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## REVIEW ARTICLE

### Bibliometric Analysis Of Research on Coronavirus Infection and Patient Safety in Health Care

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#### Abstract:

##### Objective:

The study aimed at analyzing the international scientific publications on coronavirus infection and patient safety in health care.

##### Methods:

This research is a bibliometric study carried out by searching published articles in the ISI Web of Knowledge/Web of Science database and analyzing the results through bibliometric analysis software HistCite. The selected time frame was between 1970 and 2020, and we used the following descriptors: “coronavirus infection” OR “severe acute respiratory syndrome” OR “COVID-19/SARS-CoV-2”.

##### Results:

We found 5,434 publications in 1,491 different journals; they are written by 18,274 authors linked to 4,064 institutions, which are located in 104 countries. In the citations analysis, the h-index was 155, and the average of citations each article received was 30.79.

##### Conclusion:

During the studied period, the Web of Science database showed two peaks of publications on coronavirus infections. The first comprised 768 articles published between 2003 and 2004 when a new coronavirus caused an outbreak of severe acute respiratory failure. The second consisted of 576 articles published between 2019 and 2020, during the period of the COVID-19 pandemic. The knowledge on coronavirus infection should be widely shared so that new studies can be designed and the world scientific community can contribute to improving patient safety in healthcare and preventing new pandemics of severe acute respiratory infection caused by coronaviruses.

**Keywords:** Coronavirus infection, Severe acute respiratory syndrome, COVID-19, SARS-CoV-2, Pandemic, Patient safety.

#### Article History

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## 1. INTRODUCTION

Patient safety focuses on reducing the risks associated with health care, comprising technologies and products, as well as human relations and communication failures [1].

Aiming to increase the quality of the health services provided, the World Health Organization (WHO) launched the World Alliance for Patient Safety, to which several countries signed a commitment to adopt measures to improve patient care [2].

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In this context, this alliance posed three global challenges: the first, in 2005, foregrounded the prevention of healthcare-associated infections (HAIs); the second, in 2008, concentrated actions on safety in surgical environments [3]; and the third, in 2017, centered on reducing avoidable medication-associated harm [4].

In addition, in 2009, WHO established six international patient safety goals: Identifying patients correctly, Improving health professionals' communication, Improving the safety of high-alert medications, Ensuring safe surgery, Reducing the

risk of HAIs, and Reducing fall-related injuries [5].

In Brazil, to meet WHO global challenges, in 2013, the Ministry of Health and Brazilian Health Regulatory Agency (ANVISA) regulated Ordinance 529/201376 and the Collegiate Board Resolution 36/201387, establishing the Programa Nacional de Segurança do Paciente (PNSP - National Program for Patient Safety) and actions for patient safety in healthcare services, respectively.

Patient safety has gained prominence due to the growing worldwide dissemination of the new coronavirus (COVID-19), as there is evidence of preventable adverse events occurring in the care of contaminated patients.

The COVID-19 is a respiratory disease transmitted by the inhalation of droplets released through coughing or sneezing and by the contact with oral, nasal, or ocular mucosa of infected people [6 - 8].

SARS-CoV-2, the agent of the COVID-19 disease, was first reported in Wuhan, China, at the end of December 2019. It spread quickly in a transcontinental form in a few weeks; therefore, WHO regarded it as an international public health emergency [9, 10]. According to the Pan American Health Organization, as of May 24, 2020, the pandemic had already affected more than 180 countries, a total of 5,344,539 cases reported globally, including 342,695 deaths [11].

The first case of COVID-19 in Brazil was reported on February 26, 2020 [12]. As of February 2020, the country occupied the second position among the world's most infected countries, having 347,398 thousand cases, including 22,013 deaths [13]. The analysis of these cases is useful for inferring important epidemiological parameters, such as incubation and infection period, outbreaks in progress, or the probability of an outbreak.

