Original Article

Effect of an inpatient nursing risk early warning and control system in Shanghai: A retrospective study of adverse events

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ABSTRACT

Purpose: To avoid the nursing risk of inpatients, reduce the occurrence of nursing errors and improve the safety of inpatients.

Methods: We established a nursing risk early warning and control system, which includes a safety supervisory network, risk screening and early warning tools, and a risk control process.

Results: The qualified rates of risk control measures to prevent pressure ulcers, unplanned extubation and fall/fall from bed all increased. The incidence of reported nursing errors decreased. The number of mistakes in medication-giving decreased.

Conclusion: The establishment of an inpatient early warning and control system could effectively avoid nursing risk, improve risk prevention abilities, improve patient safety, and improve nursing quality.

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1. Introduction

The early warning of nursing risk is an important component of hospital risk early warning. Several scholars have explored nursing risk early warning systems [1,2] and confirmed that the establishment of such a system could improve the ability of nurses to identify and respond to risks as well as reduce the occurrence of nursing adverse events [3]. However, there is currently a lack of effective and feasible quantitative indicators and scientific evaluating tools [2] to help nurses identify risk early and improve their ability to control risk. Since 2013, our hospital has used modern computer network technology [4,5] and applied modern and scientific managing tools to establish the Inpatient Nursing Risk Early Warning And Control System (INREWCS). This system, which is based on the nursing risks of fall/fall from bed, medicine usage error, pressure ulcer and unplanned extubation, has improved decision-making and is being used in clinical wards with favorable results.

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2. Establishment of INREWCS

2.1. Establishment of a three-level nursing safety monitoring organizational network

The Department of Nursing set up three-level nursing safety and quality grid architectures which included a nursing safety management committee and a nursing quality management committee. The nursing safety management committee consisted of a high-risk monitoring team, a nursing defects monitoring team, and a nursing quality improvement team. Each team adopted a three-level monitoring system which consisted of the Department of Nursing, the committee and safety supervisors. Each committee contained one group leader, one secretary, and 10–15 experienced nurses or head nurses selected from different wards such as internal medicine, general surgery and geriatrics. Each ward had one safety supervisor responsible for collaborating with the nurses to implement nursing risk monitoring and report information in a timely manner.

2.2. Usage of the inpatient nursing risk early warning tool

2.2.1. Inpatient nursing risk assessment scales

Based on a statistical retrospective investigation and expert meeting, inpatient risk assessment scales for pressure ulcer, unplanned extubation or fall were established. Each of these scales were formatted as checklist tables and integrated in the Hospital Information System. The nurses recorded the risks of pressure ulcer, unplanned extubation or fall either in personal digital assistants (PDAs) or in hospital computers by entering numbers in the tables. Once a nurse finished, the PDA or computer automatically calculated the total scores for each of the three scales. When the score of any scale reached 10, the patient was considered have a risk of pressure ulcer, unplanned extubation or/and fall. At that point, the computers or PDAs would show the appropriate preventive nursing measure, whether it be condition observation, catheter care or health guidance. The nurse then recorded that he/she followed the preventive measures.

2.2.2. Three-color nursing risk warning marks

A three-color warning mark system was used to indicate the extent of vigilance required. The colors were red, yellow, and green, the three colors of traffic lights [6]. For instance, in the case of unplanned extubation, the catheters were divided into three classes, each labeled with a sticker. A green sticker was used to indicate a class III catheter (e.g. nasal catheter etc.), a yellow sticker was used to indicate a class II catheter (e.g., stomach tube, urethral catheter etc.), and a red sticker was used to indicate a class I catheter (e.g. thoracic duct, arterial indwelling catheter etc.). In the case of medical usage errors, the three-color system was used for backup medication placement, specialized drug incompatibility, and treatment paths. For backup medication placement, a red color was used for electrolytic drugs, a yellow color was used for nervous system drugs, and a green color was used for insulin. For specialized drug incompatibility, red, yellow and green warning cards were used to denote different extents of harm caused by incompatible drug mixing. For treatment paths, red, yellow and green marks were used to identify venous access, access by gastrointestinal tract and access by bladder irrigation pipe, respectively.

2.2.3. High-risk medication warning and live-monitoring tools

The Department of Nursing, cooperating with the Department of Information, developed a network information barrier [7], a sort of firewall for high-risk drugs (e.g. allergic drugs, chemotherapeutics, drugs of high concentrations) and high-volume drugs. When nurses submitted requests from the pharmacy for these types of drugs, the system would remind the nurses of the correct dosages, concentrations and units. For example, when a nurse ordered penicillin for a patient allergic to penicillin, the computer automatically informed the nurse of the allergy and rejected the request. When a nurse administered electrolytic drugs, the system automatically alerted the nurse to be careful with high-concentrative electrolytes and reminded the nurse to check the patient’s electrolyte test results in order to reduce the risk of a medicine usage error.

