

Original Article

The impact of link quality management on healthcare quality: a comparative study at The Fourth Hospital of Harbin Medical University

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Abstract: Objective: To explore the impact of link quality management on healthcare quality. Methods: In 2021, The Fourth Hospital of Harbin Medical University followed various regulations and systems to manage the quality of hospital links. In 2022, the hospital upgraded and strengthened the quality management of hospital links. We collected and compared data from 2021 and 2022 on several observation indicators, including error rates in medical records, outpatient and inpatient numbers, surgical volumes, adverse event reporting, dispute complaints, inpatient medical records and outpatient prescriptions grading, timely filing rate of medical records, inpatient satisfaction rate, average length of hospital stay, rate of level 3-4 surgeries, admission rate of critically ill patients, workload index, work efficiency index, diagnostic quality index, treatment quality index, antimicrobial drug use rate, staff satisfaction rate, patient satisfaction rate, composite index, and Case Mix Index (CMI). Results: In 2021, the error rate of the first page of the general surgery medical records in The Fourth Hospital of Harbin Medical University was 27.91%, while in 2022 it significantly improved to 9.60% ($P<0.05$). The error rates of the main diagnosis, major surgical operations, other diagnoses, and other surgical operations on the medical records were all significantly different between 2021 and 2022 (all $P<0.05$). In 2022, the outpatient volume, inpatient volume, surgical volume, and adverse event reporting increased significantly compared to those in 2021, while the number of dispute complaints decreased significantly. The first-grade rate of inpatient medical records, first-grade rate of outpatient prescriptions, timely filing rate of medical records, inpatient satisfaction rate, average length of hospital stay, rate of level 3-4 surgeries, and admission rate of critically ill patients in 2022 were all significantly higher than those in 2021 (all $P<0.05$). The workload index, work efficiency index, diagnostic quality index, and treatment quality index in 2022 were all significantly higher than those in 2021 (all $P<0.05$). The outpatient antimicrobial drug use rate, emergency department antimicrobial drug use rate, and inpatient antimicrobial drug use rate in 2022 were significantly lower than those in 2021 (all $P<0.05$). In 2022, the satisfaction rate of medical staff was 93.57%, which was significantly higher than 81.16% in 2021 ($P<0.05$). In 2022, the patient satisfaction rate was 91.53%, which was significantly higher than 82.17% in 2021 ($P<0.05$). In 2022, the composite index and CMI values increased, while the error rate decreased significantly, as compared to those in 2021 ($P<0.05$). Conclusion: After upgrading and strengthening the link quality management, The Fourth Hospital of Harbin Medical University has achieved significant improvements in management level, medical quality, technical level, and staff satisfaction.

Keywords: Medical link quality management, medical quality, impact

Introduction

Link quality management is a core content of medical quality management and a key manifestation of management effectiveness [1]. Medical link quality management covers a wide range of content and can be applied to the daily work in multiple hospital departments. In

recent years, with the continuous deepening of medical reforms, the model and demands of modern medical care have undergone significant changes.

In China, the healthcare system has been undergoing significant reforms to improve the quality of care. However, challenges still exist.

The overall medical quality of a hospital is a core reflection of its management, and its impact on the sustainable development of the hospital is far-reaching [2]. Currently, the overall quality level of medical care has become a comprehensive reflection of technology services, medical staff quality, and environmental facilities [3]. A study [4] showed that there are significant differences in the incidence of adverse events caused by defects in medical quality management among different countries. The ratio is about 4% in the United States and as high as 16.6% in Australia. The European Healthcare Quality Workgroup estimated that about one in ten patients experienced preventable harm related to medical care [5]. In China, similar challenges exist, and the need for improved medical quality management is pressing. Therefore, further strengthening medical link quality management to ensure and improve the overall medical quality level has become an important task for hospitals. The clinical significance of this study lies in its potential to enhance patient care in China and possibly other countries. By reducing error rates and improving staff satisfaction, the quality of patient care can be improved. Furthermore, the decrease in antimicrobial drug use rates suggests a possible reduction in antibiotic resistance, which is a global health concern.

