Quality of life in ICU survivors from 1991 to 2022: a bibliometric analysis based on CiteSpace

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Research Article

Keywords:

Posted Date: February 3rd, 2023

DOI: https://doi.org/10.21203/rs.3.rs-2526383/v1

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Abstract

Objective: In recent years, the number of ICU survivors has increased year by year, and their health-related quality of life after discharge has been an increasingly concerned. This study aims to analyze the development status, research hotspots, research frontiers, and future development trends of the quality of life of ICU survivors after discharge.

Methods: The relevant literature was retrieved from the WOSCC database, including only the articles published in English. CiteSpace6.0R software was used to analyze the collaboration network of countries/regions, institutions, and keywords, and co-citation analysis of references.

Results: A total of 1495 related research papers were included in this study. The major countries that conducted the research included the United States (US), Australia, England, Canada, Germany, Netherlands, France, and Italy. The research institutes are mainly located in the United States and France, and the main researchers come from the research institutes in these countries. The most cited authors are Needham D, Hopkins R, Jackson J, and Ely E. The top 3 journals with the largest number of published articles were the Journal of Critical Care Medicine, Journal of Critical Care, and Journal of Intensive Care Medicine. The top 5 most commonly used keywords were cognitive impairment, symptom, critical care, acute kidney injury, long-term outcomes, and mechanical ventilation. Post-intensive care syndrome, ICU survivor, critical care outcome, acute respiratory syndrome, and frailty would be potentially cited frequently over the coming years, which represent the emerging trends.

Conclusion: This study demonstrates the global research hotspots and trends of related quality-of-life research in ICU survivors. It can help scholars quickly understand the research status and hot spots in this field.

1 Introduction

The number of patients hospitalized in critical care units (ICU) has grown during the past 50 years [1, 2]. This is especially true now that SARS-CoV-2 is under control [3]. At the same time, advancements in critical care and new technology have had a significant impact on post-ICU survival [4–6].

The effects of critical illness may be catastrophic and long-lasting for ICU survivors and their families, though, as has been more apparent over the past 20 years. Symptoms of poor physical, emotional, and cognitive health might linger for months or even years after discharge, significantly lowering the quality of life (QoL). Many patients and their families are ignorant of this truth, and they frequently have unrealistic expectations for their long-term health while underestimating the potential time and effort required to return to their prior levels of health and the activities that go along with them [7, 8]. The COVID-19 pandemic [9] has shown how crucial it is to include quality-of-life factors while making decisions [10].

Major national ICU trial groups stress that given the significant decline in ICU patient death rates, future studies must include the main goal of functional QoL rather than mortality[11]. Last but not least,
physical function was ranked as the most crucial outcome future ICU research may target (above mortality) by both patients and family members\[12]\*\* in a recent survey of ICU survivors and family members. Therefore, there is still a critical unmet need for the development of novel therapeutics to address the catastrophic impairments ICU survivors experience and enhance functional outcomes for the population of ICU survivors, which is continually expanding.

The boundaries and hotspots of this field's study are yet unknown.

CiteSpace is a Java-based tool that uses metrology, co-occurrence analysis, and cluster analysis to evaluate and display the hot areas and research frontiers in the scientific literature in a field or knowledge domain across time\[13, 14\].

To better understand the influencing elements and successful treatments linked to the quality of life in ICU survivors, we plan to evaluate the hot spot of the research frontier of health-related quality of life in survivors using CiteSpace in this study.

2 Methods

Database

This study's search was based on the Web of Science Core Collection's Science Citation Index Expanded (SCI-E) database (WOSCC). The SCI-E database now receives the highest usage for bibliometric research and contains the greatest number of natural scientific literature.

Technique for retrieval

The phrases "quality of life or HRQOL (Topic)," "intensive care unit or ICU(Topic)," and "survivors (Topic)" were entered into the SCI-E database's "Topic Terms" search box for this study. DT stands for "Article OR Review" and LA for "English." 1991 through 2022 was the publishing period. On August 28, 2022, the final search was carried out.

Some of the publications, such as articles printed ahead of time, conference papers, abstracts from conferences, retractions, and corrections, were copies of officially published materials. As a result, we eliminated any instances of duplicate articles before doing the study and used the officially released papers as the standard version.

Analysis technique

The bibliometric package of the citespace 6.1R 3 software was utilized to analyze the related articles on the quality of life in ICU survivors after the retrieval was finished. All records of the retrieval results and the cited references were exported in plain-text format after the retrieval was finished to create the source file for the analysis. The analysis looked at the number of relevant articles published and the annual change trend, the number of citations an article received and the annual change trend, the distribution of
the countries conducting the research, the cooperation between countries and the frequency of citations, the distribution of the institutions conducting the research, the cooperation between institutions and the frequency of citations, the number of articles published, the cooperation among researchers.

