

Research spot analysis of hospital efficiency evaluation based on CiteSpace

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Abstract: To understand the research hotspot and research evolution trend in the field of hospital efficiency evaluation, and to provide a reference basis for the subsequent research. CiteSpace software was used to visually analyse the Web of Science core collection related literature of hospital efficiency evaluation from January 1, 2010 to December 12, 2023. It is found that the top three keywords are data envelopment analysis, technical efficiency, and efficiency, and the first three clusters are data envelopment analysis, healthcare system and costs; The highest intensity of the hot words is impact, Followed by the term "hospitals", The lowest intensity is performance evaluation.

Keywords: CiteSpace; hospital efficiency evaluation; research hotspot; visual analysis; knowledge map

1. Introduction

With the rapid development of medical technology, the efficiency of the medical system is increasingly focused. Under the background of limited medical resources, how to efficiently use resources and improve the level of hospital service has become an important research topic. Based on this background, it is particularly important to evaluate the hospital efficiency. This paper aims to deeply analyze the research hotspots of hospital efficiency evaluation through CiteSpace tool, and provide reference and inspiration for research in related fields. This study visually analyzed the research hotspots of hospital efficiency evaluation through the CiteSpace tool, aiming to deeply explore the research status, development trends and frontier dynamics in this field. Through sorting out and analyzing research hotspots, it is helpful to find the shortcomings of research and provide new ideas and methods for subsequent research. At the same time, the results can provide reference for hospital managers and policy makers and promote the in-depth development of hospital efficiency evaluation research.

2. Source and method

2.1 Analytical methods and tools

CiteSpace Software is a software that helps people analyze and understand abstract information and data through computer image and graphics analysis technology. It is a kind of information visualization analysis software, which can conduct literature research hotspot analysis by drawing the knowledge map of a certain research field [1]. The CiteSpace6.2.R6 (64-bit) Advanced visualization software adopted in this paper presents the common word network through the co-occurrence analysis of keywords, clearly displays the number of articles and research topics, and helps researchers to screen effective information. The main analysis indicators used include centrality (Centrality), keyword clustering (Keywords Clustering), etc. The centrality index can be used to find or measure the importance of the literature. The centrality value of the nodes in the graph is positively correlated with the influence of the representatives. Usually, the centrality value of 0.1 is used as the criterion for screening the key nodes. Keywords can fully reflect the research content of the article and the issues that researchers pay wide attention to in specific fields. spatio-temporal clustering analysis of keywords can better reflect the research hotspots in this field and reveal the forefront of research from the perspective of time trend.

2.2 Data source and processing

The Web of Science core collection (hereinafter referred to as WOS) is used as the data source. In the

WOS core collection database, the search condition was set to "Topic=Hospital efficiency evaluation Or Abstract=Hospital efficiency evaluation, Publication Date=2010-01-01 to 2023-12-12". 2,099 documents were retrieved, and 230 valid samples were obtained by manually removing irrelevant papers, meetings, reports, etc. The literature was exported in Refworks, format, named as CiteSpace6.2.R6 (64-bit) Advanced identifiable file name, and the data was formatted and transformed for knowledge mapping.

3. CiteSpace to visualize the analysis results

3.1 Keyword co-occurrence map

Using CiteSpace6.2.R6 (64-bit) Advanced visualization software, taking keywords as nodes and years as the time segment, selecting high-frequency node data and combining with map pruning and manual adjustment technology processing [2], the keyword co-occurrence network map of hospital efficiency evaluation research was obtained (Figure 1). The node is in the form of a ring round, which represents the time from far to near. The width of each ring represents the frequency of the keyword, that is, the larger the node, the more frequent the keyword appears, the earlier the time appears. In order to show the research topics in the field of hospital efficiency evaluation more intuitively and clearly, this paper statistics the top 10 high-frequency keywords and their centrality on the basis of the keyword knowledge graph (as shown in Table 1). The greater the centrality (centrality), the stronger the ability of the representative keyword to derive other extended keywords in the whole graph analysis, and the greater the influence of the keyword. The centrality values are located between 0 and 1, and the nodes exceeding 0.1 are called key nodes [2].