Based on this, this study analyzed the impact of link quality management on medical quality by elaborating on the specific measures taken by The Fourth Hospital of Harbin Medical University to strengthen medical link quality management.

Methods

Specific measures to strengthen medical quality management in clinical links in The Fourth Hospital of Harbin Medical University

① Improve medical quality management system: Based on the actual situation of the hospital, a comprehensive and systematic medical quality management system was formulated, including related procedures and standards. As clinical technology expands and upgrades, new management systems and construction guidelines will inevitably emerge in the future, and The Fourth Hospital of Harbin Medical University will continuously improve the medical quality management in the same way. ② Implement

link quality management measures: A systematic medical quality management plan with sustainable improvement was established, and the critical links and objects were managed. By combining sampling inspection, on-site inspection, electronic system automatic control, manual real-time sampling and other methods, the link quality management was implemented [6]. ③ Optimize the overall process: The entire medical process was sorted out to identify relevant factors affecting medical quality, so that they could be optimized to further improve overall efficiency. Comprehensive evaluation criteria about the entire outpatient process were collected from patients, and the process was optimized based on feedback and suggestions. By strengthening public area guidance services, increasing guidance landmarks, and implementing triage call systems, the patient's diagnosis and treatment process was upgraded [7]. ④ Strengthen key link supervision: Further focus was put on key and/or weak links that affect medical quality to formulate targeted management standards and measures, such as increasing the frequency of general patient medical records and writing stage summaries for patients with complex conditions. ⑤ Pathway management and disease quality control: Clinical pathway and single-disease quality control management were promoted based on the electronic medical record system. After the electronic management was implemented, relevant medical personnel could collect, analyze, and supervise patient data through the electronic medical record system, effectively ensuring the quality of medical care and patient safety [8]. At the same time, the electronic medical record system can automatically integrate patients' daily medical orders, thereby reducing the laborious daily record-keeping tasks of medical staff. This can effectively mobilize medical staff to take timely measures and, to a certain extent, standardize any past inappropriate medical treatment behaviors [9]. ⑥ Strengthen medical safety management: A medical risk warning management system was established to prevent medical disputes associated with key departments, personnel, and links as early as possible [10]. The reporting and handling of medical adverse events were also strengthened by establishing an adverse event reporting management system and a major surgery approval system. ⑦ Strengthen internal quality control: A medical quality man-

agement team was established in each department, and a medical quality management manual was compiled to clarify the criteria for internal quality control. This involved assessing the difficulty and frequency of tasks performed by medical staff and quality control personnel, and linking these assessment results to their performance evaluations [11]. Statistical indicators were refined to the individual level, and the completion of quality control management work was displayed within the department monthly. ⑧ Real-time on-site supervision: Supervisory personnel were responsible for inspecting the implementation of core medical systems in various clinical departments every two weeks, as well as verifying the medical quality management manuals, physician rotation records, difficult case discussion records, death case discussion records, and clinical critical value registration records of each department. Organizational personnel were responsible for inspecting the medication and infection status of surgical patients in the ward. In case of unexpected events, the departments should report, communicate and rectify them in a timely manner. ⑨ Implement and improve information-based supervision methods: An electronic medical record system was created to improve its automatic assessment mechanism, which enabled an automatic evaluation of inpatient medical records on the 10th of each month. An information supervision platform was constructed based on electronic medical records and structural formatting improvements were made. This was done to fundamentally eliminate contradictory errors within the system [12, 13].

Observation indicators

We collected data on medical quality management and medical staff satisfaction in 2021 and 2022. The medical quality management data included several key indicators, such as error rates in medical records, patient volumes, surgical volumes, adverse event reporting, dispute complaints, grading of medical records and prescriptions, composite index, and Case Mix Index (CMI).

The error rates of medical records were evaluated by reviewing the first page of general surgery medical records and noting discrepancies in main diagnosis, major surgical operations, other diagnoses, and other surgical operations.