Health organizations coordinate protocols and guidelines to improve patient safety and rapid circulation of information about the pathology and possible treatments in order to minimize the impact of the disease [14]. However, despite the research works being carried out, there is still no comprehensive knowledge of the transmission mechanisms and clinical aspects of the disease, and there is no definitive treatment and vaccines for the prevention of COVID-19 [15].

In view of the issue discussed, it is crucial to conduct research on coronavirus infection and patient safety in healthcare so that this context can be reviewed and better understood. For this purpose, the questions that guide this study are: What are the valuable sources of coronavirus infection and patient safety in healthcare recognized through different author and citation metrics? What is the analysis of the indicators on different dynamics and evolution of scientific and technological information on coronavirus infection and patient safety in healthcare?

Thus, considering the importance of promoting patient safety, especially in the hospital environment, this study aims to analyze international scientific publications on coronavirus infection and patient safety in healthcare, based on the international patient safety goals.

## 2. METHODS

Bibliometric research was carried out by searching published articles on coronavirus infection and patient safety in health care in the ISI Web of Knowledge/Web of Science database in the period from 1970 to 2020. The descriptors were chosen in accordance with the Medical Subject Headings (MeSH)thesaurus; thus, the terms used for the search are: "coronavirus infection" OR "severe acute respiratory syndrome" OR "COVID-19/SARS-CoV-2."The quotation marks are used to search the exact combinations of terms with more than one word.

Our research followed the three procedures suggested: definition of the database and the criteria to be used for the collection; data collection; and their representation and analysis [16, 17].

After query refinement, which followed the search mechanisms of the chosen database, 5,434 publications were found. Web of Science does not have refinement filters of field, country, or language, covering all publications that contained the three terms. Also, the search results did not include publications such as events, conference proceedings, editorial material, and letters, resulting in only final and complete "articles" and "reviews."

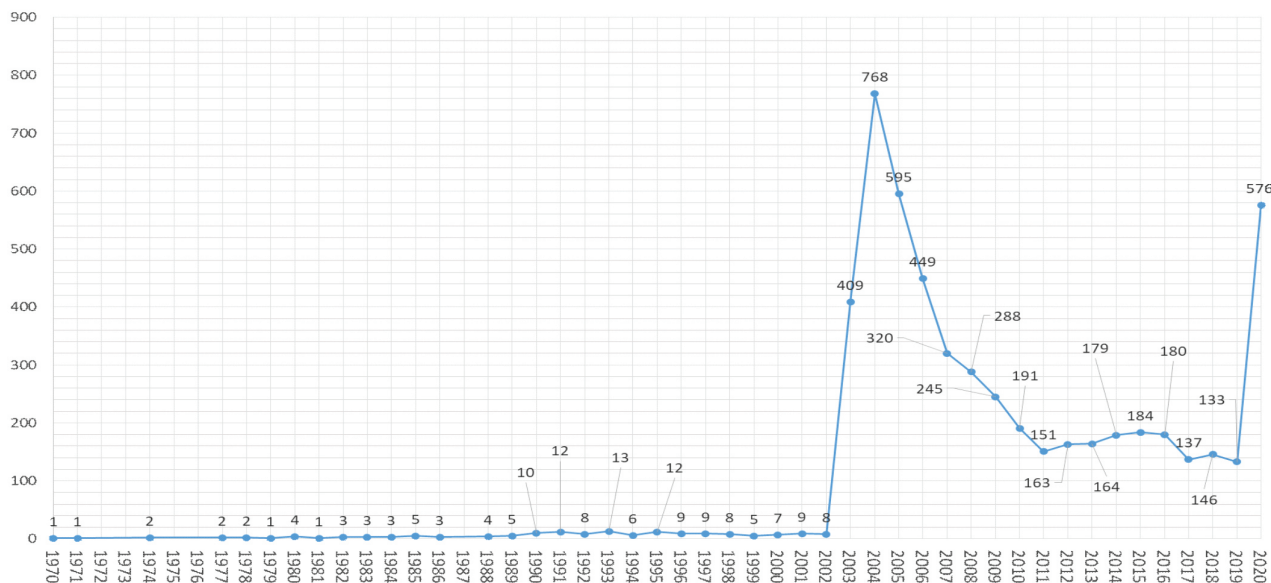
Then, we performed the bibliometric analysis, exporting the data to the software HistCite, which organized the information and facilitated the analysis. This procedure consisted of compiling the trajectory of the annual evolution of publications, the journals with the higher number of issues, the authors who published the most, and the distribution of publications according to authors' country of origin.

