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Classic Papers in Critical Care: A Bibliometric Analysis

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Abstract

Purpose- This study aimed to identify and analyze the bibliometric characteristics of the classic papers in the field of critical care.

Design/methodology/approach- In this bibliometric overview, Google Scholar, Scopus and Web of Science were used for data collection. Study sample consisted of the classic papers in the field of critical care, introduced in Google scholar. SPSS were used for data analyses.

Findings- *Critical Care* ranked the first journal in having critical care classic papers. All critical care classic papers were multi-authored. The most highly-cited paper was a paper titled "Intensive insulin therapy in the medical ICU", with 3796 received citations in Google Scholar. The United States was the top contributing country. There was a significantly positive correlation between the citations of critical care classic papers in Google Scholar, Scopus, and Web of Science ($r = .988$, $p < .001$).

Practical implications- The bibliometric overview of critical care classic papers can be beneficial to the researchers and specialists in the field as well as to the editorial teams of its related journals. Bibliometricians and library and information specialist can use the findings of the study.

Originality/value- This study is the first to analyze the classic papers in critical care field from a bibliometric perspective.

Keywords: Bibliometric analyses; Critical care; Classic papers; Google Scholar

Introduction

Google Scholar is a scientific database indexing papers published in different journals worldwide. Google Scholar provide many abstracts and, in case of open-access journals, paper

full-texts. With some innovations and facilities, Google Scholar makes the scientific papers more visible and help scholars in finding high-quality scientific works (Google Scholar, 2019). One of these facilities is "classic papers" that were introduced first in May 2017. Classic papers are most highly-cited ones in 10 recent years. Analyzing the papers helps to identify the authors, journals, research institutes, universities and countries influential in scientific development (Saberi and Ekhtiyari, 2018). It can be helpful for researchers and specialists as a road map.

One of the common ways to analyze classic papers is bibliometrics. Bibliometric analysis has been used for analyzing the highly-cited and classic papers in some field such as library and information science (Saberi and Ekhtiyari, 2018), pediatric traumatic brain injury (Karydakis, Giakoumettis and Themistocleous, 2019), dentistry (Gogos et al., 2019), intervertebral disk (Yang et al., 2019), pediatric dentistry (Perazzo et al., 2019), coronary artery bypass grafting (Chan et al., 2019), cancer immunotherapy (Zhang, Quan and Du, 2019), and robotic surgery (Connelly et al., 2019).

Changing the notion "statistical bibliography" into that of "bibliometrics", Pritchard (1969) defined it as the application of mathematical and statistical methods for books and other communication media (Mokhtari, Roumiyani, and Saberi, 2019). Lancaster (1977) conceived bibliometrics as studying the communicative patterns among authors, publications and texts by applying different statistical methods. Bibliometrics was heavily considered in the 1980s for studying many scientific fields (Campbell, 1896).

As one of the main medical fields, critical care includes life-supporting cares and intensive monitoring of patients with life-threatening conditions. Critical care helps people with life-threatening injuries and illnesses. It might treat problems such as complications from surgery, accidents, infections, and severe breathing problems. It involves close, constant attention by a team of specially-trained health care providers. It requires the high-level medical specialty and facilities, too.

However, many researchers and specialists in critical care medicine are not familiar enough with classic papers and their importance. As no comprehensive study has been conducted on the classic papers in critical care, a bibliometric analysis of its classic papers can provide valuable and informing knowledge on the field and its research topics and promote awareness of influential agents at work in this field. This can open the way to do influential and original researches in this main medical branch.

Literature Review

Searching in Google Scholar, Scopus, Web of Science (WoS) and PubMed for related literature on the topic showed many studies on the highly-cited papers, but only few on classic papers. This is rationale as the notion of classic papers was introduce recently by Google Scholar.