Patient volumes were assessed by counting the number of outpatient visits, inpatient admissions, and surgical procedures performed. Adverse event reporting and dispute complaints were tracked through hospital records. The grading of medical records and prescriptions was performed based on hospital's internal grading system. The composite index and CMI values were calculated using standard formulas in healthcare management.

Medical staff satisfaction was evaluated using a self-developed questionnaire. The questionnaire was designed to assess various aspects of job satisfaction including workload, work efficiency, diagnostic quality, treatment quality, and overall job satisfaction. The questionnaire was distributed to all medical staff, and responses were collected and analyzed to calculate the overall satisfaction rate.

The statistical analysis of medical quality management data and medical staff satisfaction data was conducted by our research team. The analysis involved comparing the data between 2021 and 2022 to assess the impact of upgraded link quality management on medical quality and staff satisfaction.

Statistical methods

GraphPad Prism 8 was used for data visualization, and SPSS 26.0 was used for data analysis. Quantitative data were expressed in the form of (mean \pm sd) and compared using T or Mann-Whitney U tests. Qualitative data were expressed in the form of n (%) and compared using the χ^2 test. $P < 0.05$ indicates statistical significance.

Results

Comparison of medical record writing

This study selected data from Ward A of the Department of General Surgery to analyze the situation of medical record writing. In 2021, a total of 1419 patients were discharged from this department, and the quality control personnel found 396 cases of errors in the medical record writing, with an error rate of 27.91%. In 2022, a total of 1584 patients were discharged from the department, and 152 cases of errors in medical record writing were found through quality control inspection, with an error

Table 1. Comparison of medical record writing

	2021	2022	χ^2	P
Number of cases	1419	1584	-	-
Number of wrong cases	396	152	-	-
Error rate (%)	27.91%	9.60%	11.001	0.001

rate of 9.60%. The difference in error rates between the two years was significant ($P<0.05$), as shown in **Table 1**.

Comparison of error distribution in medical record filling

In 2021, the error rates of the main diagnosis, major surgical operations, other diagnoses, and other surgical operations on the medical records were 5.27%, 7.39%, 10.84%, and 16.92%, respectively. In 2022, these error rates were 1.12%, 2.45%, 3.71%, and 3.89%, respectively. The differences in error rates between the two years were significant (all $P<0.05$), as shown in **Table 2**.

Comparison of medical quality management-related data

The number of outpatient visits, inpatients, surgeries, and reported incidents of adverse events in The Fourth Hospital of Harbin Medical University in 2022 increased significantly compared with those in 2021, while the number of disputes and complaints decreased significantly, as shown in **Table 3**. In terms of comparable data, the first-grade rate of inpatient medical records, the first-grade rate of outpatient prescriptions, the timely filing rate of medical records, the inpatient satisfaction rate, the average length of hospital stay, the rate of level 3-4 surgeries, and the rate of critically ill patient admission were (84.62±7.85, 90.43±5.76, 70.47±9.51, 87.89±5.74, 16.13±4.05, 30.95±3.56, 4.33±1.84), respectively, in 2021, and (91.58±6.09, 95.84±2.89, 86.82±5.13, 93.12±3.28, 13.22±2.49, 45.24±8.47, 16.81±3.27), respectively, in 2022. All these indicators improved significantly in 2022 as compared with 2021, and the differences were significant (all $P<0.05$), as shown in **Figure 1**.

Comparison of medical quality indexes

As shown in **Figure 2**, the workload index, efficiency index, diagnostic quality index, and treatment quality index were (0.64±0.17,

0.75±0.18, 0.81±0.14, 0.71±0.14) in 2021, and (0.75±0.15, 0.83±0.14, 0.88±0.11, 0.77±0.20) in 2022. These indices were significantly higher in 2022 than those in 2021 (all $P<0.05$).

Comparison of antimicrobial drug use

As shown in **Figure 3**, the outpatient antimicrobial drug usage rate, emergency department antimicrobial drug usage rate, and inpatient antimicrobial drug usage rate in 2021 were (24.21±2.86, 56.19±5.23, 81.58±9.12), respectively, while in 2022, they were (18.68±1.92, 39.72±5.02, 60.74±7.27), respectively. These drug usage rates were significantly lower in 2022 than those in 2021 (all $P<0.05$).

