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Original Article

Improving neurosurgical operating room efficiency by standardizing patient transfer process: a quality improvement study

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Abstract: Well-organized patient transfer management improves the efficiency and safety of operation, and the satisfaction of medical care in the operating room (OR). Here we explored whether patient transfer improvement by OR and ward nurse promotes surgery efficiency and satisfaction. A quality control team was set up and the members collected data of 1178 patients undergoing selective surgery to make analysis and identify problems in the surgery patient transfer. Then improvement measures were applied to another 1260 patients undergoing selective surgery in patient transfer. After improvement, qualification rate of preoperative preparation, medical record preparation, surgical site mark, postoperative instrument and equipment preparation and intraoperative nursing records were significantly increased. Time between two successive operations was shortened. Satisfaction degree of patients, surgeons and nurses was improved. Thus, we concluded that standardized neurosurgical patient transfer effectively enhanced OR efficiency and safety and therefore improved satisfaction of patients, surgeons and nurses.

Keywords: Neurosurgical patients, operating room, neurosurgery, quality control, patient transfer

Introduction

The aim of an efficient operating room group is to accelerate operation turnover on the basis of surgical patients' safety [1]. To achieve this goal, more attention should be payed to patient transfer. Inefficient patient transfer processes increase the risk of medical errors and therefore, improvements in these processes are high-priority goals for surgery patient safety [2]. In recent years, with the development of medical industry and increase in number of surgery patients in China, the operating room staff has a heavier burden than ever before, accompanied by a lot of problems, such as negligence in work handover, inadequate preoperative preparation, untimely delivery of postoperative patients, etc. [3]. These problems not only affect operating room turnover, leading to longer working hours, but also extend time of surgery and impair patients' satisfaction.

Surgery work in the neurosurgery department is more challenging for its demands for high accuracy and the more serious conditions of patients. Therefore, the operating room management of neurosurgical patients asks for higher standards [4]. Operating room management focuses on optimizing operational process to maximize the number of surgeries that can be done in a given time. Surgery patient transfer process including delivering patients to the OR and sending patients back to the ward is an indispensable part of OR management. The main handover process to the OR has been disordered with no standard policy and criterion to evaluate the process. In addition, the handover process demands cooperation between operating room nurses and ward nurses, so there is the possibility of missing and misrepresentation of information. Improvement in efficiency and patient safety was explored by streamlining the patient transfer process. The primary objectives of this quality improvement project included (1) decreasing the waste of time in transfer by 20%, (2) increasing efficiency and qualification rate by 25%, (3) decreasing handoff errors, eliminating adverse events during patient care handoff from the OR to the ward, and (4) increasing satisfac-

tion. From October 2018 to May 2019, we analyzed specific problems of neurosurgical patient transfer in the operating room. Subsequently, improvement measures were put forward combining the characteristics of both neurosurgery department and the OR to guarantee efficiency and quality.

Materials and methods

General information

There were 6 wards and 1 ICU with a total of 282 beds in the neurosurgery department. A total of 7 fully equipped specialized neurosurgery operating rooms were in service which can carry out different kinds of neurosurgery operations. The number of neurosurgery operation was 263 to 527 per month. There were 195 nurses in the neurosurgery department including 167 nurses in the ward and 28 nurses in the OR. The 28 OR nurses included three males and 25 females, with an age range from 22 to 43 (27.3±2.1) years. Time of work in the operating room ranged from 1 to 20 (4.8±1.3) years. There were 1 junior college, 26 bachelors and 1 postgraduate. As for the title, there were 26 nurses or senior nurses, 1 nurse-in-charge and 1 deputy chief nurse. Neurosurgery specialized operating rooms and general operating rooms were managed separately, with separate personnel and management. Quality control was implemented at three levels: nursing department, chief head nurse and head nurse. In this study, 1178 patients who underwent selective surgery from October to December 2018 (before the improvement of patient transfer management) were selected as the pre-improvement group, while 1260 patients who underwent surgery from march to May 2019 (after the improvement of patient transfer management) were selected as the post-improvement group. General data of the two groups were compared, as shown in **Table 1**.

