

# A bibliometric analysis using VOSviewer: Leadership in infection prevention and control



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**Abstract** This study aims to analyze the development of publications about inner leader infection prevention and control in healthcare facility settings using the SCOPUS database. This study uses a bibliometric analysis approach using the VOSviewer software tool to construct and visualize a bibliometric network. Researchers screened by leading keywords in infection prevention and control in the SCOPUS database for 2003-2022. The number of publications according to the keywords initially appeared as many as 922 articles, and then after filtering, the final result was that the number of publications was 369. The development of publications on leadership in infection and prevention control in the past 20 years has continued to increase and reached its highest point in 2020. Based on the analysis results with VOSviewer and the network visualization of co-occurrence based on keywords, there are 52 items divided into 4 groups (clusters) marked with different colors. The COVID-19 pandemic did not cause publications on the topic of leaders in infection prevention and control to decrease. On the contrary, it reached its highest point in the 2003-2022 period, namely in 2020. The analysis results using the VOSviewer application show a link between leadership and infection prevention and control interesting network for further research. This can be seen in network visualization, overlay visualization, and density visualization results.

**Keywords:** leadership, leader, infection prevention and control, healthcare

## 1. Introduction

Infections that occur in hospitals, previously known as nosocomial infections (Khan et al 2017) and later known as Healthcare-Associated Infections (HAIs), are infections that are acquired as a result of the process of health services provided at healthcare facilities (Voidazan et al 2020). HAIs can occur in patients and can also be experienced by employees or officers who provide health services (Parmeggiani et al 2010). In connection with the recent COVID-19 pandemic, health service facilities are required to improve their services to realize patient safety (Patel et al 2021; Alboksmaty et al 2021). The realization of patient safety in healthcare facilities can be achieved by planning and implementing infection prevention and control efforts (Christenson et al 2006).

All employees or officers must carry out infection prevention and control efforts in a health service facility, namely by having the knowledge and ability to implement (participate) in providing health services (Bayleyegn et al 2021; Geberemariam et al 2018). For example, healthcare facility staff who have close contact with patients or the patient care environment are nurses and cleaning services. Nurses are expected to be able to provide care to patients through the principles of infection prevention and control so that infection does not occur and achieve patient safety (Donati et al 2020).

The cleaning staff also plays an important role in preventing and controlling infections by cleaning the hospital environment (Quinn et al 2015). Especially with the COVID-19 pandemic, health service facilities must improve environmental hygiene to provide a safe and comfortable environment for all recipients of health services, including the health service providers themselves (Peters et al 2022). To achieve this, knowledge and skills are needed to be related to cleaning the environment by the principles of infection prevention and control (Doll et al 2018; Hall et al 2016).

Participation in infection prevention and control in health service facilities so that they can run well and achieve the expected goals, namely the realization of security and safety for all people in health service facilities, especially the creation of patient safety, a team or organization that is specifically responsible for infection prevention and control activities (Castro-Sánchez and Holmes 2015). The organization will run optimally if the roles and functions of the leader function properly (Saint et al 2010). A leader in an infection prevention and control organization is very important because, in addition to mobilizing its members to carry out their duties and responsibilities, they must also be able to solve problems related to infection prevention and control problems (Knobloch et al 2018).

This research aims to analyze the development of publications about leaders in infection prevention and control in the healthcare setting for 20 years (2003-2022) using data accessed on SCOPUS. The topic is interesting to remember that



prevention, and control is very important to implement in healthcare facilities, and the role of a leader is an important factor in infection prevention and control efforts, especially with the COVID-19 pandemic in the past 3 years.

### 1.1. Literature review

#### 1.1.1. Healthcare-associated infections (HAIs)

The incidence of infection in healthcare facilities, which was previously known as a nosocomial infection, is now better known as Healthcare-Associated Infections (HAIs), which is important to note and manage with a good and correct strategy by all units in healthcare facilities (Haque et al 2020), to provide security and safety for all health workers, employees, patients, and visitors to health service facilities (Al-Tawfiq and Tambyah 2014). HAIs are infections that occur during the process or as a result of health services in healthcare facilities (Voidazan et al 2020). HAIs incidents must be prevented or dealt with immediately if they are found, so the hospital as a healthcare facility must have an organization responsible for infection prevention and control to prevent HAIs from occurring or be able to take steps to deal with HAIs when incidents of HAIs are found (Castro-Sánchez and Holmes 2015).

All employees in a healthcare facility, especially health workers, must understand and participate in infection prevention and control activities, especially those directly involved in patient care (Bessesen et al 2021). It is not enough to be equipped with knowledge about infection prevention and control, and health workers must be able to implement and comply with infection prevention and control efforts (Ashinyo et al 2021; Alhumaid et al 2021). Apart from implementing infection prevention and control when providing services to patients, health workers must also participate in the cleanliness of the room and environment of healthcare facilities (Curryer et al 2020). In addition, the patient must also carry out involvement in infection prevention and control efforts (Agreli et al 2019). To support involvement in infection prevention and control in healthcare facilities, a team or organization is needed that is responsible for this (Knobloch et al 2019).

#### 1.1.2. Organization of infection and prevention control in healthcare

The infection prevention and control organization can take the form of a team or committee, according to the capacity of a hospital's resources. This is to what is stated in the Managerial Guidelines for Regulation of the Minister of Health of the Republic of Indonesia Number 27 of 2017 concerning Guidelines for Infection Prevention and Control in Health Service Facilities, which states that Infection prevention and control activities in health service facilities is a quality standard of service and is important for patients, healthcare workers, and visitors. All healthcare facilities must carry out infection control to protect patients, health workers, and visitors from infection due to cost-effectiveness (Hessels et al 2016). Implementation of infection and prevention control in health service facilities must be managed and integrated between the structural and functional of all departments/installations/divisions/units by forming an organization by the philosophy and objectives of infection and prevention control in the form of a infection and prevention control Team or Committee.