Analytical statistics

The statistics are presented as percentages and figures.

3 Results

General information

In this investigation, a total of 1,495 related research literature records were located, 1 of which was a duplicate record. There were 1,494 items altogether after the duplicate data were removed. A total of 65,427 times were cited in these publications. The h-index was 121, and the average number of citations per article was 43.76. 1259 original articles (80.65%) made up the majority of the publications, followed by 236 review articles (15.12%), 39 proceeding papers (2.5%), 15 early access (0.96%), and 12 book Chaps. (0.77%). (see Fig. 1). Each year, both the quantity of publications published and their number of citations showed a clear growing trend (see Fig. 2).

Countries

According to the analysis's findings, numerous nations have carried out pertinent research (see Fig. 3); nonetheless, most African nations and some Central Asian nations haven't done any research on this subject. The United States (US), Australia, England, Canada, Germany, the Netherlands, France, and Italy carried out the most research. Further research revealed that the US, England, Canada, and Italy have all engaged in considerable international cooperation (see Fig. 4). The US topped the list of nations citing the study's findings, with Australia, England, Canada, the Netherlands, France, and Italy coming in second and third, respectively (see Table 1).

Institution

The University of Johns Hopkins University, Vanderbilt University, and Washington Assistance Publique Hopitaux Paris APHP were the three institutions that undertook the most research on this subject. The majority of the top 10 research institutions with the most articles published were US-based (see Table 2), and these institutions frequently collaborated with one another. The University of Toronto, the University of Michigan, and the University of Pennsylvania, which had the most collaborations, were among these institutions (see Fig. 5A and Fig. 5B).

Authors

Needham D., Hopkins R., Jackson J., and Ely E. held the title of the author with the most publications (see Fig. 6A). The collaborative links between the researchers were clearly concentrated, as shown by the
visualization map in Fig. 6B, which implies that these scholars may be affiliated with the same research organizations and that they frequently collaborate. Researchers from the US and Europe are frequently quoted in articles. The two researchers from the United States who were most frequently cited were Heyland, Daren K., and Knaus, William. Schelling, Gustav was born in Germany. Davidson, Thomas A. was from Denmark, however, they didn't have the most publications, which shows that their study may be more important in this sector (see Table 3).

Journals

The statistical findings indicated that the Journal of Critical Care Medicine, Critical Care, and Intensive Care Medicine were the top 3 journals with the most articles published in them (see Fig. 7). Anesthesiology and critical care were both among the top 20 journals. The Journal of Critical Care Medicine, Critical Care, Intensive Care Medicine, Journal of Critical Care, BMJ OPEN, ACTA Anesthesiologica Scandinavica, CHEST, Current Opinion In Critical Care and Pediatric Critical Care Medicine were the primary journals in this field, according to Bradford's law (see Table 4).

Keywords

The statistical findings revealed that cognitive impairment, risk factor symptoms, critical care, acute kidney injury, long-term outcomes, and mechanical ventilation were the top 5 most often utilized terms (see Fig. 8). Patients who had survived intensive care were the ones who had been researched the most in this discipline, and the researchers' top priority was their quality of life in terms of their health (see Table 5). The three keywords that were used the most frequently combined to form three clusters, indicating the utilization of keywords in the literature (see Fig. 8 and Table 5).

"Burst words" are words that are used repeatedly over a period of time. Based on the distribution of the terms with the highest citation explosion, we can forecast the research frontier. Figure 15 displays the top 25 terms from 1991 to 2022 with the highest citation bursts. The green bars indicated infrequent keyword citations, whereas the red bars indicated frequent keyword citations. In the upcoming years, the terms post-intensive care syndrome, ICU survivor, critical care outcome, acute respiratory syndrome, and frailty might be used often to describe new phenomena (see Fig. 9).

4 Discussion

A statistical analysis of 1,495 retrieved articles was done for this study. The findings showed a clear upward trend in the number of studies on the use of quality of life in ICU survivors that were published and cited. The primary nations interested in this field of study were the US, Germany, Canada, Australia, and certain European nations; these nations worked closely together. Researchers placed higher importance on the study findings from the US, England, and other nations than they did on those from other nations, and these findings were frequently mentioned in the literature.
The US, Australia, and England were the three nations with the most publications published, but the five researchers with the most articles published were from the US and Canada, and the three researchers who received the most citations were from the US and Germany. The examination of keyword usage revealed that the frequency of keywords has changed over time, and the topics that researchers have focused on the most in the last 5 years have been cognitive impairment, acute lung injury, physical rehabilitation, post-intensive care syndrome, acute respiratory syndrome, and frailty.

