Archives of Internal Medicine	2002	372	26.57	541
39	Morigi, M et al	Mesenchymal stem cells are renotropic,	Journal of the American	2004	369	30.75	433

		helping to repair the kidney and improve function in acute renal failure	Society of Nephrology				
40	Bonventre, JV et al	Mechanisms of ischemic acute renal failure	Kidney International	1993	366	15.91	359
41	Kelly, KJ et al	Antibody to intercellular adhesion molecule 1 protects the kidney against ischemic injury	Proceedings of the National Academy of Sciences of the United States of America	1990	354	16.09	345
42	Devarajan, P et al	Update on mechanisms of ischemic acute kidney injury	Journal of the American Society of Nephrology	2006	351	35.10	370
43	de Mendonca, A et al	Acute renal failure in the ICU: risk factors and outcome evaluated by the SOFA score	Intensive Care Medicine	2000	349	21.81	436
44	Abel, RM et al	Improved survival from acute renal failure after treatment with intravenous essential L-amino acids and glucose. Results of a prospective, double-blind study	New England Journal of Medicine	1973	345	8.02	133
45	Humes, HD et al	Epidermal growth factor enhances renal tubule cell regeneration and repair and accelerates the recovery of renal function	Journal of Clinical Investigation	1989	336	12.44	217

		in postischemic acute renal failure					
46	Bonventre, JV et al	Ischemic acute renal failure: An inflammatory disease?	Kidney International	2004	335	27.92	368
47	Schrier, RW et al	Acute renal failure: definitions, diagnosis, pathogenesis, and therapy	Journal of Clinical Investigation	2002	332	27.67	376
48	Kawaida, K et al	Hepatocyte growth factor prevents acute renal failure and accelerates renal regeneration in mice	Proceedings of the National Academy of Sciences of the United States of America	1998	329	14.95	309
49	Ricci, Z. et al	The RIFLE criteria and mortality in acute kidney injury: A systematic review	Kidney International	2008	325	40.63	374
50	Marenzi, G et al	N-acetylcysteine and contrast-induced nephropathy in primary angioplasty	New England Journal of Medicine	2006	323	32.30	402
51	Akcan-Arikan, A et al	Modified RIFLE criteria in critically ill children with acute kidney injury	Kidney International	2007	320	35.56	368
52	Ishani, Areef et al	Acute Kidney Injury Increases Risk of ESRD among Elderly	Journal of the American Society of Nephrology	2009	319	45.57	364
53	Mehta, RL et al	Spectrum of acute renal failure in the	Kidney International	2004	315	26.25	368

		intensive care unit: The PICARD experience					
54	Rosner, Mitchell H et al	Acute kidney injury associated with cardiac surgery	Clinical Journal of the American Society of Nephrology	2009	310	31.00	341
55	Mehta, RL et al	A randomized clinical trial of continuous versus intermittent dialysis for acute renal failure	Kidney International	2001	309	20.60	401
56	Hakim, RM et al	Effect of the dialysis membrane in the treatment of patients with acute renal failure	New England Journal of Medicine	1994	307	13.95	287
57	Conlon, PJ et al	Acute renal failure following cardiac surgery	Nephrology Dialysis Transplantation	1999	304	17.88	395
58a	Nickolas, Thomas L et al	Sensitivity and specificity of a single emergency department measurement of urinary neutrophil gelatinase-associated lipocalin for diagnosing acute kidney injury	Annals of Internal Medicine	2008	303	37.88	344