In addition to the software analysis, we seek to identify the valuable sources of coronavirus infection and patient safety in healthcare through different author and citation metrics. For this purpose, we carried out a citation analysis of the number of citations and the h-index, based on a list of publications sorted in descending order, and an analysis of the indicators on different dynamics and evolution of scientific and technological information on the topic. Also, we calculated the average citations each article received and the sum of the number of citations of all items in the result set.

Aspects of texts of the 20 articles cited in the Web of Science were elucidated in order to identify their main contributions to the researched theme. We organized the outcomes of our analyses in tables and figures. Also, we adopted the ethical principles recommended for research of this nature, respecting ideas, citations, and authorship of the publications.

## 3. RESULTS AND DISCUSSION

We found 5,434 publications in 1,491 different journals; they are written by 18,274 authors linked to 4,064 institutions, which are located in 104 countries. Our search on the Web of Science database initially had the time frame from 1945 to 2020. However, the oldest entry of an article was from 1970; for this reason, the studied period was 1970 to 2020 (Table 1).



Fonte: Elaboração própria a partir de dados da Web of Science.

Fig. (1). Distribution of publications on coronavirus (1970-2020). Teresina – PI, 2020

Table 1. Overall results of the bibliometric survey on infection by coronavirus and patient safety in health care (1970-2020). Teresina – PI, 2020.

Bibliometric Data	Number
Publications (articles)	5,434
Indexed journals	1,491
Authors	18,274
Institutions (authors' bonds)	4,064
Countries	104
Cited references	90,132

Source: Created by the authors with data from Web of Science.

The evolution of scientific publications on coronavirus infection and patient safety in healthcare, demonstrated by the annual amount of published works in the studied period, reveals that the international interest in the subject began in 1970, with the publication of one article. From 2003 onwards, an increase in the studies was observed when 409 research works were published. In 2004, it reached a peak of 768 publications due to an outbreak of infections by a new coronavirus associated with severe acute respiratory syndrome, which started in China. Finally, 2020 accounted for 576 records, which is the year when the pandemic of COVID-19 emerged, also in China (Fig. 1).

To identify the most representative international journals regarding the researched theme, we examined 1,491 journals, taking into account the number of articles published on the topic and the number of citations of these articles. For this purpose, we defined an index by dividing the number of citations by the number of published works.

Table 2 shows the list of the ten most representative journals according to our analysis. This indicator reveals information on the impact of the works published in these journals.

Table 2. Journals that most published articles (1970-2020). Teresina – PI, 2020.

Journals	Number of Aticles	Citations	Citations/ Number
Journal of Virology	397	7132	17.96
Emerging Infectious Diseases	164	2589	15.79
Virology	86	965	11.22
Journal of Medical Virology	72	350	4.86
Proceedings of The National Academy of Sciences Of The United States of America	64	2956	46.19
Antiviral Research	58	387	6.67
Clinical Infectious Diseases	58	590	10.17
Journal of Infectious Diseases	57	700	12.28
Lancet	54	4857	89.94
Journal of General Virology	53	799	15.08

Source: Created by the authors with data from Web of Science.

The journals with the highest number of publications are the Journal of Virology, having 397 published works and been cited 7,132 times, and the Emerging Infectious Diseases, being represented by 164 works and 2,589 citations. The Journal of Virology featured as the one with the highest impact, as its index was 17.96.

This information is relevant for researchers and research centers as it maps the academic journals that are published most on the subject and are most cited by other studies. It makes it possible to recognize the articles of a more significant impact on the theme.