After two years in the ICU, patients have an average life expectancy that is comparable to the general population. Nevertheless, depending on the diagnostic group, survival was somewhat comparable to that of the general population throughout time[15]. Most ICU survivors gradually resumed their previous quality of life after being released. Patients hospitalized for a suicide attempt or chronic obstructive pulmonary disease fared badly; quality of life was mostly dependent on the diagnosis, not age or the severity of the illness. A variety of factors influenced many aspects of quality of life[16].

The study on quality of life in ICU survivors was divided into three phases: Phase 1, 1991–2005, identified the current status of health-related quality of life in ICU survivors and the tools used to measure it. In the second stage, from 2006 to 2019, the influencing factors of health-related quality of life in ICU survivors and the relationship between various diseases and health-related quality of life were studied.

Status of health-related quality of life in ICU survivors

Among all survivors, 59 percent rated their overall quality of life as good and 35 percent as fair. Quality of life may deteriorate for some, but the overall quality of life for most survivors remains acceptable and may even improve[17].

Using the EQ-5D-5L profile, the health-related quality of life (HRQOL) of ICU survivors was assessed. The Tobit regression method was used to examine the variables affecting HRQOL. The EQ-5D-5L scores of Korean ICU survivors are low, and the majority of them have one or more health issues. In particular, the proportion of level 2 is highest in the pain/discomfort dimension among the five dimensions. More severe issues than issues with mental health are those with bodily dimensions[18]. We advise early rehabilitation in the ICU and propose that HRQOL be used to gauge its long-term efficacy. To further explore the relationship between ICU treatment-related variables and survivors' long-term health outcomes, we also propose a rigorously planned prospective study.

A measurement tool for health-related quality of life in ICU survivors

In terms of quality of life, there were 276 articles, 222 of which (80%) were published since 1999. After 1999, 63% of articles measuring QOL used Short Form-36[19, 20, 21] and 19% used EQ-5D-3L[19, 20, 22, 23]. The SF-36 and eq-5d were introduced by researchers in the 1990s and subsequently recommended for intensive care survivor studies[19].

Influencing factors of health-related quality of life in ICU survivors
The Polytrauma Outcome Chart (Glasgow Outcomes Scale, Short Form 36, European Quality of Life-5 Dimensions (EQ-5D), and Trauma Outcome Profile) was used to evaluate HRQOL three months after the injury. An examination of multiple variables using stepwise regression revealed predictors of poor HRQOL. Higher age, female gender, extremity injury, traumatic injury, intensive care unit stay of 3 days, repeated nonadherence to transfusion standards, and inability to work post-injury were independent predictors of poor HRQOL. Survivors report extremely low HRQOL three months after suffering a major trauma injury. In general, physical wellness is more adversely impacted than mental well-being [24].

Preexisting comorbidity counts are substantially correlated with health-related quality of life and physical symptoms in the year following critical illness, but not with the severity of ICU illness[25].

Interventions affecting the quality of life of ICU survivors

Four therapies had a substantial impact on quality of life: two had an enhanced effect on survival and QoL (pravastatin in subarachnoid hemorrhage, dexmedetomidine in elderly patients following noncardiac surgery), and two had an adverse effect on QoL but decreased mortality (caloric restriction in patients with refeeding syndrome and systematic ICU admission in elderly patients)[26].

Post-Intensive Care Syndrome(PICS) in Survivors and healthrelated quality of life

More than half of ICU survivors worldwide suffer from PICS, which includes physical, cognitive, or behavioral health issues. Poor HRQOL associated with PICS in ICU survivors has been documented in several research, including meta-analyses, in the months and years after hospital release. PICS-F refers to psychological symptoms that ICU survivors' families and caregivers experience, and these symptoms may be just as severe as those experienced by patients. Despite the significance of PICS, there are several gaps in our knowledge of its pathophysiology and, as a result, in our preventative and treatment plans. With more patients needing ICU and post-ICU care under previously unheard-of demand conditions and social isolation, the COVID-19 pandemic has made the situation worse. For the design of prospective clinical studies, as well as for the generalization and application of their results in the future, collective action and a greater consensus on related definitions and assessment tools are prerequisites. While technological innovation and the expanding use of telecommunication are recruited to face the current challenges. Experimental research can also help us learn more, especially about the mental and physical aspects of PICS[27].