One of the main activities of infection prevention and control organizations in healthcare facilities is surveillance (Khan et al 2017), especially during the COVID-19 pandemic that has occurred in the last three years (Choi et al 2021). According to the Regulation of the Minister of Health of the Republic of Indonesia Number 27 of 2017, surveillance is an activity of systematic and continuous observation of data and information about the incidence of diseases or health problems and conditions that affect the occurrence and transmission of diseases or health problems to obtain and provide useful information directing effective and efficient infection control and control measures. Surveillance must be carried out every day or every time there is a patient service/care process carried out by trained health workers, namely the Infection Prevention and Control Nurse (IPCN) (Asmara et al 2019) and assisted the Infection Prevention and Control Link Nurse (IPLCN) (Ward 2016; Peter et al 2018).

Surveillance will provide information to relevant parties about data on HAIs events that can be used as analysis material to find the causes of HAIs events. Many studies have discussed the causes of HAIs in healthcare facilities, one of which is in a hospital. The incidence of HAIs in hospitals can be caused by the colonization of pathogens or microorganisms, which can be a source of infection, as stated in a study (Weber et al 2013), so it is necessary to increase environmental cleaning followed by disinfection (Quinn et al 2015). Especially with the recent COVID-19 pandemic, hospitals are required to carry out environmental management properly and correctly by the principles of infection prevention and control (Dietz et al 2020; Yen et al 2020). Officers closely related to environmental management in hospitals are environmental health workers (sanitarians), IPCN, and cleaning services; in many studies, they are called Environmental Service Workers (ESW).

Janitors (cleaning service) are officers who directly carry out surface cleaning or environmental cleaning in all areas of the hospital, so good skills are needed to carry out safe, good, and correct cleaning techniques. To achieve these technical cleaning skills, good and correct perception, attitude, understanding, or knowledge regarding the principles of infection prevention and control and the principles of cleaning and disinfecting the hospital environment are needed for hospital cleaners (Matlow et al 2012; Allen et al 2018). One example of the knowledge and understanding that must be given to hospital cleaners is related to standard precautions (Wong et al 2021).

#### 1.1.3. Leadership in healthcare system

The healthcare system requires a leader who can coordinate and integrate all elements in the health service facility properly, efficiently, and effectively to create professional and safe health services for patients, families, hospital visitors, and employees (Baker and Denis 2011). Leaders who are effective in running and leading a health service facility are leaders who can create, improve, or maintain the quality of health services that are oriented towards realizing safety (safety), especially for patient safety (patient safety) (Kumar and Khiljee 2016).

Leaders in health service facilities are also said to be effective if they can create a work culture in which health workers providing health services work professionally and by the code of ethics of each profession (Sakr et al 2022). The COVID-19 pandemic in the past 3 years has required leaders in health service facilities to continue to make changes, adjustments, improvements, and improvements to sustainable health services (Graham and Woodhead 2021). The improvement and improvement of health services must, of course, be balanced with improvements and increased communication between care providers or health services, so a leader is needed to make this happen (Leach et al 2021).

#### 1.1.4. Leadership in infection and prevention control

In the era of the COVID-19 pandemic, hospitals, through management in collaboration with environmental health officers, IPCN, and related units, must be able to take appropriate steps or strategies in terms of managing, monitoring, and evaluating the performance of hospital cleaners to be able to clean the environment according to standards (Hall et al 2020). Monitoring and evaluation are carried out by organizations that are specifically responsible for infection prevention and control efforts (Griffiths et al 2009). These infection prevention and control organizations can work well if the role and function of the leader can run well too, especially with The recent COVID-19 pandemic required creativity, activeness, involvement and the presence of a leader (Crain et al 2021).

A good leader is a leader who is capable of solving problems, especially in terms of infection prevention and control efforts, to prevent or reduce the occurrence of infections resulting from the provision of health services to patients, families, hospital visitors, and employees (Knobloch et al 2018). The role of the leader in an infection prevention and control organization is essential, considering that an organization cannot run well and optimally if the functions and duties of the leader are not running well and optimally either. Leaders are responsible for ensuring, supervising, and evaluating that infection prevention and control efforts can work properly and effectively so that they can provide health services by prioritizing patient safety (Ginsburg et al 2010).

## 2. Materials and Methods

This study analyzes evidence-based developments about leaders in infection prevention and control using a database online SCOPUS. The database was analyzed using the VOSviewer software tool to construct and visualize a bibliometric network using a bibliometric approach. The VOSviewer software tool used is version 1.6.18 was released on January 24, 2022 which is a product of Leiden University's Center for Science and Technology Studies (CWTS), The Netherlands. Researchers screened publications about the leader in infection prevention and control in the SCOPUS database in the 2003-2022 year range.

The researchers screened the database for 20 years to get a broad picture of developments in writing or publications related to leaders in infection prevention and control. Researchers filter publications by determining restrictions, including year, subject area, document type, keywords, and language. The final number of publications after the screening was 369 articles from the initial number before the screening of 922 articles. The filtering results are then exported in a CSV file format. Furthermore, the file is analyzed using VOSviewer software. The research method the researcher used in compiling this bibliometric is more clearly explained in Figure 1.