Comparison of medical staff satisfaction

A total of 584 medical staff participated in the satisfaction questionnaire survey in 2022 and 607 participated in 2021. The satisfaction rate of medical staff was 81.16% in 2021 and 93.57% in 2022. The satisfaction rate in 2022 was significantly higher than that in 2021 ($P<0.05$). See **Table 4** for details.

Comparison of patient satisfaction

In 2022, a total of 1,127 patients participated in the satisfaction questionnaire survey, and in 2021, 1,098 patients participated in the survey. The patient satisfaction rate in 2022 was 91.53%, which was higher than 82.17% in 2021, and the difference between the two was significant ($P<0.05$), as shown in **Table 5**.

Comparison of CMI, composite index, and error rate

In 2022, the composite index and CMI values increased compared to those in 2021, and the error rate decreased ($P<0.05$). See **Table 6** for details.

Discussion

Traditional medical quality usually refers to the timeliness, safety, and effectiveness of medical services. However, the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) [14] has proposed a new definition of medical quality, which explains that medical services can increase patient satisfaction and reduce dissatisfaction. In recent years, with the

Link quality management in healthcare

Table 2. Comparison of error distribution in medical record filling

Project	2021		2022		χ^2	P
	Number of cases	Error rate (%)	Number of cases	Error rate (%)		
Main diagnosis	75	5.29%	18	1.14%	42.935	<0.001
Major surgical procedure	105	7.40%	39	2.46%	39.969	<0.001
Other diagnoses	154	10.85%	59	3.72%	57.709	<0.001
Other surgical procedures	240	16.91%	62	3.91%	139.828	<0.001

Table 3. Comparison of medical quality management-related data

Item	2021	2022
Outpatient and emergency visits (10,000)	107.23	122.34
Hospitalizations (10,000)	8.32	8.81
Operation times (10,000)	5.62	5.74
Number of reported adverse events (cases)	1067	1285
Number of disputes and complaints (cases)	42	18

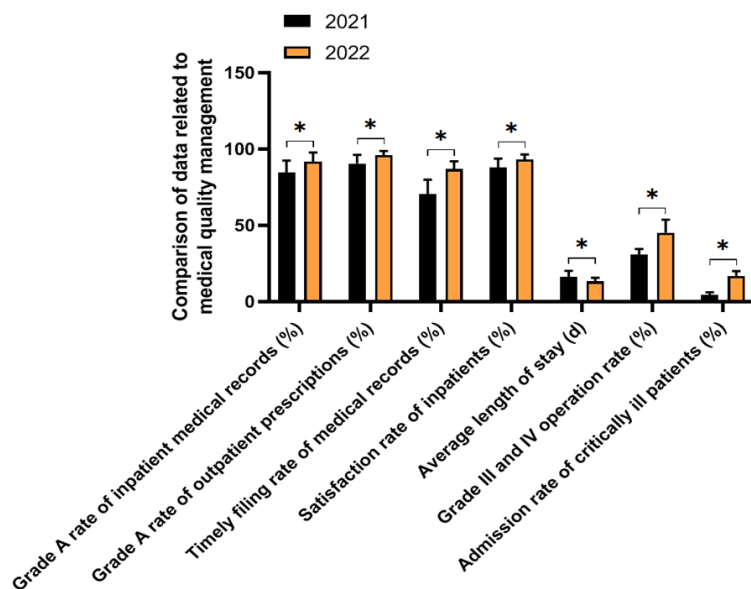


Figure 1. Comparison of medical quality management data. Note: * indicates comparison $P < 0.05$.

continuous extension and expansion of modern medical quality concepts, the connotation has become richer. Medical quality is a holistic concept, including basic quality, link quality, and terminal quality [15]. Since the medical quality of a hospital is mostly influenced by the patient's diagnosis and treatment process, the control of link quality is the top priority in medical quality management. Link quality management is the quality management of specific work practices in various links of hospitals, including patient admission, diagnosis, treat-

ment, evaluation of efficacy, and discharge [16]. By continuously revising and improving link quality management, hospitals can summarize relevant experience. Through continuous feedback of experience, the overall medical quality of hospitals can be cyclically improved.