58b	Anderson, RJ et al	Nonoliguric acute renal failure	New England Journal of Medicine	1977	303	7.77	157
59a	McCullough, Peter A et al	Contrast-induced acute kidney injury	Journal of the American College of Cardiology	2008	302	37.75	366
59b	Zager, RA et al	Rhabdomyolysis and myohemoglobinuric acute renal failure	Kidney International	1996	302	15.10	372
59c	Swann, RC et al	The clinical course of acute renal failure	Medicine	1957	302	4.79	2
60	Better, OS et al	Early management of shock and prophylaxis of acute renal failure in traumatic rhabdomyolysis	New England Journal of Medicine	1990	301	11.58	331
61	Miller, TR et al	Urinary diagnostic indices in acute renal failure: a prospective study	Annals of Internal Medicine	1978	298	7.84	163
62	Xue, Jay L et al	Incidence and mortality of acute renal failure in Medicare beneficiaries, 1992 to 2001	Journal of the American Society of Nephrology	2006	296	29.60	326
63	Bennett, Michael et al	Urine NGAL predicts severity of acute kidney injury after cardiac surgery: A	Clinical Journal of the American Society of Nephrology	2008	294	36.75	344

		prospective study					
64	Ostermann, Marlies et al	Acute kidney injury in the intensive care unit according to RIFLE	Critical Care Medicine	2007	288	32.00	324
65	Noiri, E et al	In vivo targeting of inducible NO synthase with oligodeoxynucleotides protects rat kidney against ischemia	Journal of Clinical Investigation	1995	277	13.85	272
66	Oken, DE et al	Glycerol-induced hemoglobinuric acute renal failure in the rat. I. Micropuncture study of the development of oliguria	Journal of Clinical Investigation	1959	275	5.50	65
67	Barrett, BJ et al	Preventing nephropathy induced by contrast medium	New England Journal of Medicine	2006	274	27.40	347
68	Parikh, C. R. et al	Urinary IL-18 is an early predictive biomarker of acute kidney injury after cardiac surgery	Kidney International	2006	267	26.70	309
69	Payen, Didier et al	A positive fluid balance is associated with a worse outcome in patients with acute renal failure	Critical Care	2008	265	33.13	309

70a	Ichimura, T et al	Kidney injury molecule-1: a tissue and urinary biomarker for nephrotoxicant-induced renal injury	American Journal of Physiology-Renal Physiology	2004	264	22.00	330
70b	Bouman, CSC et al	Effects of early high-volume continuous venovenous hemofiltration on survival and recovery of renal function in intensive care patients with acute renal failure: A prospective, randomized trial	Critical Care Medicine	2002	264	18.86	303
71a	Wagener, Gebhard et al	Association between increases in urinary neutrophil gelatinase-associated lipocalin and acute renal dysfunction after adult cardiac surgery	Anesthesiology	2006	263	26.30	312
71b	Koffler, A et al	Acute renal failure due to nontraumatic rhabdomyolysis	Annals of Internal Medicine	1976	263	6.58	117
72a	Chertow, GM et al	Prognostic stratification in critically ill patients with acute renal failure requiring dialysis	Archives of Internal Medicine	1995	262	12.48	282

72b	Schiffl, H et al	Biocompatible membranes in acute renal failure: prospective case-controlled study	Lancet	1994	262	11.91	242
73a	Birck, R et al	Acetylcysteine for prevention of contrast nephropathy: meta-analysis	Lancet	2003	260	20.00	388
73b	Byrd, L et al	Radiocontrast-induced acute renal failure: a clinical and pathophysiologic review	Medicine	1977	260	7.03	123
74a	Marenzi, G et al	Contrast-induced nephropathy in patients undergoing primary angioplasty for acute myocardial infarction	Journal of the American College of Cardiology	2003	259	21.58	297
74b	Ali, Tariq et al	Incidence and outcomes in acute kidney injury: A comprehensive population-based study	Journal of the American Society of Nephrology	2007	259	28.78	297
75a	Sharples, EJ et al	Erythropoietin protects the kidney against the injury and dysfunction caused by ischemia-reperfusion	Journal of the American Society of Nephrology	2004	257	21.42	287
75b	Dangas, G et al	Contrast-induced nephropathy after percutaneous coronary interventions in	American Journal of Cardiology	2005	257	23.36	309