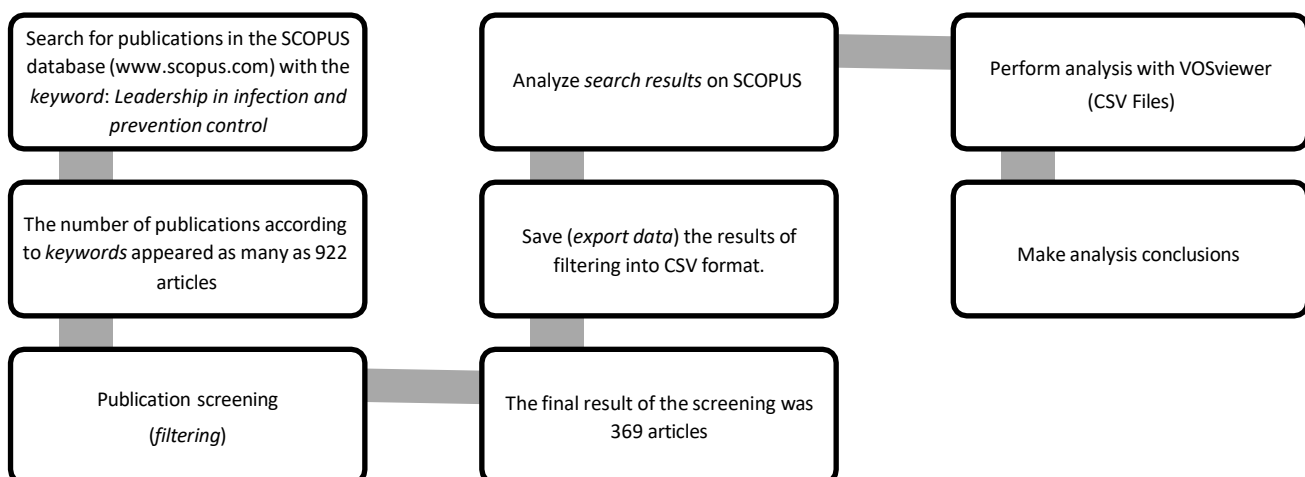


Figure 1 Research methods.

### 3. Results

#### 3.1. Publication per year

The development of publications on leadership in infection and prevention control for the past 20 years is quite interesting. As shown Figure 2, the trend tends to increase from 2003 until it reached its highest point in 2020. Interestingly, when the world was in the COVID-19 pandemic in the range of 2019 to 2021, it did not cause publications to decline. On the contrary, the number of publications reached its highest point in 20 years, namely in 2020, then decreased from 2021 to 2022.

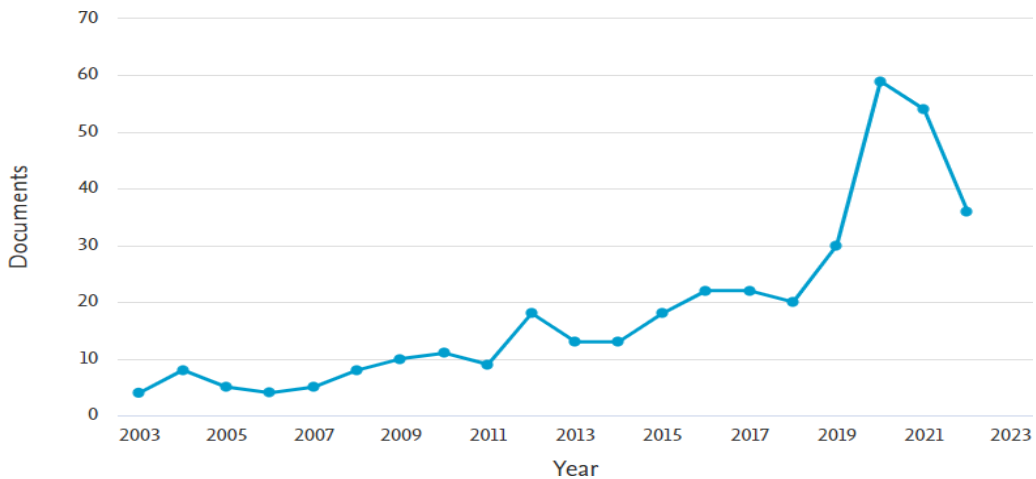


Figure 2 Annual publications. Source: Scopus Database.

#### 3.2. Documents by affiliation

Based on Table 1, it can be seen that in 20 years, the most affiliations were by the Centers for Disease Control and Prevention with 20 articles, followed by Organization Mondiale de la Santé with 17 documents, then followed sequentially: by the University of Michigan Medical School 12 documents; VA Ann Arbor Healthcare System 12 documents; and in 10th place affiliation with the University of Washington with 8 documents.

Table 1 Top 10 affiliates related to the topic.

Affiliate	Number of Publications
Centers for Disease Control and Prevention	20
Organization Mondiale de la Santé	17
University of Michigan Medical School	12
VA Ann Arbor Healthcare System	12
Harvard Medical School	11
University of Toronto	11
University of California, San Francisco	11
University of Michigan, Ann Arbor	10
VA Medical Center	9
University of Washington	8

Source: Scopus Database

#### 3.3. Documents by author

Based on Table 2, the most influential author is Saint, Sanjay K., a writer from the United States who has contributed to the publication of 489 documents and whose publications totaled 24,885. At the same time, the second position went to Krein, Sarah L., a writer from the United States with a total of 247 publications that have been written and 8,352 documents whose publications have been cited.

The table above shows that the countries that contributed the most publications on research topics were the United States with 192 documents, followed by the United Kingdom with 45 documents, and Australia in third place with 29 documents. The results shown in the table above are quite interesting. The country where research on the topic in the Asian continent was conducted was only China. Even then, in the top 10 countries, most publications related to the topic occupy the 7th position.



**Table 2** Top 10 authors with the most publications related to the topic.

Author	Number of Publications
Saint, Sanjay K.	12
Krein, Sarah L.	9
Allegranzi, Benedetta	6
Pittet, Didier	6
Knobloch, Mary Jo	5
Safdar, Nasia	5
Tomczyk, Sara M.	4
Holmes, Alison Helen	4
Mody, Lona R.	4
Stone, Patricia W.	4

Source: Scopus Database

### 3.4. Documents by country

The Table 3 shows that the countries that contributed the most publications on research topics were the United States with 192 documents, followed by the United Kingdom with 45 documents, and Australia in third place with 29 documents. The results shown in the table above are quite interesting. The country where research on the topic in the Asian continent was conducted was only China. Even then, in the top 10 countries, most publications related to the topic occupy the 7th position.