The management of hospital link quality is not merely an abstract concept. To truly enhance management quality, practical quality control standards are indispensable. Drawing from previous research and hospital experience, we identified several persisting issues in clinical medical link quality management. 1. Absence of specific procedures and link control: At present, hospital medical quality management primarily relies on quality control, which involves comparing actual quality outcomes with standard quality results to identify and rectify non-conformities [17]. Although this management model emphasizes the quality of factors and links,

the lack of specific process and link control cannot guarantee the quality. When formulating standards, hospitals may not realize the deficiencies in their own systems, rendering the standards themselves insufficient to guarantee the level of medical quality [18]. Therefore, hospitals must enhance and fortify relevant management practices and establish a corresponding interconnected system in the process of shaping medical service quality. 2. Unclear quality objectives: While medical quality has gradually become a holistic concept, some hos-

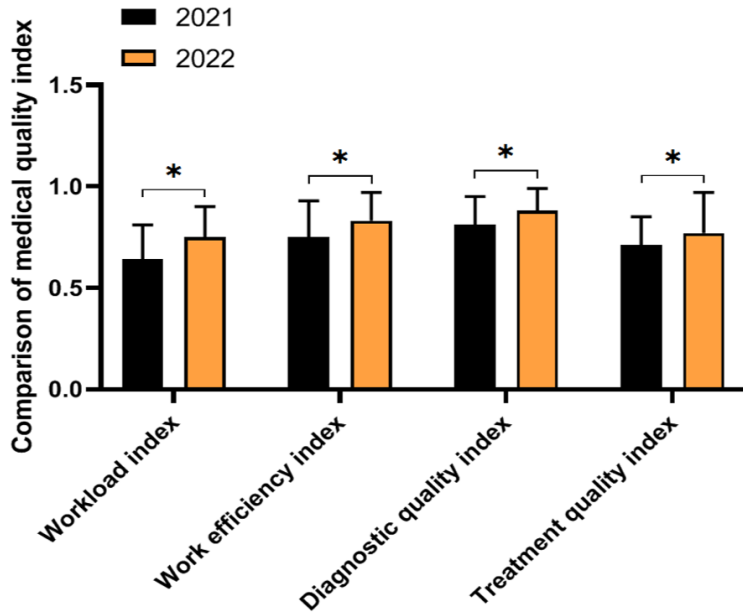


Figure 2. Comparison of medical quality index. Note: * indicates comparison $P < 0.05$.

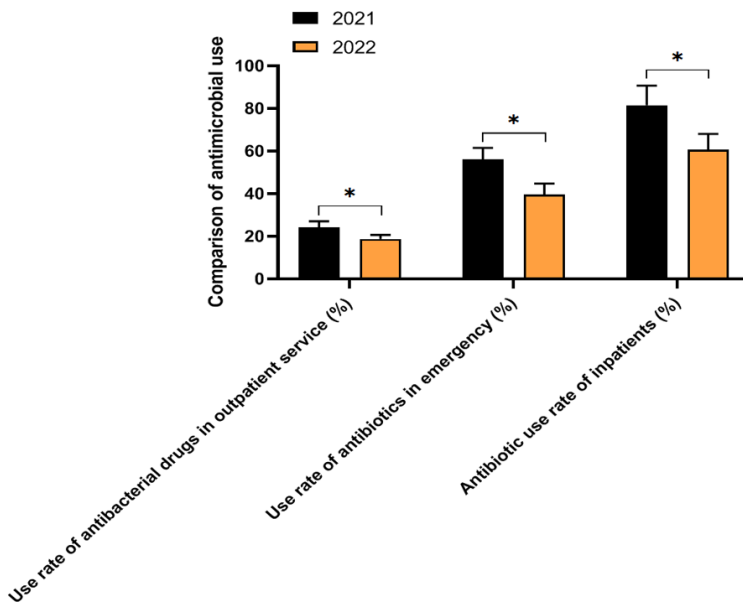


Figure 3. Comparison of antibiotic use. Note: * indicates comparison $P < 0.05$.