		relation to chronic kidney disease and hemodynamic variables					
76	Thakar, CV et al	A clinical score to predict acute renal failure after cardiac surgery	Journal of the American Society of Nephrology	2005	254	23.09	304
77a	Mehta, RL et al	Diuretics, mortality, and nonrecovery of renal function in acute renal failure	JAMA- Journal of the American Medical Association	2002	253	18.07	290
77b	Coca, S. G et al	Biomarkers for the diagnosis and risk stratification of acute kidney injury: A systematic review	Kidney International	2012	253	31.63	351
77c	Bonventre, JV et al	Dedifferentiation and proliferation of surviving epithelial cells in acute renal failure	Journal of the American Society of Nephrology	2003	253	19.46	300
78	Norman, DJ et al	Myolysis and acute renal failure in a heart-transplant recipient receiving lovastatin	New England Journal of Medicine	1988	252	9.00	162
79	Tomita, K et al	Plasma endothelin levels in patients with acute renal failure	New England Journal of Medicine	1989	250	9.26	140

80	Lin, FM et al	Hematopoietic stem cells contribute to the regeneration of renal tubules after renal ischemia-reperfusion injury in mice	Journal of the American Society of Nephrology	2003	247	19.00	304
81	Sutton, TA et al	Microvascular endothelial injury and dysfunction during ischemic acute renal failure	Kidney International	2003	244	17.43	271
82a	Arendshorst, WJ et al	Pathogenesis of acute renal failure following temporary renal ischemia in the rat	Circulation Research	1977	243	5.93	285
82b	Parikh, CR et al	Urine IL-18 is an early diagnostic marker for acute kidney injury and predicts mortality in the intensive care unit	Journal of the American Society of Nephrology	2005	243	22.09	83
83a	Kay, J et al	Acetylcysteine for prevention of acute deterioration of renal function following elective coronary angiography and intervention - A randomized controlled trial	JAMA- Journal of the American Medical Association	2003	239	18.38	327

83b	Shusterman, N et al	Risk factors and outcome of hospital-acquired acute renal failure. Clinical epidemiologic study	American Journal of Medicine	1987	239	8.24	254
83c	Bonventre, Joseph V et al	Cellular pathophysiology of ischemic acute kidney injury	Journal of Clinical Investigation	2002	239	47.80	228
84a	Togel, Florian et al	Vasculotropic, paracrine actions of infused mesenchymal stem cells are important to the recovery from acute kidney injury	American Journal of Physiology-Renal Physiology	2005	237	26.33	284
84b	Burne, MJ et al	Identification of the CD4(+) T cell as a major pathogenic factor in ischemic acute renal failure	Journal of Clinical Investigation	2001	237	15.80	267
84c	Waikar, Sushrut S et al	Declining mortality in patients with acute renal failure, 1988 to 2002	Journal of the American Society of Nephrology	2006	237	23.70	254
85a	Melnikov, VY et al	Impaired IL-18 processing protects caspase-1-deficient mice from ischemic acute renal failure	Journal of Clinical Investigation	2001	236	15.73	253
85b	Cigarroa, RG et al	Dosing of contrast material to prevent	American Journal of Medicine	1989	236	8.74	282