Regarding "classic papers" in Google Scholar, two main studies can be mentioned. López-Cózar, Martín-Martín and Orduna-Malea (2017) wrote a paper entitled as "Classic papers: déjà vu, a step further in the bibliometric exploitation of Google Scholar". After giving a brief overview of Eugene Garfield's contributions to the identification and study of the most cited scientific papers, manifested in the creation of his Citation Classics, they identified the main characteristics and features of Google Scholar's new service, i.e. classic papers as well as its main strengths and weaknesses. They found that this new product currently displays the most cited English-language original research papers by fields and published in 2006.

In a study entitled "Characteristics of classic papers of library and information science: a scientometric study", Saberi and Ekhtiyari (2018) found that the journal *Scientometrics* has

the highest classic papers in the field. About 60% of its classic papers were multi-authored. The United States had the most influential role in producing the classic papers in this field.

Considering highly-cited papers, many studies have been conducted. Chen et al. (2019) authored a paper under the title "The 100 most cited manuscripts in coronary artery bypass grafting" and identified the features of the 100 most cited manuscripts in coronary artery bypass grafting, extracted from Web of Science. The search yielded a total of 11 560 papers which were ranked in order of their citations. *New England Journal of Medicine* published the most papers and generated the most significant number of citations, followed by the *Journal of the American College of Cardiology*.

Connelly et al. (2019) wrote a paper titled "the 100 most influential manuscripts in robotic surgery: a bibliometric analysis" and found that the majority of these manuscripts featured case series/reports (n = 42), followed by comparative studies (n = 24). The year and country with the greatest number of publications were 2009 (n = 15) and the USA (n = 68). The Johns Hopkins University published the most top 100 manuscripts in the field (n = 18).

In a bibliometric overview entitled as "Top 100 cited systematic reviews and meta-analyses in dentistry", Gogos et al. (2019) extracted the related data from Web of Science. The findings showed that citations ranged from 642 to 140 and the most productive years were 2008 and 2009. The majority of top cited papers were published in *Clinical Oral Implants Research*, and *Journal of Clinical Periodontology*. The leading countries were the United States, followed by Switzerland. Major topics of interest were dental implants and periodontology.

Karydakis, Giakoumettis and Themistocleous (2019) conducted a bibliometric analysis under the title "The 100 most cited papers about pediatric traumatic brain injury: a bibliometric analysis" found that about 75% of top 100 highly-cited papers in the field were published during 2010-2018 in 44 different journals. The citation mean rate was 140.59. Four hundred thirty-five authors have contributed to these articles, most of them from the USA.

Perazzo et al. (2019), in a study entitled "The top 100 most-cited papers in Paediatric Dentistry journals: A bibliometric analysis" concluded that the received citations of these paper ranged from 42 to 182. Seven papers were cited more than 100 times. Most of the papers were published in *the International Journal of Paediatric Dentistry* (36%), and between 2006 and 2015 (55%). The countries with the highest number of most-cited papers were the United States (25%), Australia (11%), and Brazil (9%), respectively.

Yang et al. (2019) conducted a study entitled "Bibliometric analysis of the 100 most cited articles on intervertebral disk research: from 1900 to 2017". They showed that these 100 papers received citations ranged from 209 to 1269 and they were published from 1953 to 2009. Spine published 57 of the most cited 100 papers. The greatest contribution came from the United States (n=41), followed by the United Kingdom (n=18) and Japan (n=9).

Zhang, Quan and Du (2019) in a study titled "The 100 top-cited studies in cancer immunotherapy" showed that these papers were cited from 591 to 5332 times and published between 1986 and 2016. They were published in 27 journals and *New England Journal of Medicine* published most of the studies (n = 14), followed by *Nature* (n = 11) and *Journal of Clinical Oncology* (n = 10). They were published from 10 countries, and the USA published most of the studies (n = 82), followed by France (n = 5) and Netherlands (n = 3).