pitals remain overly focused on medical effects, neglecting quality requirements in other aspects [19]. Traditional medical quality management often emphasizes outcome indicators such as clinical cure rate and mortality rate, which limits quality management. Due to neglecting management, there are still many deficiencies in service awareness, concept,

and goals [20], which hinder the attainment of the “patient-centered” objective in medical quality management. 3. Unclear division of responsibilities and authority: Each functional department of the hospital has a certain scope of authority. However, some hospitals have an unclear and ambiguous division of responsibilities and authority among relevant personnel. In practice, this lack of clarity may lead to ineffective coordination, overlapping responsibilities, and work inefficiency [21], seriously impacting the quality of medical management. 4. Insufficient education and low awareness regarding quality management among medical staff: Medical work requires high cohesion, and the operation within the medical system must be coordinated and stable [22]. Therefore, hospital management needs the cooperation and participation of all medical staff. In the past, some hospitals only offer superficial education to medical staff, resulting in insufficient control over the patient’s diagnosis and treatment process and ineffective corrective measures [23]. This situation can render the hospital’s overall medical care passive, affecting work efficiency and reputation of the hospital. 5. Inadequate execution of hospital management system: To date, medical and health institutions in China have established many effective systems and operating procedures in medical quality management. However, due to inadequate implementation of the system and poor management, hospitals face challenges in smoothly implementing these effective systems, which can seriously affect the public image of healthcare system. To address these deficiencies, we upgraded and strengthened the management of hospital link quality in 2022. We also dis-

Table 4. Comparison of medical staff satisfaction

	Number of cases	Satisfied	Generally satisfied	Dissatisfied	Total Satisfaction Rate (%)
2021	584	474	76	34	81.16%
2022	607	568	28	11	93.57%
χ^2	-	-	-	-	41.884
P	-	-	-	-	<0.001

Table 5. Comparison of patient satisfaction

	Number of cases	Satisfied	Generally satisfied	Dissatisfied	Total Satisfaction Rate (%)
2021	1127	794	132	201	82.17%
2022	1098	859	146	93	91.53%
χ^2	-	-	-	-	42.534
P	-	-	-	-	<0.001

Table 6. Comparison of CMI, composite index, and error rate

	Error rate	CMI	Composite index
2021	28.29%	1.08	0.62
2022	9.27%	1.31	1.09
χ^2	11.858	-	-
P	<0.001	-	-

Note: CMI, Case Mix Index.

cussed the impact of link quality management on medical quality by comparing relevant data between 2021 and 2022.

This study revealed that the error rate in the completion of the general surgery case index at The Fourth Hospital of Harbin Medical University significantly decreased from 27.91% in 2021 to 9.60% in 2022 ($P < 0.05$). In comparison, a previous study in a similar hospital setting reported a reduction of only 10% over a similar timeframe, suggesting that the interventions at The Fourth Hospital were particularly effective. Similarly, the error rates for the main diagnosis, primary surgical operation, other diagnoses, and other surgical operations in the case index also demonstrated significant statistical differences between the two years (all $P < 0.05$). In 2022, the hospital experienced a substantial increase in the number of emergency and outpatient visits, hospitalizations, surgeries, and reported adverse events compared to the previous year. This contrasts with findings from Park et al. [24], where only a modest increase in patient interactions was observed after implementing quality management measures. Moreover, the rates of grade A hospitalization medical records, grade A outpatient prescrip-

