

Exploration on the New Path of Hospital Based on the Goal of Improving Medical Quality and Safety

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Abstract:

At present, hospitals are faced with problems such as “formal response”, limitations of traditional tools, insufficient data mining and neglect of patient feedback in quality and safety management. In this study, a four-in-one improved model of “data-driven-intelligent early warning-process reengineering-patient collaboration” was constructed, covering five core modules: multidimensional quality data monitoring, AI-assisted decision-making, critical process reengineering, patient participation platform and continuous improvement guarantee, forming a dynamic closed-loop system of “monitoring-analysis-intervention-feedback”. Through the construction of intelligent data center, the development of AI risk early warning system, the reconstruction project of clinical pathway, the improvement of patients’ participation quality and the construction of dynamic improvement guarantee system, the quality management will be promoted to be precise, dynamic and collaborative. Taking the VTE quality improvement project of general surgery (pilot) and hepatobiliary surgery (control) in a 3A hospital as an example, the multi-dimensional evaluation method was adopted. The results showed that the pilot ward was significantly superior to the control ward in terms of timely VTE risk assessment rate, drug prevention implementation rate, mechanical prevention implementation rate and VTE standard prevention rate, and the incidence of confirmed VTE was also significantly reduced. This study provides a feasible solution for the reconstruction of hospital quality and safety management system, which has important theoretical and practical value.

Keywords:

Medical Quality and Safety, New Path, Hospital, VTE Quality, Risk in VTE, VTE Incidence

1. Introduction

Medical quality and safety is the core proposition of hospital survival and development, which is directly related to patients' life and health rights and the credibility of medical services. In recent years, with the rapid development of global medical technology and the diversification of patients' health needs, the complexity of medical quality and safety management has increased significantly. The Global Action Plan for Patient Safety issued by the World Health Organization (WHO) points out that there are about 134 million medical-related adverse events in the world every year, of which 4.2 million directly lead to the death of patients, which highlights

the urgency of quality and safety management. In China, the National Health and Wellness Commission (formerly the National Health and Family Planning Commission) has continuously issued the Measures for the Management of Medical Quality and the National Report on Medical Service and Quality and Safety since 2016, and has formulated the National Medical Quality and Safety Improvement Goal year by year since 2021, taking 10 indicators such as reducing surgical complications and improving the standardized prevention rate of venous thromboembolism (VTE) as the core tasks of national medical institutions [1,2].

However, at present, hospitals still face multiple challenges in quality and safety management. Some hospitals have a tendency of "formal response" to the improvement objectives and lack systematic improvement paths, which leads to slow improvement of core indicators [3]; Although traditional tools such as PDCA cycle and quality control circle are widely used, there are some problems such as lagging data collection, single analysis dimension and fragmented improvement measures, which are difficult to adapt to complex medical scenarios [4]; Although electronic medical record (EMR) and hospital information system (HIS) have been popularized, massive clinical data have not been fully tapped, and intelligent technologies such as AI-assisted decision-making and risk early warning have not been deeply integrated into the quality control process; As the direct experience of medical services, patients' safety feedback is often ignored, and the quality improvement model of doctor-patient collaboration has not yet been established [5].

The purpose of this study is to build a new hospital management path that integrates big data analysis, AI intelligent early warning, process reengineering and patient participation mechanism around the goal of improving medical quality and safety, and promote the transformation of quality management to precision, dynamics and synergy. The research follows the logic of problem diagnosis-path design-empirical verification-strategy optimization, and comprehensively uses the methods of literature analysis, policy interpretation, investigation interview and case study to identify the pain points of quality and safety management, design a collaborative model combining technology empowerment with process optimization, evaluate the implementation effect through quantitative index comparison and qualitative interview, and finally put forward the optimization strategy and guarantee mechanism that can be popularized.

2. New Path Design of Hospital Quality and Safety Improvement

2.1. Overall framework of path design

Guided by the goal of national medical quality and safety improvement, this study constructs a four-in-one improvement model of "data-driven-intelligent early warning-process reengineering-patient collaboration", and forms a dynamic closed-loop system of "monitoring-analysis-intervention-feedback", covering five core modules of multidimensional quality data monitoring, AI-assisted decision-making, key process reengineering, patient participation platform and continuous improvement guarantee, so as to promote the intelligent, collaborative and sustainable development of quality management Figure 1.