The Induction System for Real-time Monitoring of Infusion tool performed real-time monitoring of parameters such as infusion progress and speed of high-risk intravenous drugs. The infusion alarm sensors automatically identified the specifications of the infusion bag, monitored the residual liquid, and sent the information wirelessly back to the nurse station and remote monitoring center. The tool showed the status of the infusion to the nurses and doctors and reminded the nurses when the infusion ended.

2.3. Inpatient nursing risk control system

The Department of Nursing formulated a series of management systems, processes and standards, early warning tools, key monitoring objects, links and more. These included “Rules of Security Network Management”, “Rules of Monitoring and Assessment of Nursing Risk”, “Management Systems of the Key Nursing Objects and Links”, “Management Systems of High-risk Drug Safety” and “Nursing Safety Path and Emergency Handling Process”. The nurses took measures according to the nursing safety path and dealt with accident security issues or risk events according to the corresponding emergency handling process. At the same time, the “work standards” and “evaluation criteria” were made to clarify the different personnel responsibilities and assessment content, respectively.

3. Applications of INREWCS

3.1. System operation

INREWCS performed a quantitative analysis of the input data and a qualitative evaluation and risk analysis, with warning signals issued if thresholds were passed. All inpatients were evaluated when admitted to our hospital, after surgeries or apostasis. Patients with risk assessment scores over the threshold or using high-risk drugs were considered high-risk patients. In risk control, different management measures...
were taken under different conditions such as normal state, alert condition and crisis state. For patients in the normal state, clinical nurses evaluated the patients once per week and cared for them strictly according to the “nursing safety path”. When patients’ risk assessment scores were 10 points or more, the patients were considered to be in the alert condition. After the head nurses confirmed the scores, the safety supervisors reported them to the high-risk monitoring committee. The primary nurses assessed the patients every day and gave warning marks depending on the extent and type of risk. In addition, the head nurses and monitoring team members assessed the patients once per week. Moreover, the monitoring team members gave the site instructions of risk pre-control, while the safety supervisor entered the high-risk monitoring measures into the monitoring records every week. Patient were considered to be in the crisis state when near-miss events or nursing errors occurred. Once the alert condition or crisis state occurred, the clinical nurses (1) launched the contingency plan, (2) entered the emergency handling process to prevent the expansion and spread of the risks, and (3) reported to an adverse event platform.

3.2. Quality control

3.2.1. Summary and feedback of nursing adverse events

The Department of Nursing collected the reported data and made a “Quarter Safety Communications Manual”, which summarized the types of adverse events, the proceedings, and the people involved. The manual was then compared to the manual from the previous quarter and the manual from the same quarter of the previous year. The nursing adverse events and error-preventing events were also analyzed. Finally, the whole process of occurrence, analysis, improvement, evaluation and track were described in detail and shared as cases in the manuals, which were given to the wards to educate the nurses and potentially improve the system.

3.2.2. Training and assessment of risk early warning and control methods

Safety management committees introduced the application of risk management tools to the safety supervisors through seminars, on-site demonstrations and other methods at fixed intervals. The Department of Nursing held safety and quality evaluation meetings each quarter to improve the risk awareness and risk management abilities of the nurses through actual case analyses. Nine quality management teams, under the quality management committee, evaluated the assessment records, the accuracy and normalization of early warning tools usages, the implementation and target rate of prevention and control measures through simulation drills, and the nursing documents.

4. Results

4.1. Comparison of nursing adverse events before and after implementation

This study focused on the four main types of nursing risks, including fall/fall from bed, pressure ulcer, unplanned extubation and medicine usage error. According to whether or not the adverse events caused injuries to the patients, the events were divided into two categories: nursing error and near-miss event. The medicine usage errors were further divided into order errors and medicine-giving errors. The frequencies of nursing adverse events and medicine usage errors reported by the safety supervisors before and after INREWCS implementation (in 2009 and 2013, respectively) are shown in Tables 1 and 2.

The quality management committee assessed the nursing clinical risk prevention and control measures through spot checking. A score of over 80 points was considered to be the standard. The contents of the assessment included nursing prevention and control measures of fall/fall from bed, pressure ulcer, unplanned extubation and medicine usage error. The qualified rate of preventing unplanned extubation risk increased from 91.5% in 2009 to 98.4% in 2013; the qualified rate of preventing falls/falls from bed increased from 89.4% to 98.3%; the qualified rate of preventing pressure ulcers increased from 90.5% to 99.77% (Table 1).