Establishment of a quality control team for neurosurgical patient transfer

The team consisted of 5 members including head nurse of the neurosurgery operating room, head nurse in the neurosurgery ward, two nurses in the neurosurgery OR and one nurse in the neurosurgery ward. The OR head nurse was designated as the group leader fully responsible for implementation and overall arrangement; head nurse of the ward mainly coordinated the work of the operating room and the ward; OR nurses dealt with data collection and analysis; ward nurses assisted in the implementation and supervision of the project. Group leader of the quality control team conducted training for the members before implementation, including the standards of patients transfer, standardized medical records, regulations in the operating room, risk precautionary measures in the operating room and the safety objectives of patients.

Evaluation

Evaluation methods: all indexes of surgical patients were collected and analyzed by members of the quality control team from October to December 2018, before improvement, and March to May 2019, after improvement. Satisfaction degree was investigated by sending questionnaires to patients, doctors and nurses respectively.

(1) Average time of patient transfer.

Total time between patients left the ward and finally returned to the ward was counted and the average time of patient transfer was calculated.

(2) Time between two successive surgeries.

Time between two successive surgeries referred to the time from one patient leaving the operating room to another patient entering the operating room. It was recorded by the operating room nurse.

(3) Preoperative preparation.

After each patient entered the operating room, all items on the preparation list (hospital gown, medical records, preoperative examination results, drugs, and other special items) were checked by the quality control team members. Unqualified preoperative preparation was defined as any items missing or insufficient.

(4) Surgical site mark.

According to the operation name and operation procedure, surgical site was examined. Failure to mark the surgical site or improper mark was identified as unqualified surgical site mark.

(5) Quality of preoperative medical records.

Preoperative medical records were evaluated. Essential items including general information, progress notes, preoperative discussion, doc-

Table 1. Comparison of general data between the two groups

Group	Disease					Type of anesthesia		Operation methods				Time of operation		
	Intracranial occupative disorders	Intracranial vascular disease	Intraspinal occupying lesion	Functional disease	Other	General anesthesia	Local anesthesia	Craniotomy	Trans-sphenoidal approach	Trans-spinal approach	Stereotaxis	<4	4-8	>8
Before improvement (n=1178)	608	128	110	206	126	998	180	754	105	138	181	293	850	35
After improvement (n=1260)	624	145	137	214	140	1073	187	782	139	160	179	316	907	37
X^2	2.352					0.092		4.130				0.015		
P	0.671					0.762		0.248				0.991		

Table 2. Analysis of problems in patient transfer

Before patients were admitted to the operating room	After operation when patients were sent back to the ward or ICU
• Some patients failed to change their hospital gown and remove their jewelry or watch in time even if they were told to do so in advance. • The in-patient information card is vague or wrong. • Some pages of the medical record were missing and results of some key examination were not included in the medical record. In some records, the signature of superior doctor is vacant. • Surgical site was not marked. • Nurses in the ward failed to hand the necessary preoperative information to the operating room nurse, such as preoperative imaging data. • Potential risks on the way to the operating room for lack of accompanied doctors. When patients are transported to or from the operating room without the company of doctors, certain patients like infants, patients with epilepsy, limb dysfunction, mental disorder etc. have a high chance of accidents.	• Patients' goods were lost. • Specimens were not properly preserved. • Cannula fell off while moving the patient. • Poor communication with ICU or ward nurses delayed the transfer. In some cases, adverse events happen due to inadequate preparation of the emergency equipment. • Nurses in the ward are not clearly aware of the order to pick surgical patients and failed to set priorities. As a result, patients that needed immediate medical care were not addressed in time. • Incorrect records after the operation due to the inaccurate description of the intraoperative situation. • OR nurses failed to explain the postoperative caring notes to the accompanied relatives of the patients in time.

tor's advice, informed consent of blood transfusion, anesthesia and operation, relevant examination results and signatures of patient, nurses and doctors were checked. An unqualified preoperative medical record was defined as one or more items missing.

(6) In-ward equipment preparation after surgery.

Preparation of bedside instruments and equipment including the hospital bed, ECG monitor, ventilator (if necessary) were checked by the head nurse of the ward before the patient was sent back to the ward after surgery. According to the postoperative standard, lack of instruments or unprepared instruments were considered unqualified.