**Table 3** Top 10 countries with the most publications related to the topic.

Country	Number of Publications
United States	192
United Kingdom	45
Australia	29
Switzerland	26
Canada	22
South Africa	19
China	13
France	9
Germany	9
Tanzania	8

Source: Scopus Database

### 3.5. Documents per year by source

**Table 4** Top 10 publications based on the most sources related to the topic.

Source	Number of Publications
American Journal Of Infection Control	34
International Journal Of Environmental Research And Public Health	11
Infection Control And Hospital Epidemiology	10
Clinical Infectious Diseases	8
Journal Of Hospital Infection	8
BMC Health Services Research	6
Globalization And Health	6
Journal Of Acquired Immune Deficiency Syndromes	6
Antimicrobial Resistance And Infection Control	5
BMJ Open	5

Source: Scopus Database

### 3.6. Co-occurrence of Keywords

Based on the analysis results with VOSviewer, the network visualization of co-occurrence based on keywords, as shown in Figure 3, has 52 items divided into 4 clusters marked with different colors. Cluster 1 consists of 19 items, such as the attitude of health personnel, hand hygiene, healthcare personnel, infection control, healthcare-associated infection, infection control, infection prevention, patient safety, and staff training. Cluster 2 consists of 16 items, such as COVID-19, healthcare management, healthcare organization, healthcare system, medical education, medical staff, and personal protective equipment. Cluster 3 consists of 10 items: behavior change, decision-making, education, health education, leadership, and

motivation. While cluster 4 consists of 7 items: healthcare planning, quality, organization, organization and management, program development, program evaluation, and public health service.

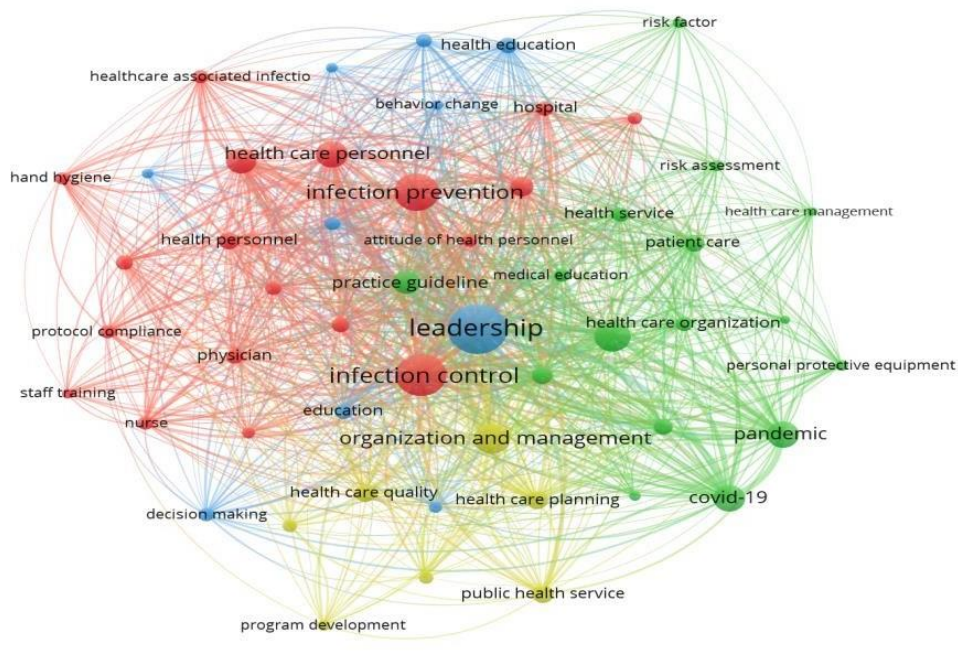


Figure 3 Network visualization of co-occurrence based on keywords.

### 3.7. Co-authorship

As shown in Figure 4, the most influential writer in 20 years on the research topic is Saint, Sanjay K., followed by Krein, Sarah L., and Allegranzi, Benedetta.

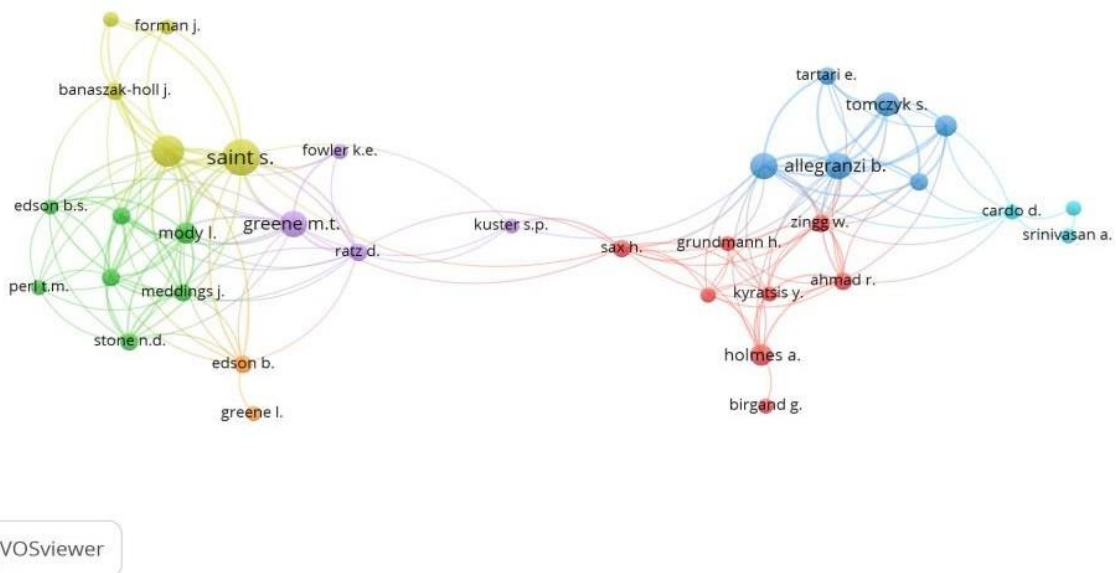
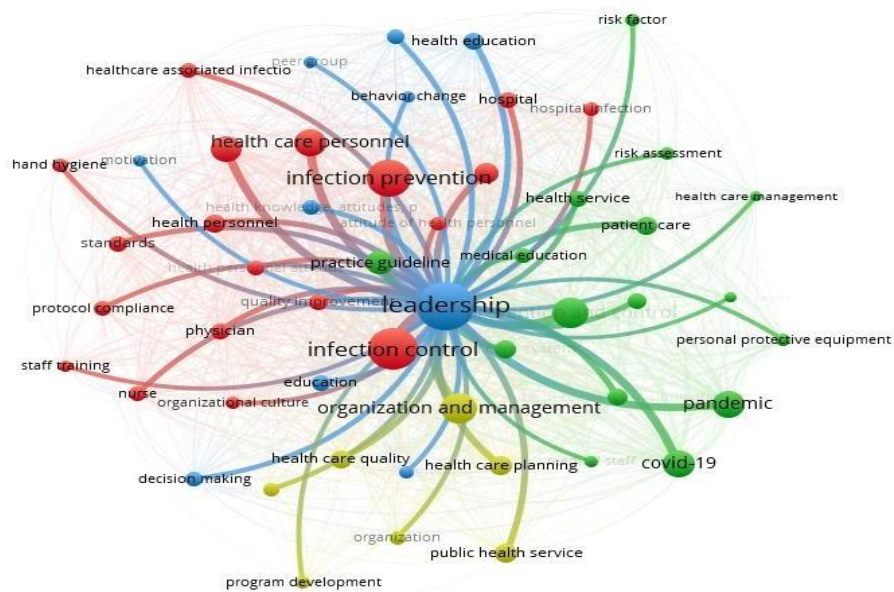