5. Discussion

5.1. INREWCS can avoid nursing risks and ensure patient safety

The first step of nursing risk management is the early warning of high risk, which can occur only after the awareness of high risk [8]. However, the establishment of nursing risk indexes is an important link of early warning [9]. The nursing risk assessment scales used in this study were used to evaluate the existing or potential risks in the nursing processes used in our hospital. The scales were also used to screen risk factors of high risk, which provided scientific evidence of preventing and solving risk measures. Using the hospital’s information network platform, INREWCS not only effectively helped prevent human errors, but also increased the efficiency of risk management. The control standards and measures formulated from the four aspects of organization, tool, emergency handling process, and system further ensured inpatient safety. The results showed that INREWCS could effectively lessen the occurrence of nursing adverse events, as the numbers of nursing error events of falls/falls from bed, unplanned extubation, pressure ulcers and medicine usage errors decreased after implementation of INREWCS. In addition, many risks were identified and stopped by the nurses and reported as near-miss events. The data indicated that both the medicine-ordering error numbers and the medicine-giving error numbers in the near-miss events increased after implementation of INREWCS. There was a significant difference between the proportions of the two medicine usage error types ($p < 0.001$), indicating that INREWCS could help medical workers stop the nursing risks from the perspective of system and avoid the occurrence of the nursing errors.
Comparison of nursing adverse events before and after INREWCS implementation.

Table 1 — Comparison of nursing adverse events before and after INREWCS implementation.

<table>
<thead>
<tr>
<th></th>
<th>Fall/fall from bed [n(%)]</th>
<th>Inevitable pressure ulcer [n(%)]</th>
<th>Unplanned extubation [n(%)]</th>
<th>Medicine usage error [n(%)]</th>
<th>Total [n]</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>14(13.5)</td>
<td>10(9.6)</td>
<td>62(59.6)</td>
<td>18(17.3)</td>
<td>104</td>
</tr>
<tr>
<td>2013</td>
<td>9(19.1)</td>
<td>3(6.4)</td>
<td>32(68.1)</td>
<td>3(6.4)</td>
<td>47</td>
</tr>
</tbody>
</table>

Table 2 — Comparison of medicine usage error types before and after implementation.

<table>
<thead>
<tr>
<th></th>
<th>Order error</th>
<th>Medicine giving error</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>69(35.4)</td>
<td>126(64.6)</td>
<td>195</td>
</tr>
<tr>
<td>2013</td>
<td>1012(70.1)</td>
<td>412(28.9)</td>
<td>1424</td>
</tr>
<tr>
<td>x²</td>
<td></td>
<td></td>
<td>92.42</td>
</tr>
<tr>
<td>p</td>
<td></td>
<td></td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

5.2. INREWCS can increase nurse risk management consciousness

The objective of risk early warning is to realize risk control, and the final link of risk control to implement control measures. The nurses are the ones directly involved in the clinical risks, the ones who perform nursing risk prevention and control measures. Thus, it is extremely important to increase their risk management consciousness and abilities. In our hospital, the “Quarter Safety Communications Manual” was made and quarterly meetings of safety and quality evaluation were held in part to keep the risk management training in the nurses’ consciousness. The quality committee monitored the implementation quality of nursing risk early warning and control. The risk self-control and organizational control promoted the continuous improvement of nursing quality. Assessments of nursing risk prevention and control measures for pressure ulcer, fall/fall from bed and unplanned extubation showed that the qualified rates increased in 2013 compared with 2009. This increase indicates that the risk management consciousness and abilities of nurses were enhanced and the risk prevention and control measures were effectively implemented. Foreign medical risk supervision systems suggested that near-miss events were one of the important nursing security implications, though these events did not cause any actual injuries to the patients [10]. Thus, reporting near-miss events was encouraged in our hospital. The near-miss events, which could cause major injuries to patients, were considered as high-risk events and analyzed together with nursing errors. In addition, the responding measures and plans were recorded in the “Quarter Safety Communications Manual” to alert the medical workers in other departments. According to the reporting data, the number of near-miss events was markedly larger in 2013 than in 2009, indicating that the nurses’ risk management consciousness and risk avoidance abilities had increased.

6. Conclusions

Prevention and control measures for nursing risks such as fall, fall from bed, medicine usage errors, pressure ulcer, and unplanned extubation were listed in “Evaluation Rules of High Quality Nursing Service”, published by the National Health and Family Planning Commission in 2014. The INREWCS established in our study proved to be a reliable, controllable, efficient and safe managing system which decreased the incidence of the above-mentioned nursing risks. Unfortunately, there were no prediction tools for other nursing-related risks (e.g. upper extremity deep venous thrombosis, pulmonary embolism) [11]. Nursing managers could refer to or introduce evaluation tools for these other risks to increase risk identification and evaluation accuracy. On the other hand, managers should carefully consider the tenability of risk early warning and control tools in clinics and establish a matched nursing management system. The diverse factors of nursing risk management are closely related to each other. Managers should build a specialized team for risk prevention, collaborate with other disciplines [12], and provide an efficient, supportive and harmonious working environment for nurses on the basis of ensuring nursing quality and patient safety.

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References