Methodology

In this bibliometric study, three known databases were used: Google Scholar, Scopus, and Web of Science. Research sample included all classic papers in critical care medicine. Classic

papers include all highly-cited papers in the world during recent ten years (2006-2016). These are original research papers, not including review papers, editorial notes, instructions and so on (Saberi and Ekhtiyari, 2019). In May 2017, Google Scholar introduced top ten highly-cited papers in each scientific field as its classical papers in 8 main categories: life science and earth science, business economics and management, chemical and material science, engineering and computer science, humanities, literature and arts, health and medical science, physics and mathematics, and social sciences. As a medical field, intensive care is included in the category of health and medical science. This study was conducted in six steps.

In the first step, the related features of the classic papers in intensive care (such as paper titles, author names, paper publishing journals and citation counts) were extracted from the category of health and medical science in Google Scholar in September 2019. Figure 1 depicts the page of critical care classic papers in Google Scholar.

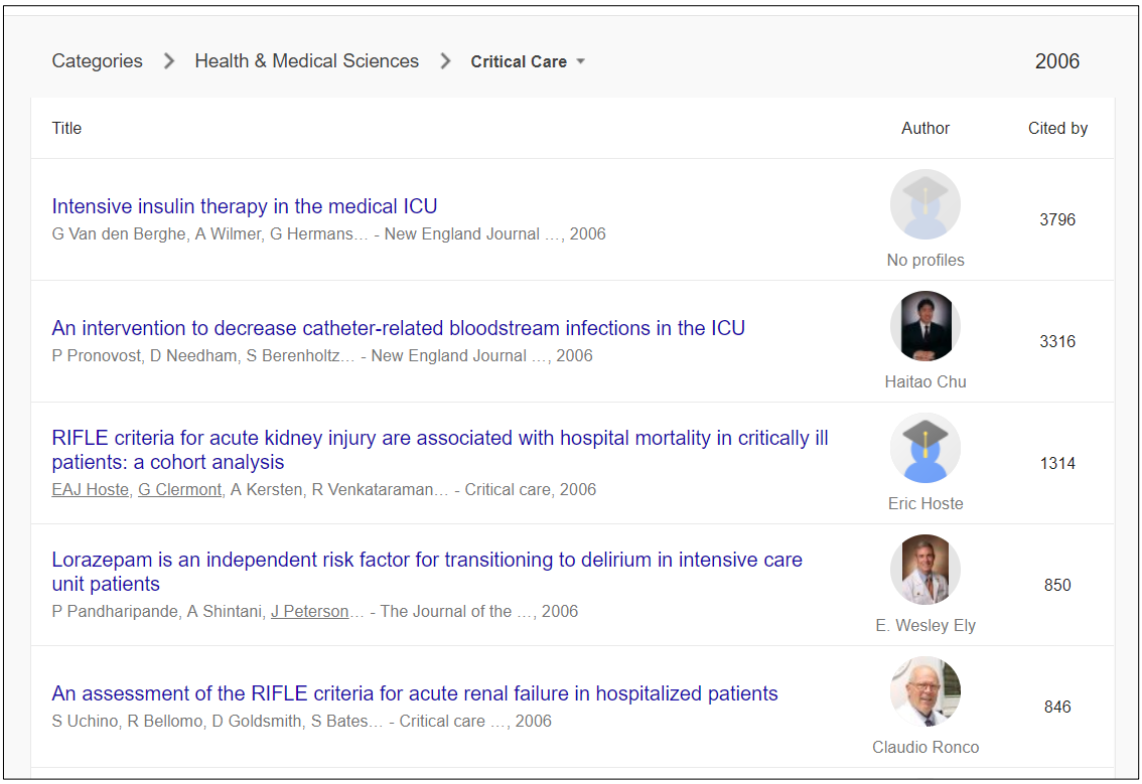

Figure 1. The page of critical care classic papers in Google Scholar

In the second step, Scopus and Web of Science were used for extracting the bibliometric indicators of the identified papers, such as impact factors, h-indices and SJR. In the third step, the authorship patterns of the papers (i.e. the number of authors of a paper) were identified. In the fourth step, the titles of the classic papers were searched manually in Scopus and Web of Science for their received citation counts in these databases. In the fifth step, the affiliations of the authors of the papers were determined in the author name section of Scopus. In the last step, the possible correlation of the citations of the papers in the three databases was tested with Spearman's correlation test in SPSS.