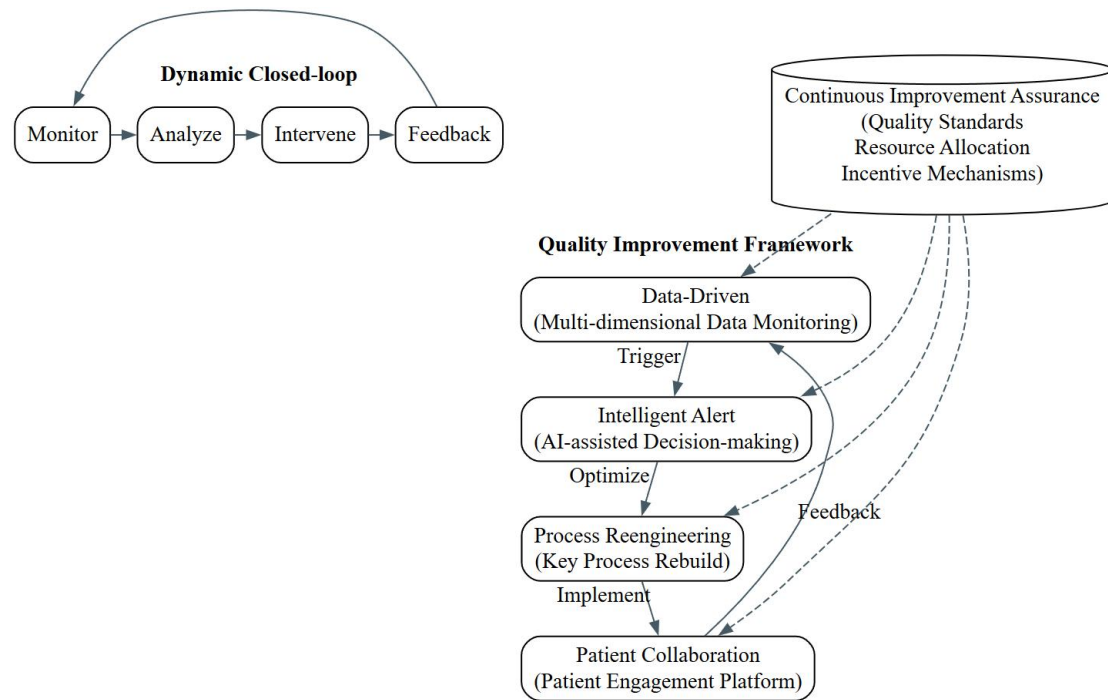


Figure 1. Overall framework of path design.

This methodology emphasizes the collaborative innovation of technical tools and management system, which not only meets the requirements of national medical quality and safety improvement goals, but also adapts to the digital transformation trend of medical institutions, and provides a landing solution for the reconstruction of hospital quality and safety management system.

2.2. Specific implementation method

2.2.1. Intelligent data hub construction

Multi-source heterogeneous data integration uses ETL tools to integrate 30+ data sources such as HIS, EMR, nursing system and equipment Internet of Things, and build a clinical data center (CDR). Focus on grabbing VTE prevention, surgical complications, drug safety and other related fields, and establish a quality index data warehouse. The development of real-time monitoring dashboard uses Tableau/Power BI to build a dynamic visualization platform and set the threshold warning function. In VTE prevention module, indicators such as risk assessment rate and timeliness of preventive measures are displayed in real time [6]. The data governance mechanism establishes the clinical data standardization committee and formulates the Medical Quality Data Dictionary V2.0, which contains 128 quality index definitions and collection specifications to solve the problem of data islands and caliber differences.

2.2.2. Development of AI risk early warning system

Construction of machine learning model Using LSTM neural network to process sequential medical data, a prediction model of surgical complications was established. The VTE risk assessment tool is developed by using random forest algorithm, and 15 characteristic variables such as D- dimer and Caprini score are integrated. Intelligent reminder embedding process deploys real-time early warning plug-ins in doctors' workstations. When the system identifies high-risk patients, it automatically pops up a list of preventive measures and reminds the nursing team synchronously [7].

Abnormal event monitoring uses NLP technology to analyze the nursing record text, and develops the monitoring model of adverse events such as pressure injury, falling down and falling out of bed, which improves the efficiency by three times compared with traditional manual reporting.