Figure 4 Co-authorship.

### 3.8. Co-occurrence of keyword: Leadership

Based on the results of the analysis with VOSviewer, the results of the network visualization of co-occurrence based on the keyword: leadership as shown in Figure 5, it is known that the keyword leadership has relations with quite some items such as infection control, organization, and management, procedure, practice guideline, healthcare personnel, patient safety, COVID-19, pandemic, personal protective equipment, healthcare planning, nursing education, behavior change, education, physician attitude, staff training, decision making, program development.

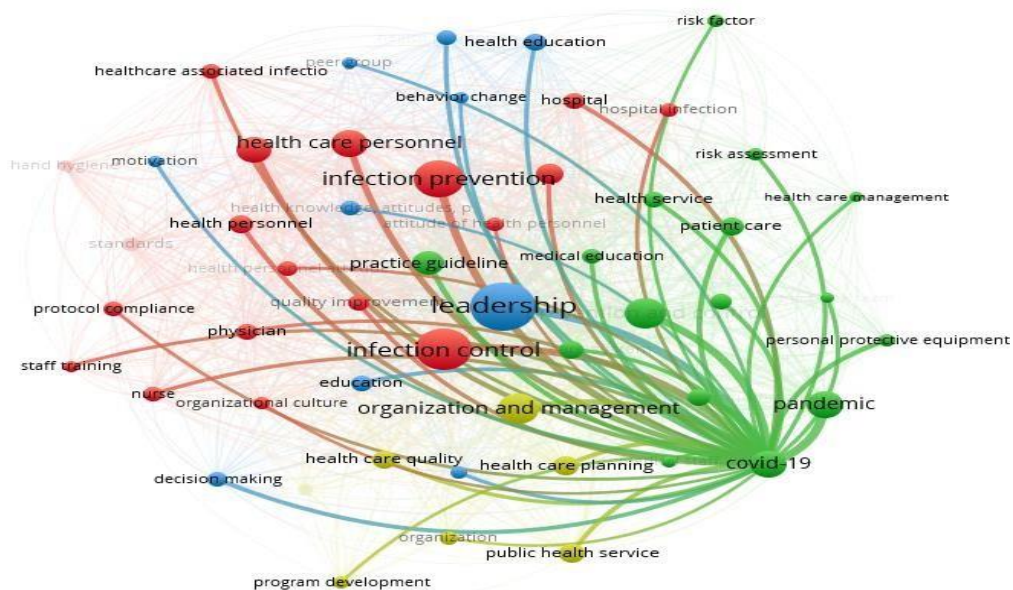




**Figure 5** Network visualization of co-occurrence based on keyword: Leadership.

### 3.9. Co-occurrence of keyword: COVID-19

Based on the results of the analysis with VOSviewer, the results of the network visualization of co-occurrence based on the keyword: COVID-19, as shown in Figure 6, it is known that the keyword COVID-19 has quite some related items such as leadership, infection control, organization and management, practice guidelines, healthcare personnel, prevention and control, staff training, professional standard, nursing staff, public health service, protocol compliance, healthcare management, risk assessment, health education, organizational culture.