Combined with the results of Figure 1 and Table 1, it can be seen that the top three keywords in frequency are data envelopment analysis, technical efficiency and efficiency, indicating that scholars mainly focus on data envelopment analysis, technical efficiency and other topics, and tend to focus on the application and improvement of methods and models.

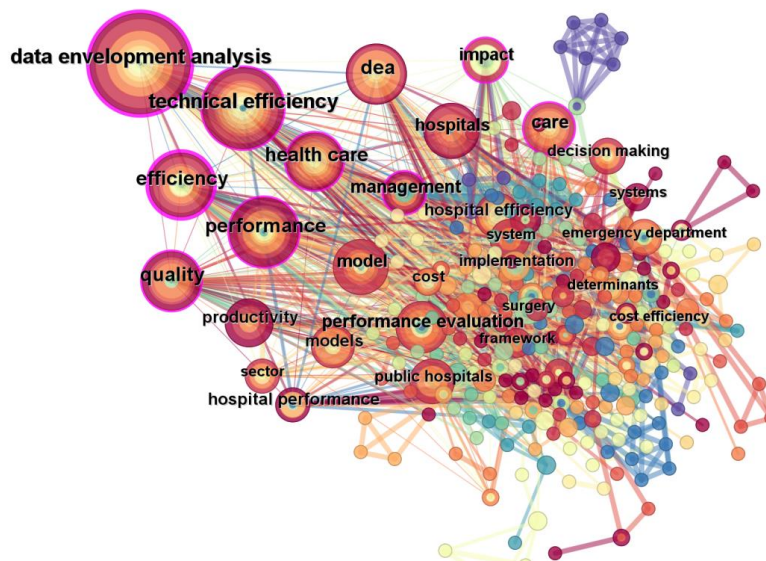


Figure 1: Literature high-frequency keyword map

Table 1: High-frequency keywords in the field of hospital efficiency evaluation

Keywords	Frequency	Centrality	Keywords	Frequency	Centrality
data envelopment analysis	100	0.29	quality	21	0.17
technical efficiency	43	0.17	care	20	0.15
efficiency	30	0.21	model	16	0.08
performance	27	0.16	performance evaluation	15	0.1
health care	24	0.14	management	12	0.12

3.2 Cluster analysis of knowledge graph networks

Using CiteSpace6.2.R6 (64-bit) Advanced visualization software, with keywords as nodes, with years

as time fragments, on the basis of keyword co-occurrence of cluster analysis.

The literature knowledge map constructed based on keywords is shown in Figure 2, and the top 8 network clusters of the literature knowledge map include data envelopment analysis, healthcare system, cos, robust optimization techniques, emergency department, opteamizer, modified ahl algorithm and resource allocation. The key words focus on DEA, data model analysis, algorithm improvement and optimization, and other aspects, and the research topics are micro-diversified, and the field segmentation is more obvious. In general, the research of hospital efficiency evaluation focuses on several subdivided efficiency categories such as technical efficiency and operational efficiency, as well as the accuracy of optimization evaluation from model and algorithm, especially using DEA method to evaluate efficiency. Therefore, the application of DEA method in hospital efficiency evaluation is the focus of the research.