tions, timely medical record archiving, patient satisfaction, average length of stay, third- and fourth-level surgeries, and treatment of critically ill patients all demonstrated significant improvements in 2022 compared to those in 2021 (all $P < 0.05$). The workload index, work efficiency index, diagnosis quality index, and treatment quality index all showed marked enhancements in 2022 compared to those in 2021 (all $P < 0.05$). This aligns with the findings of Rozenfeld et al. [25], who also observed improvements in similar indices after strengthening hospital management systems. The rates of outpatient antibiotic use, emergency antibiotic use, and inpatient antibiotic use all significantly declined in 2022 compared to those in 2021 (all $P < 0.05$), echoing the global trend of reduced antibiotic usage due to better management practices. The satisfaction rate of medical staff at The Fourth Hospital of Harbin Medical University increased significantly from 81.16% in 2021 to 93.57% in 2022 ($P < 0.05$). This is notably higher than the average increase reported in a meta-analysis by Hussein et al. [26], emphasizing the effectiveness of the hospital interventions. The mechanisms behind these improvements may be multifaceted. Enhanced training programs, streamlined communication channels, and the introduction of advanced technological tools could have played pivotal roles. Additionally, the hospital's commitment to continuous feedback and iterative improvements might have fostered a culture of excellence, contributing to these positive outcomes.

This study aimed only at a single department in a single hospital, and which limited the general-

izability of the results. The outcomes might be influenced by factors unique to the institution and the department. However, the hospital is generally similar to other medium-sized hospitals in terms of services and personnel. The quality management measures adopted in this study are consistent with the best practices reported in the literature, suggesting that they can be reasonably adopted by other similar hospitals. Namely, although the specific improvement effects of different hospitals may be different, the overall trends of lower error rate, higher efficiency, and higher satisfaction observed in this study may exert similar directional changes when adopting evidence-based quality management strategies. It is suggested that further studies involving multiple hospitals/departments should be carried out to query the generalizability of the research results. It should be emphasized that although the quality management measures adopted in this study were limited to local implementation, they were aimed at the universal challenges of healthcare delivery. They may provide a reference for policies and norms in other places and be incorporated with customized adjustments. Connecting the research results with a wide range of medical quality patterns, and discussing the improvement of quality management in individual hospitals can help to systematically improve the overall medical quality and safety.

With the continuous expansion of medical resources and rapid changes in medical demand in recent years, the relationship between continuous improvement of medical quality and high-quality environmental management has become closer. Of course, the continuous improvement of medical quality cannot be separated from the guidance of hospital leaders and the support of various functional departments. Through the strengthening implementation of environmental quality management, we realized that in actual clinical work, only by continuously improving and revising evaluation rules and system construction can we truly achieve the goal of patient-centered care. Only by continuously strengthening the connotation of medical quality management and improving its related systems can we fundamentally elevate the overall level of medical quality in hospitals. This is also improved with the introduction of advanced technology tools, including electronic medical record system, which integrates with computerized physician order entry, bar-coded medication management, advanced

clinical decision support, and data analysis capabilities.

The limitations of this study are several. First, the study's focus on a single department within one hospital may limit the generalizability of the findings. The specific practices and outcomes observed might not be representative for other departments or hospitals, and the results could be influenced by factors associated with the specific studied department and hospital. Second, the absence of a control group in the study design limited a more robust comparison of the changes in 2022. Without a control group, it is less convincing to attribute the observed improvements to an upgraded link quality management alone. Third, the retrospective nature of the study, which relies on historical data, can introduce biases related to data collection and recording, and it does not allow for control over variables that may have changed over time. Fourth, the study uses satisfaction rates of medical staff and patients as an outcome measure, which can be subjective and influenced by factors not related to link quality management. The design and administration of the satisfaction surveys may also impact the results. Lastly, the study compared data only from two consecutive years. Longer-term follow-up could assess the sustainability of the improvements. To address these limitations, future studies should expand the scope to include multiple departments and hospitals to enhance the generalizability of the findings. Implementing a control group would allow for a more robust comparison and help attribute observed improvements to specific changes in management. Shifting from a retrospective to a prospective study design could reduce biases related to data collection and recording, allowing for better control over variables. To address the subjectivity in satisfaction surveys, standardized and validated tools could be used, and the relationship between satisfaction and quality of care could be further explored. Furthermore, conducting long-term follow-up studies would be of value.

Conclusion

After upgrading and strengthening the quality management of hospital links, The Fourth Hospital of Harbin Medical University has achieved significant improvements in management level, medical quality, technical level, and staff satisfaction.

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Disclosure of conflict of interest

None.

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Link quality management in healthcare

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