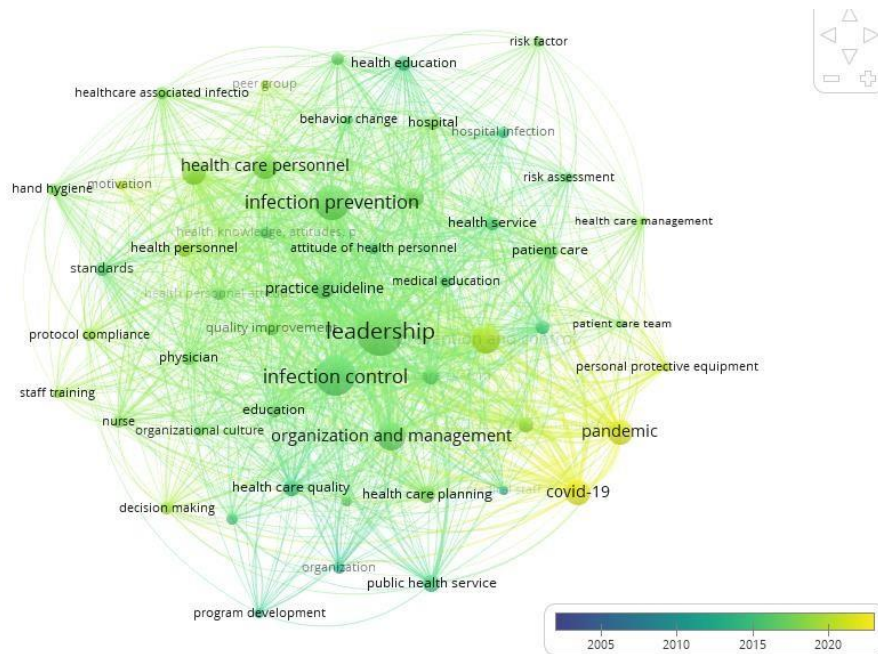


**Figure 6** Network visualization of co-occurrence based on keyword: COVID-19.

### 3.10. Overlay visualization of leadership in infection prevention and control

According to the founders of the VOSviewer application (van Eck and Waltman 2023), overlay visualizations are used to show the progress of publications over time. In this study, the authors set the range of years in the overlay visualization from 2003 to 2022, as shown in Figure 7. A circle with a darker color (blue) indicates the year of publication is older, while on the contrary, a circle with a lighter color (yellow) indicates the year of publication is newer. For example, the author displays publications about leadership in infection prevention and control as shown in Figure 7, which shows that publications about leadership and infection control are marked with a green circle, which means the publications were made around 2015 to 2020 and interestingly the publications on this topic are networked with the topic of the publication, both with publications in earlier

or later years. This shows that publications about leadership in infection prevention and control are still quite interesting to be explored further.

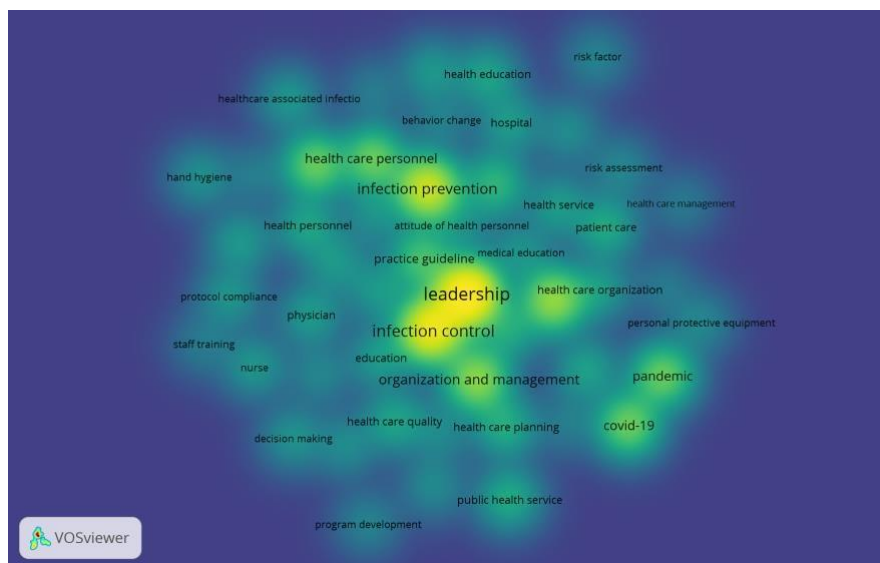


**Figure 7** Overlay visualization of leadership in infection prevention and control publications 2003-2022.

**3.11. Item density visualization of leadership in infection prevention and control**

Figures 8 and 9 are density visualizations used to show an overview of the main items and clusters on the research topic. According to (van Eck & Waltman, 2010), each point on the item density has a color that indicates the item density at that point. By default, colors range from blue to green to yellow; the greater the number of items around a point and the higher the weight of the surrounding items, the closer the color of the dot is too yellow. Conversely, the smaller the number of items around a point and the lower the weight of the items around it, the closer the point's color is to blue, as shown in Figure 8.

Cluster density is similar to item density except that item density is shown separately for each item cluster. In cluster density, the color of a point in the visualization is obtained by mixing different cluster colors. The weight assigned to a particular cluster color is determined by the number of items belonging to that cluster around that point, as shown in Figure 9. Each point on the map has a color that depends on the density of items at that point. The density view is very useful for getting an idea of the general structure of the map and for drawing attention to the most important areas of the map. Figure 9 shows the dominant clusters related to transformational leadership clusters, such as leadership, infection control, infection prevention, organization and management, and healthcare personnel.



**Figure 8** Item Density visualization of leadership in infection prevention and control publications 2003-2022.



3.12. Cluster density visualization of leadership in infection prevention and control

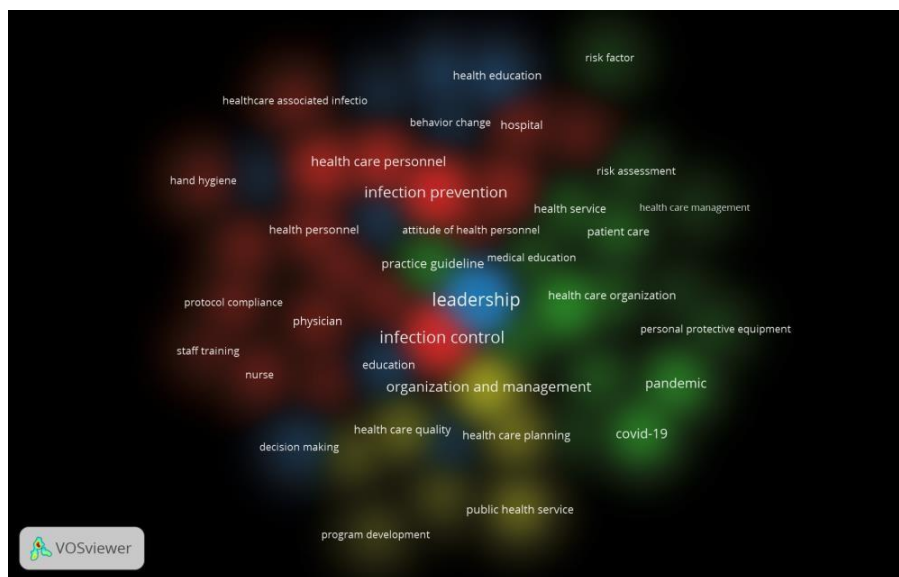


Figure 9 Cluster Density visualization of leadership in infection prevention and control publications 2003-2022.