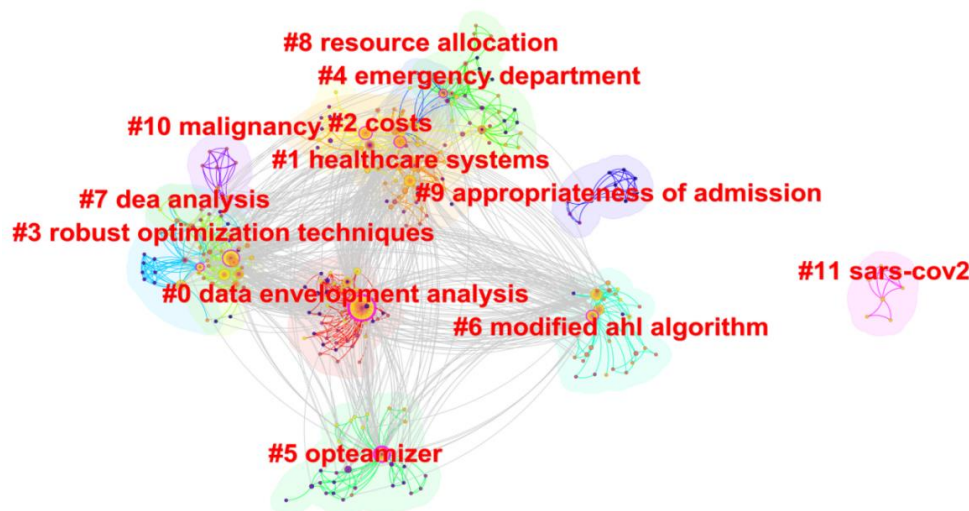


Figure 2 Knowledge network clustering of literature keyword construction

4. Research hotspots and progress analysis

4.1 Sudden occurrence analysis of hot words

A key word with a sudden increase in frequency in a research field in the short term is the emergent word, which reflects the research frontier in the emergent period [3]. The greater the intensity of emerging words (Strength), the more attention is paid to the research frontier. The visual map of emerging hot words in foreign literature was constructed in order of intensity (Strength). The top 11 emerging keywords were selected in this paper (Figure 3).

Top 11 Keywords with the Strongest Citation Bursts

Keywords	Year	Strength	Begin	End	2010 - 2023
impact	2010	3.17	2014	2016	
hospitals	2011	2.72	2020	2023	
models	2017	2.65	2017	2020	
model	2013	2.43	2020	2023	
surgery	2013	2.4	2013	2014	
public hospitals	2018	2.31	2018	2020	
services	2019	2.3	2019	2020	
management	2011	2.29	2011	2013	
quality	2013	1.73	2020	2021	
cost efficiency	2016	1.67	2016	2019	
performance evaluation	2011	1.63	2020	2021	

Figure 3 The chart of hospital efficiency evaluation

Among the emerging words in the hospital efficiency evaluation literature, the highest intensity was "impact" (3.17), followed by "hospitals" (2.72), and the lowest intensity was "performance evaluation"

(1.63). The first occurrence time of emergent words was in 2011-2020, and the occurrence time distribution of emergent words was relatively uniform. There are two sudden words lasting in 2023, both of which are "hospitals" and "model" for the first time in 2020, which shows that the use of models to analyze hospital efficiency is the focus and hotspot of current research. From the perspective of the time span of the emergence of sudden words, there are "evaluation" and "hospital efficiency" spanning more than 5 years, but these two keywords are highly related to the theme and are not meaningful.

4.2 Analysis of time partition and evolution path

Figure 4 depicts the evolution trend of the research keywords in the field of hospital efficiency evaluation between 2010 and 2023. By observing the evolution of the subject keywords can be found, the hospital efficiency evaluation related research has strong continuity, before late cable density shows that early research topic with sustainable development in different periods[4], under the influence of industrial change and social change related research gradually around the basic theoretical framework and achievements to improve and conduct a comprehensive and in-depth continuous exploration. The hospital efficiency evaluation study can be divided into two stages, the first stage is 2010-2016, and the second stage is 2017-2023.

4.2.1 Phase I hotspot analysis

In the first stage, the most keywords appear and high frequency, indicating that this stage is the basic research period of hospital efficiency evaluation research, which lays the main line of later research, especially the research evaluation of hospital efficiency by data envelope analysis (DEA). In this stage, there is a trend of integration of medicine, management and statistics, focusing on data envelope analysis, and taking technical efficiency and efficiency performance as the core.