Results

Publishing Journals

Table 1 shows the titles of journals publishing the classic papers in critical care field. These five journals (the number of published paper in each) are: *Critical Care* (3 papers), *New England journal of Medicine* (2 papers), *Anesthesiology* (2 papers), *Critical Care Medicine* (2 papers) and *Annals of internal Medicine* (1 paper). The first rank belonged to *Critical Care* with publishing 3 papers.

Table 1. Journals publishing classic papers in critical care

No.	Classic paper title	Publishing journal title
1	Intensive insulin therapy in the medical ICU	*New England Journal of Medicine*
2	An intervention to decrease catheter-related bloodstream infections in the ICU	*New England Journal of Medicine*
3	RIFLE criteria for acute kidney injury are associated with hospital mortality in critically ill patients: a cohort analysis	*Critical Care*
4	Lorazepam is an independent risk factor for transitioning to delirium in intensive care unit patients	*Anesthesiology*
5	An assessment of the RIFLE criteria for acute renal failure in hospitalized patients	*Critical care*
6	Variability of blood glucose concentration and short-term mortality in critically ill patients	*Anesthesiology*
7	A high positive end-expiratory pressure, low tidal volume ventilatory strategy improves outcome in persistent acute respiratory distress syndrome: a randomized, controlled trial	*Critical Care Medicine*
8	The effect of age on the development and outcome of adult sepsis	*Critical Care Medicine*
9	Real-time ultrasound-guided catheterisation of the internal jugular vein: a prospective comparison with the landmark technique in critical care patients	*Critical Care*
10	Device-associated nosocomial infections in 55 intensive care units of 8 developing countries	*Annals of Internal Medicine*

The citation-based performance of the journals publishing critical care classic papers were shown in Table 2. These journals are all from the United States. The highest h-index, impact factor, CitesScore and SJR belong to the *New England Journal of Medicine*. All journals are in Quartile 1.

Table 2. Citation-based performance of journals publishing critical care classic papers

Journal title	Country	publisher	SJR	CiteScore 2018	impact factor	Quartile	h-index
New England Journal of Medicine	United States	Massachusetts Medical Society	19.524	16.10	70.670	1	933
Critical Care	United States	Springer Nature	2.540	5.01	6.959	1	146
Anesthesiology	United States	Wolters Kluwer Health	2.109	3.13	6.424	1	214
Critical Care Medicine	United States	Wolters Kluwer Health	3.244	3.31	6.971	1	249
Annals of Internal Medicine	United States	American College of Physicians	7.338	4.20	19.315	1	359

Authorship Pattern

Table 3 shows the authorship pattern of these papers. As can be seen, all papers were multi-authored (ranging from 2 to 13 authors for each paper).