Leaders have an important role in terms of infection prevention and control efforts through the organization that is responsible for the implementation of infection prevention and control. This is to the results of research conducted by (McAlearney et al 2013), which concluded that, in general, the success and sustainability of HAIs prevention are determined by the role of leadership. The results of VOSviewer's analysis in this study also reinforce this opinion, as seen from the results of the co-occurrence of keywords: leadership is connected with quite some items, ranging from infection control, healthcare personnel, behavior change, healthcare planning, education, staff training to the COVID-19 pandemic which occurred within 3 years. Research conducted by (Aagaard and Earnest 2021) supports this; namely, the role of a leader is important and very much needed in terms of handling the COVID-19 pandemic through effective decision-making and leadership communication.

Leaders are expected to be able to make changes or create a work culture in healthcare facilities that are oriented toward patient safety oriented. This is to the results of research by (Ginsburg et al 2010), which says that leadership support is very important in terms of services that can prioritize the realization of patient safety. The results of VOSviewer's analysis in this study also support the results where patient safety items are linked to leadership, infection control, healthcare personnel, and staff training. More details can be seen in Figure 10.

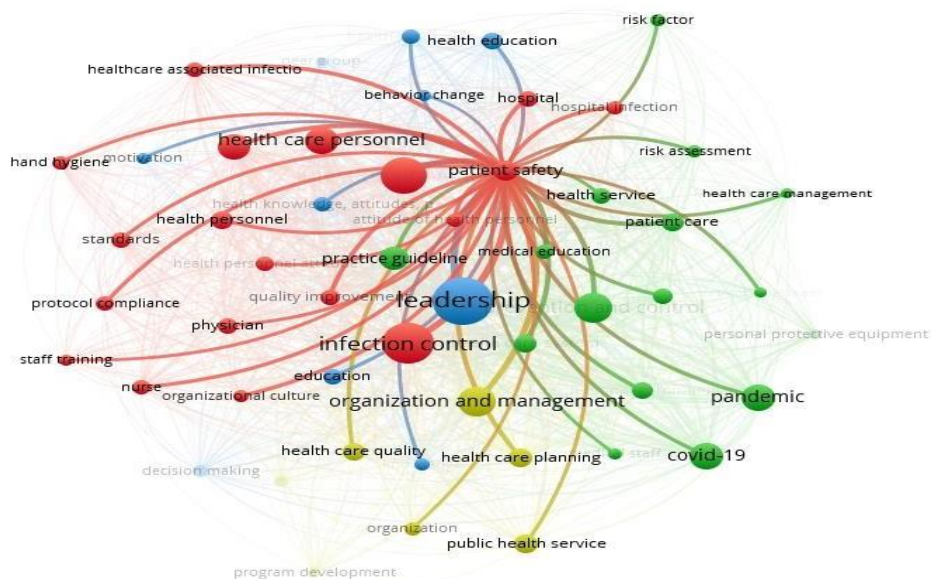
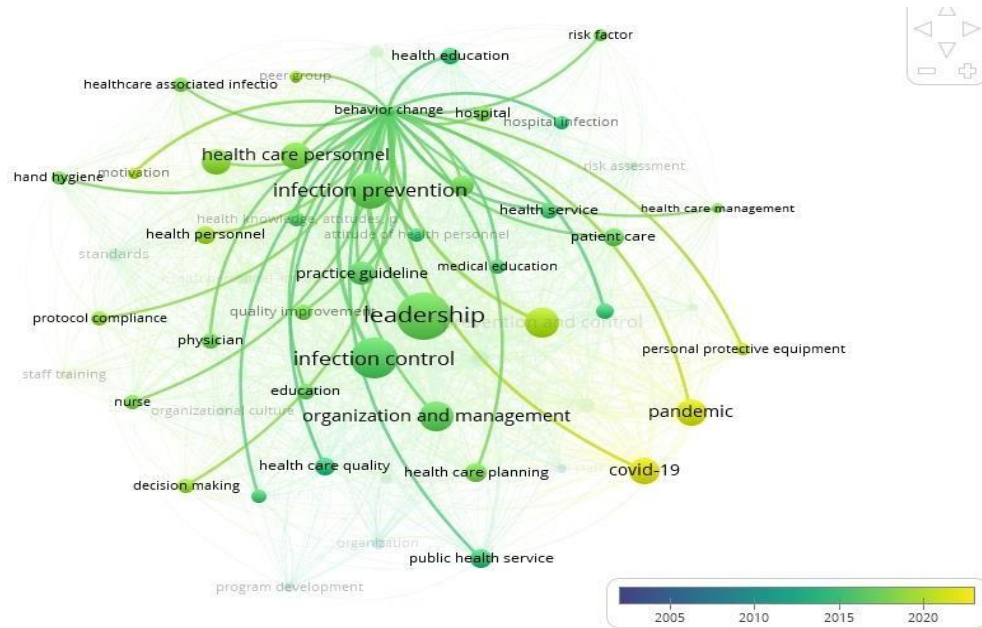


Figure 10 Network visualization of co-occurrence based on keyword: patient safety.