(1) Data envelope analysis (DEA) study. DEA method is a method to evaluate the relative effectiveness of the same decision-making unit with multiple input and multiple output characteristics, which has been widely used in efficiency evaluation in the medical and health field[5]. Typical classifications include DEA-BCC model[6]-[8], two-stage DEA[9]-[11], three-stage DEA[12]-[14], four-stage DEA[15], and network DEA[16]-[18].

(2) Technical efficiency (TE) research. YLi et al. (2022) used DEA-BCC model to evaluate the technical efficiency of municipal TCM hospitals in Gansu Province, and used Manny-Whitney test to compare the input and output variables of technical efficiency and inefficient hospitals[19]. A Kucuk et al. (2020) analyzed the technical efficiency of 669 public hospitals in Turkey through the output-oriented model of DEA[20]. I Vrabkova (2021) et al. used the DEA model to model the technical efficiency of 47 public hospitals in the Czech Republic to determine the technical efficiency difference of public hospitals in terms of hospital size and the type of some human resources[21].

4.2.2 The second stage of the hot-spot analysis

The second stage for 2017-2023, DEA model research further development, the efficiency evaluation of public hospital research further attention, for productivity research has gradually become a hot spot, and resource allocation, system, patient satisfaction and facilities is the research hotspot and may continue for a period of time in the future.

(1) Model study. The use of the DEA model is emphasized above, and it will not be repeated here to introduce some other models to evaluate hospital efficiency. FWu et al. (2022) proposed a research method of hospital informatization grade evaluation model based on decision tree algorithm to evaluate hospital informatization, which improved the evaluation efficiency[22]. FF Jahantigh et al. (2020) used PROMETHEE II method to identify and classify 47 effective factors in the unit performance evaluation of Tehran Teaching Hospital, and analyzed the efficiency of 40 medical science university hospitals in Tehran combined with DEA model[23]. M Abdel-Basset et al. (2022) proposed a comprehensive evaluation model for evaluating ED under the framework of multiple theory, which solved the uncertainty and ambiguity in information[24].

(2) Efficiency evaluation study of public hospitals. Based on the measured data of 49 tertiary public hospitals, MSun et al. (2023 in Fujian Province) introduced the Tobit regression model to evaluate the operation efficiency of public hospitals in Fujian Province[25]. Sultan et al. (2018) used data envelope analysis to evaluate and analyze the relative productivity of public hospitals in Jordan[26]. JB Moskovitz et al. (2021) to study the impact and efficiency of medical screening tests in the anterior treatment area of public hospitals in New York City in the context of the novel coronavirus (COVID-19) surge[27].

(3) Productivity study. X Liu et al. (2023) used the Bootstrap-Malmquist-DEA model to evaluate the productivity and relative efficiency of public tertiary TCM hospitals in Hubei Province[28]. I Vankova et al. (2022) used multi-standard decision-making methods to determine trends and differences in productivity analysis of hospital care at the regional level in the Czech Republic and the Slovak Republic [29]. E Berk et al. (2019) analyzed the productivity of the health care sector reform in Turkey through DEA-Malmquist index model based on 5 years of provincial health data[30]