Table 3. The authorship pattern of critical care classic papers

No	Classic paper title	Author number	Author names
1	Intensive insulin therapy in the medical ICU	9	Greet Van den Berghe; Alexander Wilmer; Greet Hermans; Wouter Meersseman; Pieter J. Wouters; Ilse Milants; Eric Van Wijngaerden; Herman Bobbaers; Roger Bouillon,
2	An intervention to decrease catheter-related bloodstream infections in the ICU	13	Peter Pronovost; Dale Needham; Sean Berenholtz; David Sinopoli; Haitao Chu; Sara Cosgrove; Bryan Sexton; Robert Hyzy; Robert Welsh; Gary Roth; Joseph Bander; John Kepros; Christine Goeschel,
3	RIFLE criteria for acute kidney injury are associated with hospital mortality in critically ill patients: a cohort analysis	7	Eric AJ Hoste; Gilles Clermont; Alexander Kersten; Ramesh Venkataraman; Derek C Angus; Dirk De Bacquer; John A Kellum
4	Lorazepam is an independent risk factor for transitioning to delirium in intensive care unit patients	8	Pratik Pandharipande; Ayumi Shintani; Josh Peterson; Brenda Truman Pun; Grant R. Wilkinson; Robert S. Dittus; Gordon R. Bernard; E Wesley Ely
5	An assessment of the RIFLE criteria for acute renal failure in hospitalized patients	5	Uchino, Shigehiko; Bellomo, Rinaldo; Goldsmith, Donna; Bates, Samantha; Ronco, Claudio
6	Variability of blood glucose concentration and short-term mortality in critically ill patients	5	Moritoki Egi; Rinaldo Bellomo; Edward Stachowski; Craig J. French; Graeme Hart
7	A high positive end-expiratory pressure, low tidal volume ventilatory strategy improves outcome in persistent acute respiratory distress syndrome: a randomized, controlled trial	4	Villar, Jesús; Kacmarek, Robert M; Pérez-Méndez, Lina; Aguirre-Jaime, Armando
8	The effect of age on the development and outcome of adult sepsis	3	Martin, Greg S.; Mannino, David M.; Moss, Marc
9	Real-time ultrasound-guided catheterisation of the internal jugular vein: a prospective comparison with the landmark technique in critical care patients	10	Dimitrios Karakitsos; Nicolaos Labropoulos; Eric De Groot; Alexandros P Patrianakos; Gregorios Kouraklis; John Poularas; George Samonis; Dimosthenis A Tsoutsos; Manousos M Konstadoulakis; Andreas Karabinis
10	Device-associated nosocomial infections in 55 intensive care units of 8 developing countries	10	Victor D. Rosenthal; Dennis G. Maki; Reinaldo Salomao; Carlos Álvarez Moreno; Yatin Mehta; Francisco Higuera; Luis E. Cuellar; Özay Akan Arikan; Rédouane Abouqal; Hakan Leblebicioglu

Received citations

The total numbers of citations received by the studied papers in Google Scholar, Scopus and Web of Science were shown in Table 4. As can be seen, the received citations by all of the papers in Google Scholar are more than those of Scopus and Web of Science. The first rank in received citations in Google Scholar and Scopus belonged to the paper titled "Intensive insulin therapy in the medical ICU" with 3796 and 2664 received citations, respectively. However, the first-ranked paper in Web of Science is a paper entitled "An intervention to decrease catheter-related bloodstream infections in the ICU" with 2296 received citations.

Table 4. Number of citations received by critical care classic papers in Google Scholar, Scopus and Web of Science

No.	**Classic paper title**	**Google Scholar Citations**	**Scopus Citations**	**Web of** Science Citations
1	Intensive insulin therapy in the medical ICU	3796	2664	2164
2	An intervention to decrease catheter-related bloodstream infections in the ICU	3316	2634	2296
3	RIFLE criteria for acute kidney injury are associated with hospital mortality in critically ill patients: a cohort analysis	1314	979	815
4	Lorazepam is an independent risk factor for transitioning to delirium in intensive care unit patients	850	710	588
5	An assessment of the RIFLE criteria for acute renal failure in hospitalized patients	846	642	579
6	Variability of blood glucose concentration and short-term mortality in critically ill patients	741	575	475
7	A high positive end-expiratory pressure, low tidal volume ventilatory strategy improves outcome in persistent acute respiratory distress syndrome: a randomized, controlled trial	623	476	412
8	The effect of age on the development and outcome of adult sepsis	563	436	398
9	Real-time ultrasound-guided catheterisation of the internal jugular vein: a prospective comparison with the landmark technique in critical care patients	519	421	342
10	Device-associated nosocomial infections in 55 intensive care units of 8 developing countries	517	320	296

Country-wise contributing authors

The frequency distribution of the authors of critical care classic papers by country is showed in Table 5. Of 72 contributing authors, 29, 11, 7 and 5 authors are from the United States, Belgium, Australia and Greece, respectively. 3 authors are from Japan and Spain in each and Turkey and India have 2 authors in each. Therefore, the United States has the first rank in this regard.