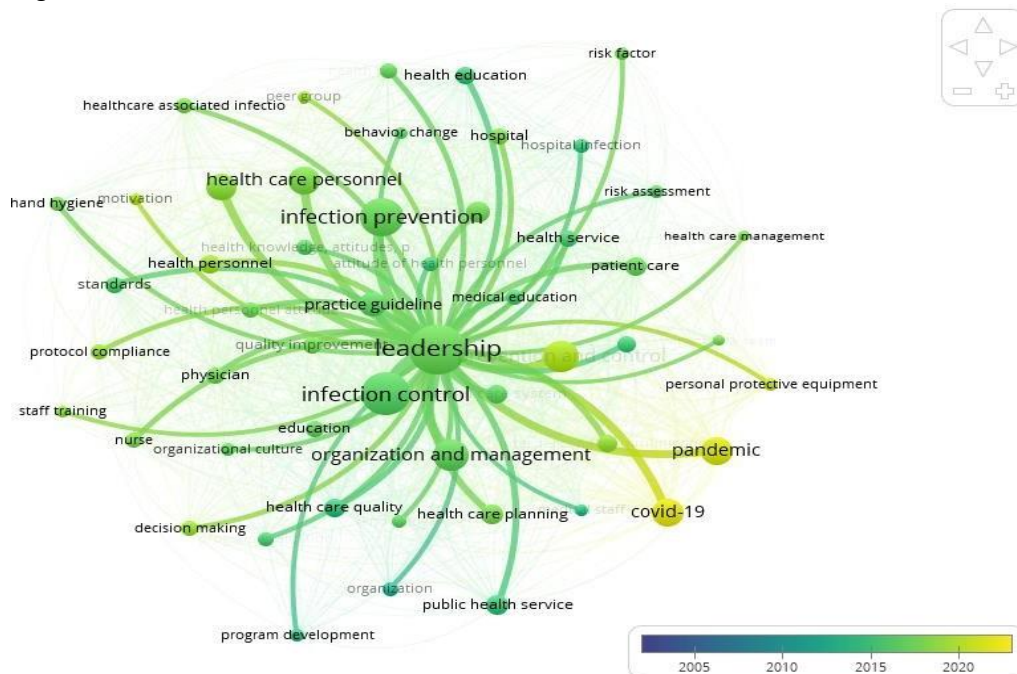
The COVID-19 pandemic requires health service facilities to make changes, especially in terms of changes in the behavior of health workers in providing health services, so that they comply with the principles of infection prevention and control to

realize the achievement of patient safety and the health workers themselves. This is to the results of the VOSviewer analysis, which shows that behavior change has a relationship with quite some items, as shown in Figure 11, and the connected items are interesting enough to be used as further research topics that can be related to leadership or infection control/ infection prevention.



**Figure 11** Overlay visualization of co-occurrence based on keyword: behavior change.

The bibliometric analysis in this study has practical and academic implications that are useful for future research. The results of this study show that the topics discussed have shown an increasing trend for 20 years, and interestingly the topics in this study reached their highest point during the COVID-19 pandemic, namely in 2020. Future research can examine topics with quite a lot of choices, not only the link between leadership and infection prevention but can also relate leadership to other topics, as shown in Figure 12.



**Figure 12** Overlay visualization of co-occurrence based on keyword: leadership.

#### 4. Discussion

Research on leaders in infection prevention and control in healthcare is still a topic of interest. This can be seen from developments over the past 20 years; the number of publications on this topic has continued to increase. Based on this study,

the existence of the COVID-19 pandemic did not cause publications on the topic to decrease. On the contrary, it reached its highest point in the 2003-2022, namely in 2020. This was due to the existence of the COVID-19 pandemic in the past 3 years, which requires health service facilities, especially units responsible for infection prevention and control, to make changes ranging from regulations and procedures to increasing employee compliance in terms of infection prevention and control (Crain et al 2021).

Leaders have an important role in terms of infection prevention and control efforts through the organization that is responsible for the implementation of infection prevention and control. This is to the results of research conducted by (McAlearney et al 2013), which concluded that, in general, the success and sustainability of HAIs prevention are determined by the leadership role. The results of VOSviewer's analysis in this study also reinforce this opinion, as seen from the results of the co-occurrence of keywords: leadership is connected with quite some items, ranging from infection control, healthcare personnel, behavior change, healthcare planning, education, staff training to the COVID-19 pandemic which occurred within 3 years. Research conducted by (Aagaard and Earnest 2021) supports this; namely, the role of a leader is important and very much needed in handling the COVID-19 pandemic through effective decision-making and leadership communication.

Leaders are expected to be able to make changes or create a work culture in healthcare facilities that are oriented towards. This is to the results of research by (Ginsburg et al 2010), which says that leadership support is very important in terms of services that can prioritize the realization of patient safety. The results of VOSviewer's analysis in this study also support the results, where patient safety items are linked to leadership, infection control, healthcare personnel, and staff training. More details can be seen in Figure 10.

The COVID-19 pandemic requires health service facilities to make changes, especially in terms of changes in the behavior of health workers in providing health services, so that they comply with the principles of infection prevention and control to realize the achievement of patient safety and the health workers themselves. This is to the results of the VOSviewer analysis, which shows that behavior change has a relationship with quite some items, as shown in Figure 11, and the connected items are interesting enough to be used as further research topics that can be related to leadership or infection control/ infection prevention.

## 5. Conclusion

Research on leaders in infection prevention and control in healthcare is still a topic of interest. This can be seen from developments over the past 20 years; the number of publications on this topic has continued to increase. Based on this study, it can be seen that the COVID-19 pandemic did not cause publications on the topic to decrease; on the contrary, it reached its highest point in the 2003-2022 period, namely in 2020. This was due to the COVID-19 pandemic in the past 3 years, which requires health service facilities, especially units responsible for infection prevention and control, to make changes ranging from regulations and procedures to increasing employee compliance in terms of infection prevention and control.

### 5.1. Limitations

The limitation of this study is that the analysis was carried out only using bibliometric analysis from one database, namely SCOPUS. Apart from SCOPUS, there are other citations and abstract indexing databases, such as Microsoft Academic, Dimensions, Web of Science, PubMed, Crossref, Europe PMC, and others. Each of these databases has advantages and disadvantages, so it will be more interesting and add to the results of a more comprehensive analysis of additions or comparisons between several databases when carrying out a bibliometric analysis.

### 5.2. Implications for future research

The bibliometric analysis in this study has practical and academic implications that are useful for future research. The results of this study show that the topics discussed have shown an increasing trend for 20 years, and interestingly the topics in this study reached their highest point during the COVID-19 pandemic, namely in 2020. Future research can examine topics with quite a lot of choices, not only the link between leadership and infection prevention but can also relate leadership to other topics, as shown in Figure 12.

### Ethical considerations

Not applicable.

### Conflict of Interest

The authors declare that they have no conflict of interest.

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