As was already noted, there are numerous pertinent study fields and directions. In order to give a general picture of the state of research in this area, we undertook a statistical analysis of the pertinent literature. Based on the findings of this study, scientists now have a general grasp of which nations have more advanced research results, which research institutions and researchers have more research results, and which core journals are relevant to those results. Our findings should be useful as a point of reference for literature searches and for facilitating academic discussions. It is possible to understand the present study's focus based on the use of keywords, and our findings also show which topics have not gotten
Our findings also imply that, in order to enhance the quality of life for ICU survivors in some underdeveloped nations, we should focus more on this issue there.

5 Limitation

There are still some limitations to discuss: (1) Only studies collected from WOSCC databases were collected in this paper, which may result in publication bias. Therefore, more data sources and powerful software are recommended in future research. (2) We only extracted research and review articles in English, and articles published in non-English languages or non-research/review articles were not included in this study, which may lead to some omissions. (3) We did not use the timeline visualization keyword, which may lead to the bias of hotspot prediction due to ignoring the time data. (4) Because new research is updated every day, we may overlook some influential newly published research. (5) Since the data selection was done by two authors, the problems encountered were solved through consultation with experts to reach a final consensus.

6 Conclusion

In summary, this study is the first scientific and comprehensive bibliometric analysis of research trends related to the quality of life of ICU survivors. The study systematically summarizes global publishing trends and helps academics identify important authors, institutions, and journals in the field. In addition, keyword and co-citation cluster analysis also guide researchers to select new research directions, mainly "the terms post-intensive care syndrome, ICU survivor, critical care outcome, acute respiratory syndrome, and frailty ". We can expect that further collaboration between authors, institutions, and countries will accelerate the development of quality-of-life research for ICU survivors in the future.

Abbreviations

ICU: Intensive care unit; QoL: Quality of life; HRQOL: Health-related quality of life; EQ-5D-5L: EuroQoL 5D 5L; EQ-5D: European Quality of Life-5 Dimensions; SF-36: Short Form 36; PICS: Post-intensive care syndrome; PICS-F: Post-intensive care syndrome-family.

Declarations

Ethical Approval
Not applicable.

Competing interests
The authors declare that they have no conflicts of interest.

Author contributions
LF and YN conceived and designed the study. LF, YN, and YL collected the data. YD and JD re-examined the data. LF and YB analyzed the data. LF wrote the first draft of the manuscript.

YN and YL wrote sections of the manuscript. YD reviewed and revised the manuscript. All authors contributed to the article and approved the submitted version.

**Funding**

No funding.

**Availability of data and materials**

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

**Acknowledgments**

We would like to express their gratitude to CM Chen, who invented CiteSpace, which is free to use.

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Tables

Tables 1 to 5 are available in the Supplementary Files section.

Figures

![Figure 1](image-url)

**Figure 1**

Types of articles.
Figure 2

Times Cited and Publications Over Time.

Figure 3

Distribution of the number of articles published by country.
Figure 4

Cooperation between countries.
Figure 5

A Institutional collaborations.

B Institutional collaborations.
Figure 6

A Author collaborations.

B Author collaborations.
Figure 7

Cited Journals.

Figure 8

Keyword Bursts.
### Top 25 Keywords with the Strongest Citation Bursts

<table>
<thead>
<tr>
<th>Keywords</th>
<th>Year</th>
<th>Strength</th>
<th>Begin</th>
<th>End</th>
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<td>1991</td>
<td>7.9</td>
<td>1991</td>
<td>2005</td>
<td></td>
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<td>cardiac surgery</td>
<td>1991</td>
<td>7.68</td>
<td>1999</td>
<td>2008</td>
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<tr>
<td>outcome assessment (health care)</td>
<td>1991</td>
<td>5.53</td>
<td>2005</td>
<td>2011</td>
<td></td>
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<td>memory</td>
<td>1991</td>
<td>5.35</td>
<td>2005</td>
<td>2010</td>
<td></td>
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<td>prolonged mechanical ventilation</td>
<td>1991</td>
<td>7.95</td>
<td>2006</td>
<td>2012</td>
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<td>2010</td>
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<td>unit survivor</td>
<td>1991</td>
<td>8.36</td>
<td>2012</td>
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<td>1991</td>
<td>7.15</td>
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<td>1991</td>
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<td>2016</td>
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**Figure 9**

Top 25 keywords with the strongest citation bursts.

**Supplementary Files**

This is a list of supplementary files associated with this preprint. Click to download.

- [Tables.docx](#)