Table 5. The frequency distribution of the authors of critical care classic papers by country

Country	Name of Contributor	Number
United States	1-Pronovost, Peter J. 2-Needham, Dale M. 3-Berenholtz, Sean M. 4-Sinopoli, David J. 5-Chu, Haitao 6-Cosgrove, Sara E. 7-Sexton, John Bryan 8-Hyzy, Robert C. 9-Welsh, Robert James 10-Roth, Gary 11-Bander, Joseph J. 12- Kepros, John P. 13-Goeschel, Christine A. 14- Clermont, Gilles 15- Angus, Derek C. 16- Kellum, John A. 17- Pandharipande, Pratik P. 18-Peterson, Josh F. 19-Pun, Brendat Truman 20-Wilkinson, Grant R. 21-Dittus, Robert S. 22-Bernard, Gordon R. 23- Ely, Eugene Wesley 24- Kacmarek, Robert M. 25- Martin, Greg S. 26-Mannino, David M. 27-Moss, Marc 28- Labropoulos, Nicos N. 29- Maki, Dennis George	29
Belgium	1-Van den Berghe, Greet 2-Wilmer, Alexander 3-Hermans, Greet 4-Meersseman, Wouter 5-Wouters, Pieter Jozef 6-Milants, Ilse 7-van Wijngaerden, Eric 8-Bobbaers, Herman J. 9-Bouillon, Roger A. 10- Hoste, Eric 11-de Bacquer, Dirk A.	11
Australia	1-Bellomo, Rinaldo 2-Goldsmith, Donna 3-Bates, Samantha 4-Bellomo, Rinaldo 5-Stachowski, Edward R. 6-French, Craig J. 7-Hart, Graeme Kevin	7
Greece	1-Patrianakos, Alexandros Petros 2-Samonis, George J. 3-Tsoutsos, Dimosthenis A. 4-Konstadoulakis, Manoussos M. 5-Karabinis, Andreas P.	5
Japan	1-Shintani, Ayumi K. 2-Uchino, Shigehiko 3- Egi, Moritoki	3
Spain	1-Villar, Jesús 2-Pérez-Méndez, Lina Inmaculada 3-Aguirre-Jaíme, Armando J.	3
Turkey	1-Arikan, Özay Akan 2-Leblebicioglu, Hakan	2
India	1-Venkataraman, Ramesh 2-Mehta, Yatin B.	2
Argentina	1-Rosenthal, Víctor Daniel	1
Brazil	1-Salomao, Reinaldo	1
Colombia	1-Álvarez-Moreno, Carlos Arturo	1
Germany	1-Kersten, Alexander	1
Italy	1-Ronco, Claudio	1
Mexico	1-Higuera, Francisco	1
Morocco	1-Abouqal, Redouane	1
Netherlands	1-de Groot, Eric E.	1
Peru	1-Cuéllar, Luis Ernesto	1
Saudi Arabia	1-Karakitsos, Dimitrios N.	1

Correlations between Google scholar, Scopus and Web of Science citations

Spearman's rank correlation test was used for testing the possible correlation between citations of critical care classic papers in Google Scholar, Scopus, and Web of Science. As Table 6 shows, there was a significant correlation between citations in these database (r= .988, p<.001). It means that with increase in the citations of classic papers in Google Scholar, the citations of the papers are increased in Scopus and Web of Science.

Table 6. Correlation between the citations of critical care classic papers in Google scholar, Scopus and Web of Science

		Google scholar Citations	**Scopus Citations**	**Web of Science Citations**
Google scholar Citations	Correlation Coefficient	1.000	1.000**	.988**
	Sig. (2-tailed)	.	.	.000
Scopus Citations	Correlation Coefficient	1.000**	1.000	.988**
	Sig. (2-tailed)		.	.000
Web of Science Citations	Correlation Coefficient	.988**	.988**	1.000
	Sig. (2-tailed)	.000	.000	.
** Correlation is significant at the 0.01 level (2-tailed).				