In the citation analysis of the number of citations, the results indicated the value of the h-index equal to 155, and the average of citations each article received was 30.79, which corresponds to the average number of articles that made the citation for all items in the set of results, which is the sum of

the count of the number of citations divided by the number of results in the set of records, based on a list of publications sorted in descending order. Moreover, the goal was to achieve the sum of the number of citations equal to 168,095, as the total number of citations for all items in the result set.

The next step was identifying the authors that published most on the topic (Table 3).

**Table 3. Authors that most published (1970-2020). Teresina – PI, 2020.**

Authors	Number of Articles	Affiliation (Institution of bond)	Country
Yuen KY	95	The University of Hong Kong	China
Peiris JSM	83	University of Hong Kong	China
Baric RS	82	University of North Carolina at Chapel Hill	USA
Sung JJY	70	The Chinese University of Hong Kong	China
Chan PKS	68	The Chinese University of Hong Kong	China
Chan KH	64	The University of Hong Kong	China
Perlman S	56	University of Iowa	USA
Poon LLM	56	The University of Hong Kong	China
Guan Y	50	The University of Hong Kong	China
Li Y	50	Sichuan Agricultural University	China

Source: Created by the authors with data from Web of Science.

The authors with the highest number of publications on the theme, in the Web of Science, were Yuen KY, having published 95 articles, Peiris JSM, having 83 published articles, and Baric RS, having 82 published articles.

We also observed the countries which have the higher scientific publications. Table 4 shows an overview of the institutions of the representative countries to which authors were linked.

China and United States feature as the most representative countries. The former was the most prominent country, with 1,767 publications. The latter is the second, with 1,570 publications. Brazil appears in the 20<sup>th</sup> position, having 42

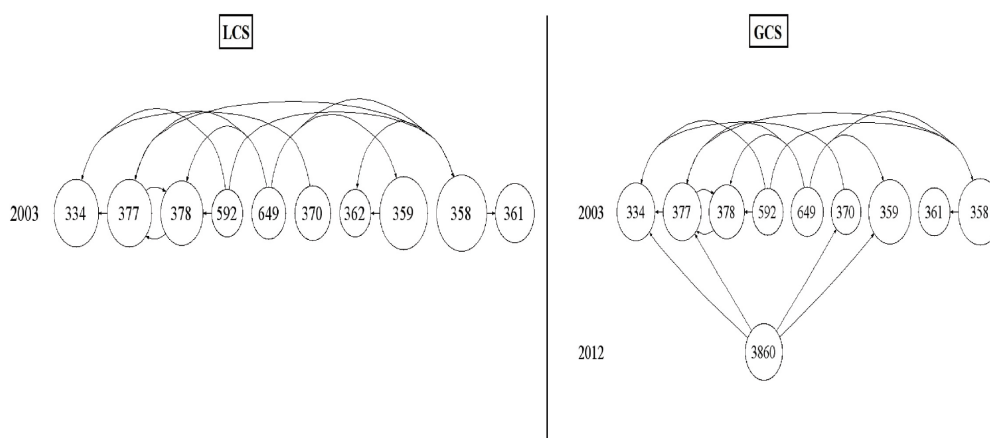
publications on the topic.

To conclude our analysis, we examined how the most cited articles were connected. For that, we divided them into two groups: (I) articles that received most citations from other works through the database of ISI Web of Science™ (GCS) and (II) articles that received most citations from the works of the selected group of this bibliometric study (LCS). Fig. (2) indicates the most representative studies on the subject by showing the number of citations and the connections between the analyzed works through citations (represented by lines connecting the circles). Thus, groundbreaking research and subsequent studies are pointed out.

**Table 4. Amount of articles by country of origin of the institutions of bond of the authors (1970-2020). Teresina – PI, 2020.**

Country	Amount
China	1,767
USA	1,570
Canada	432
Taiwan	358
UK	320
Singapore	287
Germany	266
Japan	215
Unknown	203
Netherlands	176
Italy	161
Australia	157
South Korea	136
France	135
Saudi Arabia	106
Switzerland	95
India	87
Spain	84
Belgium	42
Brazil	42

Source: Created by the authors with data from Web of Science.