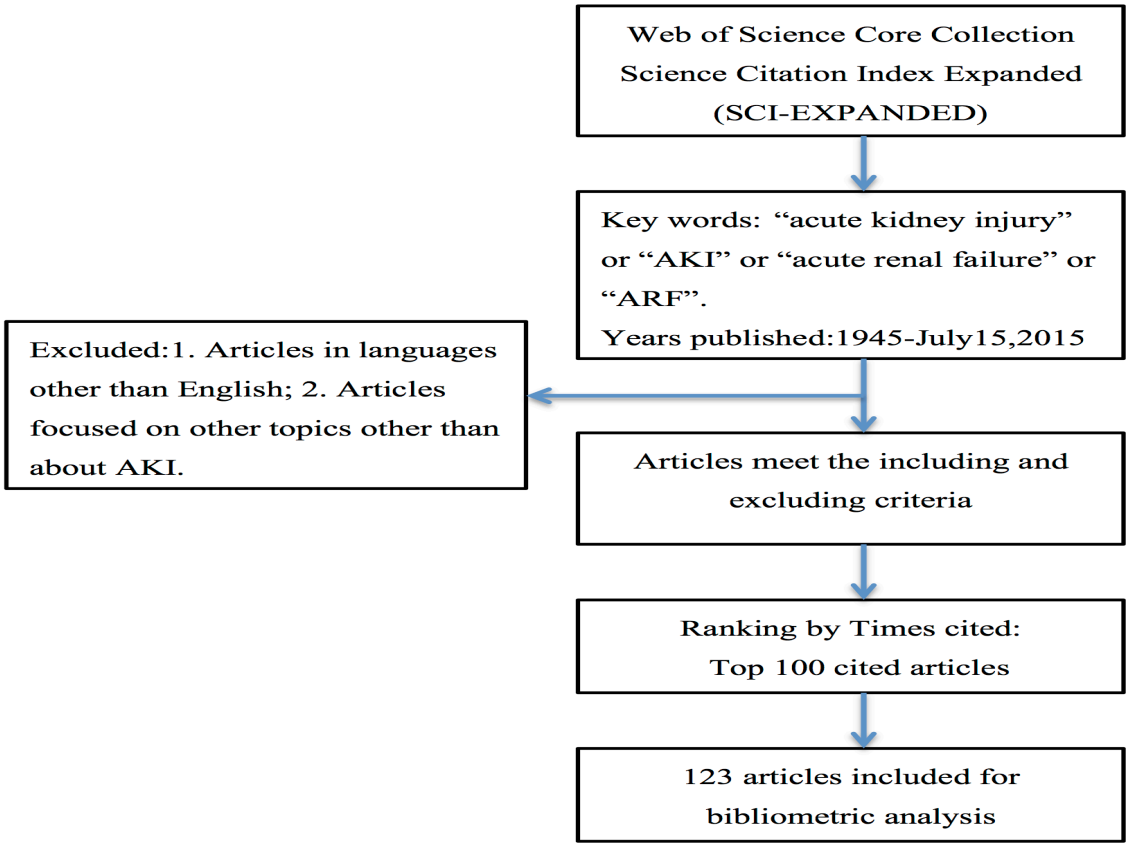
		contrast nephropathy in patients with renal disease					
86	Vinsonneau,Christophe et al	Continuous venovenous haemodiafiltration versus intermittent haemodialysis for acute renal failure in patients with multiple-organ dysfunction syndrome: a multicentre randomised trial	Lancet	2006	235	23.50	312
87	Thurau, K et al	Acute renal success. The unexpected logic of oliguria in acute renal failure	American Journal of Medicine	1976	234	5.85	121
88a	Firth, JD et al	Endothelin: an important factor in acute renal failure?	Lancet	1988	233	8.32	276
88b	Coca, Steven G et al	Long-term Risk of Mortality and Other Adverse Outcomes After Acute Kidney Injury: A Systematic Review and Meta-analysis	American Journal of Kidney Diseases	2009	233	33.29	110
89	Marenzi, G et al	The prevention of radiocontrast-agent-induced nephropathy	New England Journal of Medicine	2003	231	17.77	355

		by hemofiltration					
90	Zanardo, G et al	Acute renal failure in the patient undergoing cardiac operation. Prevalence, mortality rate, and main risk factors	Journal of Thoracic and Cardiovascular Surgery	1994	229	10.41	275
91a	Herrera, MB et al	Mesenchymal stem cells contribute to the renal repair of acute tubular epithelial injury	International Journal of Molecular Medicine	2003	228	19.00	273
91b	Bouchard, Josee et al	Fluid accumulation, survival and recovery of kidney function in critically ill patients with acute kidney injury	Kidney International	2009	228	32.57	264
92a	Vaidya, VS et al	Urinary kidney injury molecule-1: a sensitive quantitative biomarker for early detection of kidney tubular injury	American Journal of Physiology-Renal Physiology	2006	227	22.70	294
92b	Rich, MW et al	Incidence, risk factors, and clinical course of acute renal insufficiency after cardiac catheterization in patients 70 years of age or older. A prospective study	Archives of Internal Medicine	1990	227	8.73	283