2.2.3. Clinical pathway reengineering project

Through the clinical pathway reengineering project, combining with the improvement of lean management tools, the definition-measurement-analysis-improvement-control model was introduced to optimize the preoperative disinfection process, improve the qualified rate of skin preparation, digitize standardized operating procedures, transform 18 core systems into intelligent checklists and compulsory electronic signatures, and establish a virtual team for quality improvement, and jointly develop an intelligent reminder system for catheter maintenance to realize systematic improvement and intelligent control of medical quality.

2.2.4. Patient participation in quality improvement

Establish a patient participation quality improvement system, create a “doctor-patient bridge” WeChat applet, and integrate the functions of self-examination, rehabilitation guidance and gamification interaction to enhance patient participation; Using emotion analysis technology to mine patient complaint data, identify service pain points and promote pharmaceutical service optimization; Innovate the establishment of patient safety officer system, recruit patients in rehabilitation period to record service experience, and provide real feedback and new perspective for process improvement.

2.2.5. Dynamically improve the security system

Construct a dynamic improvement guarantee system, and simulate the effect of improvement strategy through the quality and safety digital twin system, and verify that strengthening discharge follow-up can reduce the unplanned readmission rate; Applying blockchain technology to realize the chain storage of quality data to ensure the traceability and authenticity of the process; And build a "Quality and Safety Cloud College", and combine AR simulation assessment to improve the training effect, improve the annual training compliance rate, and form a long-term mechanism for technical empowerment and ability improvement.

3. Case Demonstration and Effect Evaluation

3.1. Case background

In this study, the general surgery (pilot) and hepatobiliary surgery (control) in a 3A hospital were taken as the target wards, and the VTE quality improvement project was carried out in 2023. Based on the standard prevention rate baseline of 78.6% in the whole hospital in 2022, the VTE intelligent risk assessment system, the prevention execution tracking module and the “anti-thrombosis little guardian” WeChat applet were deployed to construct the whole process improvement mechanism covering evaluation, execution and education.

3.2. Appraisal procedure

Multi-dimensional evaluation method is adopted, covering three types of indicators: structure, process and result. Structural indicators include system deployment rate and

data interface integrity, which are used to evaluate the infrastructure of improvement measures; Process indicators cover the timely rate of risk assessment and the implementation rate of preventive measures, reflecting the prevention rate of VTE norms and the incidence of confirmed VTE.

In the analysis method, the double difference method is used to compare the index change trend between the pilot and control wards, and the difference between groups is analyzed by combining χ test and t test, and the trend monitoring of process indicators is carried out through the control chart to comprehensively evaluate the effect and stability of the improvement path.

3.3. Result

After 12 months' implementation, the timely rate of VTE risk assessment, the implementation rate of drug prevention, the implementation rate of mechanical prevention and the prevention rate of VTE standard in the pilot ward were significantly better than those in the control ward, with statistical significance ($p < 0.001$), and the incidence of VTE diagnosis was also significantly reduced. See Table 1 below.

Table 1. Comparison of key indicators (implemented for 12 months).

Index	Experimental ward (n=620)	Control ward (n=585)	P value
Timely rate of VTE risk assessment	98.2%	83.5%	<0.001
Implementation rate of drug preventive measures	95.7%	79.2%	<0.001
Implementation rate of mechanical preventive measures	89.3%	68.4%	<0.001
VTE standard prevention rate	96.1%	80.3%	<0.001
Incidence of confirmed VTE	0.8%	2.1%	0.021

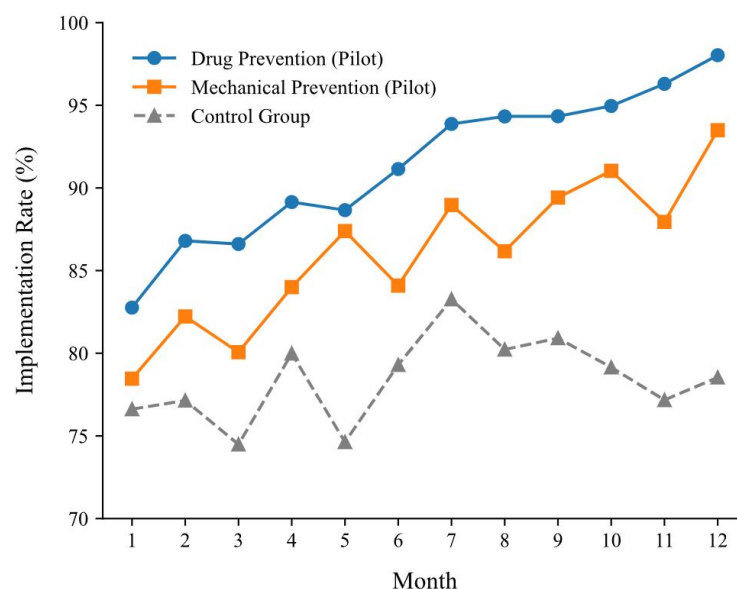


Figure 2. Trend change of process indicators.