**Fig. (2).** Top 25 articles most cited on the Web of Science (Global Citation Score) and most cited by the selected articles (Local Citation Score), within the selection set (1970-2020).

Upon observing the connections between the texts, we can identify the figures as titled authority article or baseline article; they refer to article XXXX358, [18] which have 1,939 citations, that is, 107.72 citations per year. This work is the primary source of other studies, which, for their part, also were highly cited. These studies are 359 [19] (Drosten, C; Gunther, S; Preiser, W; *et al.*, 2003); 377 [20] (Rota, PA; Oberste, MS; Monroe, SS; *et al.*, 2003); 334 [21] (Peiris, JSM; Lai, ST; Poon, LLM; *et al.*, 2003); 3,860 [22] (Zaki, Ali Moh; Van Boheemen, Sander; Bestebroer, Theo M.; *et al.*, 2012); 378 [23] (Marra, MA; Jones, SJM; Astell, CR; *et al.*, 2003); 649 [24] (Li, WH; Moore, MJ; Vasilieva, N; *et al.*, 2003); 361 [25] (Lee, N; Hui, D; Wu, A; *et al.*, 2003); 592 [26] (Guan, Y; Zheng, BJ; He, YQ; *et al.*, 2003), and 370 [27] (Peiris, JSM; Chu, CM; Cheng, VCC; *et al.*, 2003).

Besides the authority article, there are hub or connection articles, which are those that condense important information from previous works by connecting them to more recent ones and also are highly cited. There were two hub articles in our analysis, 1,998 [28] (Li, WD; Shi, ZL; Yu, M; *et al.*, 2005), which had been cited 897 times, and 1,960 [29] (Lau, SKP; Woo, PCY; Li, KSM; *et al.*, 2005), which had received 671 citations.

As our research is based on the WHO six International patient safety Goals [5], we discuss in detailed the 25 publications of most significant impact on the chosen theme articulating these goals.

Of these 25 publications, 13 (52%) were related to the fifth goal of- reducing the risk of HAIs, namely, 35919 Identification of a Novel Coronavirus in Patients with Severe Acute Respiratory Syndrome; 369 [30] Epidemiological determinants of spread of causal agent of severe acute respiratory syndrome in Hong Kong; 334 [21] Coronavirus as a possible cause of severe acute respiratory syndrome; 370 [27] Clinical progression and viral load in a community outbreak of coronavirus-associated SARS pneumonia: a prospective study; 377 [20]. Characterization of a Novel Coronavirus Associated with Severe Acute Respiratory Syndrome; 425 [31] Spread of SARS(Book chapter); 484 [32] Newly discovered coronavirus as the primary cause of severe acute respiratory syndrome; 967 [33] Identification of a new human coronavirus; 2,031 [34] Superspreading and the effect of individual variation on disease emergence; 3,860 [22] Isolation of a Novel Coronavirus from a Man with Pneumonia in Saudi Arabia; 371 [35] Lung pathology of fatal severe acute respiratory syndrome; 361 [25] A Major Outbreak of Severe Acute Respiratory Syndrome in Hong Kong; 358 [18] A Novel Coronavirus Associated with Severe Acute Respiratory Syndrome.

Three studies (12%) were related to the third goal of improving the safety of high-alert medications and the fifth goal, namely 362 [36] Identification of Severe Acute Respiratory Syndrome in Canada; 414 [37] Clinical Features and Short-term Outcomes of 144 Patients With SARS in the Greater Toronto Area; 5,096 [38] Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. One article (4%), A Cluster of Cases of Severe Acute Respiratory Syndrome in Hong Kong, was related to the first goal of identifying patients correctly; it also relates to the third and

fifth goals. Another one (4%), Corona Main Proteinase (3CLpro) Structure: Basis for Design of anti-SARS Drugs, was related only to the third goal.