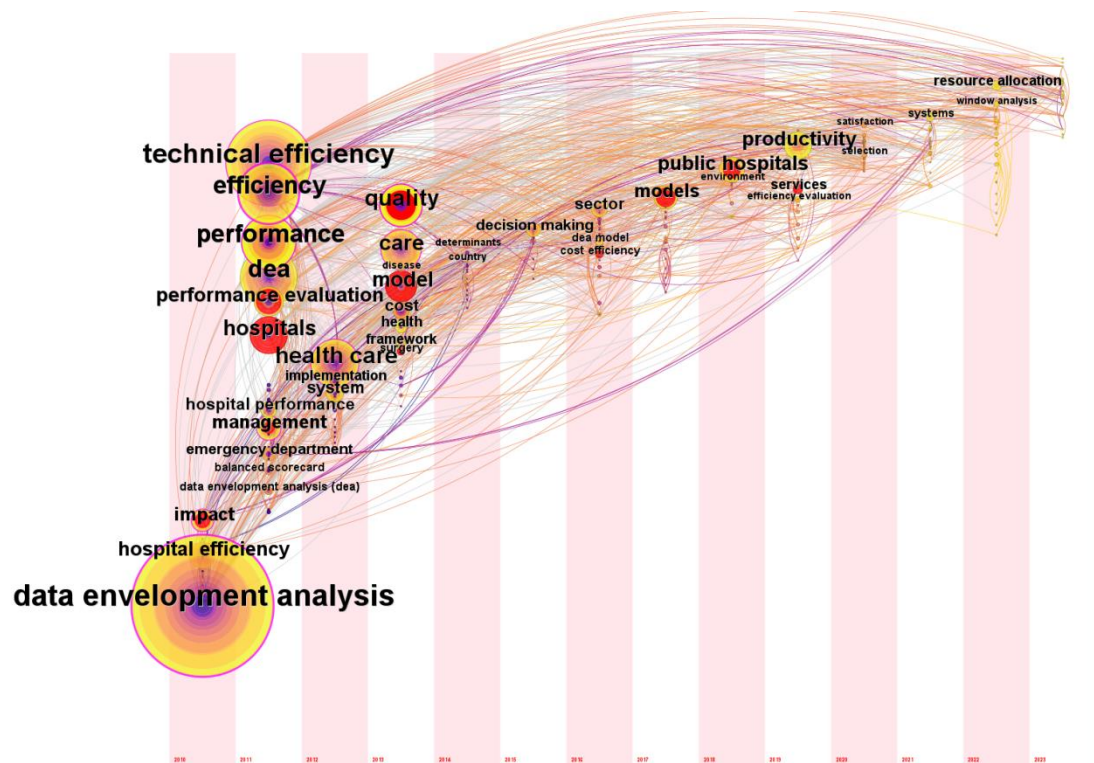


Figure 4: Spatio-temporal partition map of the hospital efficiency evaluation study

5. Conclusions

With the help of CiteSpace visualization software, this paper sorts out the focus and frontier research of the literature related to hospital efficiency evaluation from 2010-2023, intuitively shows the research hotspot and development evolution of hospital efficiency evaluation research, and forms a systematic cognition of the research theme and theoretical framework in the field of hospital efficiency evaluation. We can summarize it from the following aspects:

(1) 10 keywords are found as high-frequency keywords. The first three high-frequency keywords are data envelopment analysis, technical efficiency and efficiency, and the highest centrality is data envelopment analysis. This shows that scholars mainly pay attention to the improvement and application of model methods such as DEA.

(2) Keyword clustering analysis obtained 11 network clusters. The hospital efficiency evaluation research focuses on several subdivided efficiency categories such as technical efficiency and operational efficiency, as well as the accuracy of optimization evaluation from the model and algorithm. The application of DEA method in hospital efficiency evaluation is the focus of research.

(3) The emergence analysis of hot words obtains 11 emergent keywords, and the emergence intensity of emergent words in the literature is generally high. impact, model, surgery, public hospitals and other studies are the frontier hotspots. Using models to evaluate and analyze the efficiency of hospitals is the key point

(4) The analysis of the evolution process of research hotspots shows that from the early focus on comprehensive efficiency evaluation and analysis to the more detailed medical evaluation and analysis focusing on service efficiency and bed utilization efficiency in the later stage, some scholars innovatively the efficiency evaluation and analysis under different research models and methods. The evolution of the research hotspot is further extended on the basis of the first stage of the research results, from the original

technical efficiency evaluation to productivity, and constantly paying attention to the combined application of DEA model and other models.

Conflicts of Interest

The authors report no conflict of interest concerning the materials or methods used in this study or the findings presented in this paper.

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