The trend analysis of Figure 2 shows that after the implementation of improvement measures, all indicators in the pilot ward show a steady upward trend, which is obviously better than that in the control ward. The implementation rate of drug prevention exceeded 90% in the fourth month, indicating that systematic intervention took effect quickly; The initial period of mechanical prevention fluctuated greatly, reflecting the problem of process running-in period, but it became stable from the ninth month, reflecting the continuous effect of intelligent reminder system. In terms of abnormal points, the decline in the control ward in the seventh month may be related to seasonal factors, while the slight decline in the mechanical prevention rate in the pilot ward in the fifth month needs to be further investigated in combination with equipment maintenance records.

The analysis in Figure 3 shows that after the implementation of the new improved path in the pilot ward, the VTE standard prevention rate increased significantly from 78.6% to 96.1%, with an absolute increase of 17.5 percentage points, while the control ward only increased by 1.2 percentage points; The double difference method shows that the improvement effect mainly comes from the implementation of the new path after excluding factors such as time trend. The histogram further shows that the implementation rate of the pilot ward is stable above 95%, which reflects the continuous and stable effect of the intervention measures. At the same time, the incidence of VTE decreased from 2.1% to 0.8%($p=0.021$), indicating that quality improvement effectively translated into improvement of clinical outcome.

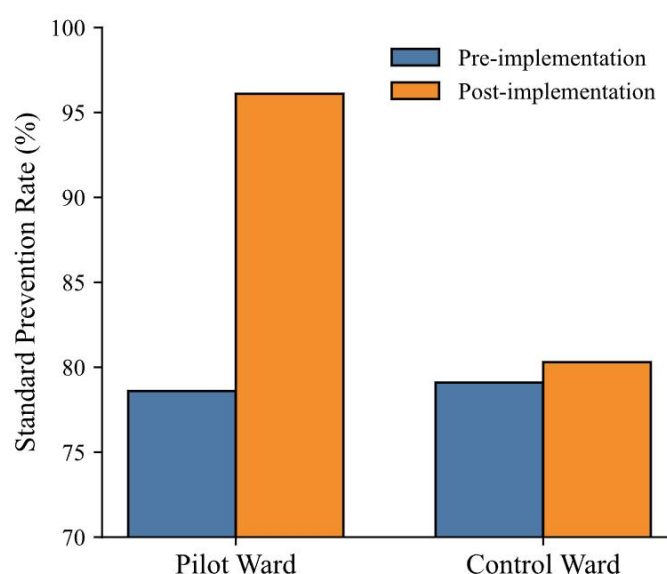


Figure 3. Standardize the improvement effect of prevention rate.

4. Conclusions

Focusing on the improvement goal of medical quality and safety, this study explored a new path of hospital management by constructing a four-in-one improved model of “data-driven-intelligent early warning-process reconstruction-patient collaboration”. The model covers five core modules: multidimensional quality data monitoring, AI-assisted decision-making, key process reengineering, patient participation platform and continuous improvement guarantee, and forms a dynamic closed-loop system of “monitoring-analysis-intervention-feedback”. In the empirical study, VTE quality improvement project was implemented with general surgery (pilot) and hepatobiliary surgery (control) as the target wards in a 3A hospital. The results

show that the timely rate of VTE risk assessment, the implementation rate of drug prevention, the implementation rate of mechanical prevention and the prevention rate of VTE standard in the pilot ward are significantly better than those in the control ward, and the incidence of confirmed VTE is significantly reduced. This shows that the new path can effectively improve the level of medical quality and safety management and promote the improvement of core indicators. This study also emphasizes the importance of collaborative innovation of technical tools and management system, which provides a feasible solution for the reconstruction of hospital quality and safety management system. In the future, the application of intelligent technology in medical quality control process should be further promoted, and the construction of patient safety feedback mechanism should be strengthened to achieve more efficient and accurate medical quality and safety management.

Conflicts of Interest

The author declares that there is no conflict of interest regarding the publication of this article.

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