Discussion and conclusion

As core and high quality works in a scientific field, classic papers have more citation performance and are heavily considered by scholars (Erfanmanesh, 2017). Analyzing these papers is beneficial to the scholars of their related fields. This study aimed at investigating the bibliometric features of the classical papers in critical care field, introduced in Google Scholar. The results showed that these papers have been published in 5 main journals, including *Critical Care*, *New England Journal of Medicine*, *Anesthesiology*, *Critical Care Medicine*, and *Annals of Internal Medicine*. Of them, *Critical Care* ranked first by publishing 3 classic papers. This journal is a pioneering and leading open-access journal in critical care medicine, publishing influential research worldwide (*Critical Care*, 2019). Therefore, the chance of papers published in this journals being highly-cited and/or classic paper will be more.

All of these journals were in Q1. This means that papers published in Q1 journals have more chance of being highly-cited and classic. Authors that intend to have highly-cited papers can publish in Q1 journals. In other words, journals with high impact factors, h-indices, CiteScores, and SJRs receive more citations. This was emphasized in case of library and information sciences classic papers that their publishing journals were in Q1 (Saberi and Ekhtiyari, 2018).

Having more than one author, all classic papers in critical care were multi-authored, this finding is not in accordance with the findings by Saberi and Ekhtiyari (2018). They found that about 60% of the classic papers in library and information science had one author. One reason for that may be the nature of different disciplines. Medical papers are mostly authored by team-based authors. As a result, team work and collaboration increase the received citations. In studying Indian authors' highly-cited papers in Science Citation Index Expanded

database, Elango and Ho (2017) found that collaboration and co-authorship can increase received citations. This emphasizes the importance of scientific collaboration as the mainstream and a motivator of high-quality scientific researches (Lu and Ma, 2017). Scientific collaboration is an inevitable necessity of doing scientific research (Parish,Boyack & Ioannidis, 2018), resulting in producing high-quality works (Hart, 2000), publishing in journals with high impact factors (Low et al., 2014), more scientific productivity (Stvilia et al, 2011), and recieving more citations (Abramo & D'Angelo, 2015; Huang, Wu & Wu, 2015; Mokhnacheva, 2015).

We found that the paper with the lowest citation number in critical care classic papers had 517 received citations in Google scholar. Therefore, it can be said that a potential author with a classic paper in the field should receive more than 500 citations in Google Scholar. In the field of library and information science, this threshold was 410 received citations (Saberi and Ekhtiyari, 2018).

The citations received by critical care classic papers in Google Scholar were more than those by Scopus and Web of Science. This result accords with the findings by Bauer and Bakkalbasi (2005) and Saberi and Ekhtiyari (2018). The reason is that Google Scholar automatically identifies and indexes the received citations, since Scopus and Web of Science have special policies in selecting received citations (Kousha, Thelwall and Rezaie, 2011).

Out of 72 authors of critical care classic papers, 29 authors were affiliated by the research institutes of the United States. The influential role of the United States in contributing to highly cited papers has been explored in several studies (e.g. Connelly et al., 2019; Elango & Ho, 2017; Gogos et al.,2019; Saberi, Barkhan and Hamzehei, 2019; Martín-Del-Río et.al, 2018; Perazzo et al.,2019; Zhang, Quan and Du, 2019; Saberi and Ekhtiyari, 2018; Yang et al., 2019). Therefore, collaboration with authors affiliated by the United States can result in authoring highly-cited papers.

In this study, a significant correlation was found between citations in Google Scholar, Scopus, and Web of Science. In other words, increase in citations received by classic papers in Google scholar results in increase in their received citations in Scopus and Web of Science. This finding is in accordance with the findings by Bauer and Bakkalbasi (2005), and Saberi and Ekhtiyari (2018).

Further research is needed for more theoretical and practical arguments on classic papers. It is proposed that for gain better knowledge on highly-cited and classic papers, the bibliometric status of the classic papers in other fields is studied and the results are compared with the results of this and previous related studies.

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