Three studies (12%) investigated animals (bats) as natural reservoirs of coronaviruses similar to SARS and related to the fifth goal, titled 1,960 [29] Severe acute respiratory syndrome coronavirus-like virus in Chinese horseshoe bats; 592 [26] Isolation and Characterization of Viruses Related to the SARS Coronavirus from Animals in Southern China, and 1,998 [28] Bats Are Natural Reservoirs of SARS-Like Coronaviruses [38 - 40].

Four studies (16%) focused on the molecular description of the virus; however, they were related to the international patient safety goals. These studies were 515 [41]. Unique and Conserved Features of Genome and Proteome of SARS-coronavirus, an Early Split-off From the Coronavirus Group 2 Lineage; 649 [24]. Angiotensin-converting enzyme 2 is a functional receptor for the SARS coronavirus; 1,560 [42]. Characterization and Complete Genome Sequence of a Novel Coronavirus, Coronavirus HKU1, from Patients with Pneumonia, and 378 [23]. The Genome Sequence of the SARS-Associated Coronavirus.

None of 25 most cited articles of our analysis directly refers to the second goal, improving health professionals' communication, the fourth, ensuring safe surgery, nor the sixth, preventing fall-related injuries. Although, communication, surgical procedures, and accidents are important themes in the care of patients infected by coronaviruses.

The relation of the 25 publications of greatest impact with WHO's Goals for patient safety in healthcare demonstrates that, in international literature, the subject was widely discussed during the two pandemics of coronaviruses infection, in 2003 and 2004 and 2019 and 2020. The analysis of the dynamics and evolution of scientific information about coronavirus infection and patient safety in healthcare showed a large number of studies related to –the fifth goal, reducing the risk of HAIs. Nonetheless, there is a gap in knowledge when considering goals number 2, 4, and 6, demonstrating little articulation among the studies, authors, and institutions around the world.

This bibliometric analysis has a limitation as it has used only one database, Web of Science; although, it serves as a point of reference of scientific citations designed to support scientific research works and academic institutions for its extensive coverage of sciences and social sciences. Also, another limitation is related to the HistCite software, which does not allow selecting articles according to low and middle-income countries.

## CONCLUSION

We found 5,434 publications on coronavirus infection in 1,491 different journals; they are written by 18,274 authors linked to 4,064 institutions, which are located in 104 countries. These publications are valuable sources on the topic, recognized through different author and citation metrics. The Web of Science database showed two peaks of publications. The first comprised 768 articles and was in 2003 and 2004 when a new coronavirus caused an outbreak of severe acute

respiratory failure. The second consisted of 576 articles published between 2019 and 2020, the period of the COVID-19 pandemic.

Given the evolution and spread of COVID-19 disease, this research is of great relevance for the nursing field, as it deals with coronavirus infection and patient safety in healthcare. The SARS-CoV-2 caused more than one million deaths, collapses in health systems, and severe effects on the economy worldwide. Nursing professionals are ensuring patient safety by adopting standard precautions and biosafety measures to prevent and control the pandemic. These are fundamental measures, as there is little evidence of effective actions to reduce risks related to safety, as well as limited official care protocols. Through scientific communication and technology, we can make advancements in early diagnosis and treatment. The set of evidence on the subject, even if preliminary in all areas, including nursing, is sufficiently relevant for discovering new diagnostic methods and new treatment strategies, especially for more critical patients in Intensive Care Units. Therefore, we consider that our study contributes to encouraging nursing teams to keep up to date on the global and national scenario of human infection by a coronavirus and actively intervene in the prevention and control of this disease.

The knowledge on coronavirus infection should be deepened and widely shared so that new studies can be designed, and the world scientific community can contribute to improving patient safety in health care and preventing new pandemics of severe acute respiratory infection caused by coronaviruses.

#### CONSENT FOR PUBLICATION

Not applicable.

#### AVAILABILITY OF DATA AND MATERIALS

The data sets used during the current study can be provided from the corresponding author [N.A.], upon reasonable request.

#### FUNDING

None.

#### CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

#### ACKNOWLEDGEMENTS

Declared none.

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