92c	Stein, JH et al	Current concepts on the pathophysiology of acute renal failure	American Journal of Physiology	1978	227	5.97	64
93a	Bates, DW et al	Mortality and costs of acute renal failure associated with amphotericin B therapy	Clinical Infectious Diseases	2001	226	15.07	285
93b	Richards, WO et al	Acute renal failure associated with increased intra-abdominal pressure	Annals of Surgery	1988	226	6.85	213
94a	Supavekin, S et al	Differential gene expression following early renal ischemia/reperfusion	Kidney International	2003	225	17.31	242
94b	Diaz-Sandoval, LJ et al	Acetylcysteine to prevent angiography-related renal tissue injury (the APART Trial)	American Journal of Cardiology	2002	225	16.07	296
95	Bruno, Stefania et al	Mesenchymal Stem Cell-Derived Microvesicles Protect Against Acute Tubular Injury	Journal of the American Society of Nephrology	2009	224	32.00	230
96	Liangos, Orfeas et al	Urinary N-acetyl-beta-(D) -glucosaminidase activity and kidney injury molecule-1 level are associated with	Journal of the American Society of Nephrology	2007	222	24.67	260

		adverse outcomes in acute renal failure				
97	Kuitunen, A et al	Acute renal failure after cardiac surgery: Evaluation of the RIFLE classification	Annals of Thoracic Surgery	2006	221	22.10	255
98	Morcos, SK et al	Contrast-media-induced nephrotoxicity: a consensus report	European Radiology	1999	220	12.94	290
99	Ward, MM et al	Factors predictive of acute renal failure in rhabdomyolysis	Archives of Internal Medicine	1988	218	7.79	242
100	Heyman, SN et al	Acute renal failure with selective medullary injury in the rat	Journal of Clinical Investigation	1988	215	7.68	156

Supplementary figure 1



Supplement File: Flow diagram representing the study selection process

Correction: *Hundred top-cited articles focusing on acute kidney injury: a bibliometric analysis*

Liu Y-hui, Wang S-qi, Xue J-hua, *et al*. Hundred top-cited articles focusing on acute kidney injury: a bibliometric analysis. *BMJ Open* 2016;6:e011630. The published affiliations of the authors in this article were incorrect. The correct affiliations are given below.

Ning Tan, Yuan-hui Liu, Yong Liu, Ji-yan Chen, Peng-cheng He and Ning Tan: Department of Cardiology, Guangdong Cardiovascular Institute, Guangdong Provincial Key Laboratory of Coronary Heart Disease Prevention, Guangdong General Hospital, Guangdong Academy of Medical Sciences, Guangzhou 510100, Guangdong, China;

Sheng-qi Wang: [1]Department of Mammary Disease, Guangdong Provincial Hospital of Chinese Medicine, The Second Clinical College of Guangzhou University of Chinese Medicine, Guangzhou, China; [2]Department of Pharmacy, Nanfang Hospital, Southern Medical University, 1038 Guangzhou, China.

Guo-feng Li: Department of Pharmacy, Nanfang Hospital, Southern Medical University, Guangzhou, 510515, China.

Jin-hua Xue: [1]Department of Pathophysiology, School of Basic Medical Sciences, Southern Medical University, Guangzhou, 510515, China. [2]Department of Physiology, School of Basic Medical Sciences, Gannan Medical University, Ganzhou, 341000, China.

BMJ Open 2016;**6**:e011630corr1. doi:10.1136/bmjopen-2016-011630corr1