(7) Nursing records quality.

Intraoperative nursing records were examined. Records with missing items or signatures were regarded as unqualified records.

(8) Cannula condition.

The drainage tube, catheter, and venous infusion tube were checked. Any cannulas falling off was considered unqualified.

(9) Patient satisfaction.

The questionnaire was designed on the basis of literature and expert consultation including 15 items in 5 aspects: preoperative visit, attitude of operating room personnel, informed consent, operating room environment, and postoperative follow-up.

(10) Doctor satisfaction.

After designing the doctor satisfaction questionnaire, conducting preliminary survey on surgeons and discussing with experts, the final questionnaire was determined including 15 items in four aspects: environment of the operating room, preoperative preparation, transition after operation, and cooperation of nurses.

(11) Nurse satisfaction.

Self-designed questionnaire, including 12 items from three aspects: system, management and patients.

Likert 5-level scoring method was used in each item for patients, doctors and nurses satisfaction. Highly satisfactory, partly satisfactory, fair, not satisfactory and dissatisfactory, 1-5 points were given successively, with a total score of 75 points. The higher the score, the higher the satisfaction degree was.

Statistics

All data were analyzed by SPSS 13.0 statistical software. Data were expressed as the mean ± standard deviation. Comparison between groups was made by an independent t-test. $P< 0.05$ was considered statistically significant.

Results

Analysis of problems in patient transfer

Before the improvement of regular management process and problem analysis, patients were taken into the operating room by OR nurses and after surgery, sent back to the ward or ICU by circuit nurse. The problems are shown in **Table 2**. The quality control team members analyzed the above problems and concluded the following main reasons: lack of quality control in preoperative visit, non-standard preoperative preparation procedure, unclearly defined role in work and poor communication between medical staff. Additionally, there was a lack of systematic training for all nurses on how to transfer patients safely and efficiently.

Improvement measures

Quality control nurses discussed with the chief resident and anesthetist and worked out five improvement measures. 1. A preoperative preparation item table was designed and the preoperative visiting mode was enhanced: to make patients better prepared for the operation, operation-related contents were printed and distributed to patients including what should be done and what shouldn't, how to clean the surgical site and how to protect cannula from falling out. Before the operation, the OR nurse gave the preoperative preparation list to the patients or their relatives and asked them to make preparations accordingly. After the preoperative visit, the patient's relatives, the OR nurse and the ward nurse signed on the surgical visit record sheet. Designated nurse in the

Table 3. Comparison of time related index before and after improvement in the operating room

Group	Case amount	Average time to take a patient to the OR (min, $\bar{x}$ ± SD)	Average time to deliver a patient to the ward (min, $\bar{x}$ ± SD)	Time between two successive surgeries (min, $\bar{x}$ ± SD)
Before	1178	12.1±3.7	20.5±5.3	25.5±4.5
After	1260	9.6±4.2	15.7±4.8	15.5±5.5
t		15.552	23.463	6.018
P value		0.000	0.000	0.000

ward was responsible for the patient until the operation began. 2. Quality standards for medical record were established. The improved standards include four parts: complete items with no information missing, correct handwriting, complete preoperative examination results and all required signatures. To ensure that all surgeons gained necessary information of patients, the progress record and preoperative summary must be complete; the patient's information on the medical record must be correct; all the examination results must be complete; doctors and patients' relatives must sign on the informed consent forms. 3. A handover record form was designed to record the patient's basic condition including the state of consciousness, intubation condition, skin condition, and patient's belongings etc. Both OR nurse and ward nurse signed on the form after all the listed items were confirmed. 4. A transfer system for special patients was established. Unconscious patients must be closely observed to check the patient's consciousness and skin condition by the doctor in charge to avoid adverse events. After the operation, the patient was sent back to the ward or ICU by circuit nurse, anesthesiologist and the doctor in charge. Patients with epilepsy were protected from falling out of bed or extubation. Tracheotomy patients must be taken good care to avoid blockage or folding of the breathing cannula. 5. The OR nurse was asked to call the ward nurse near the end of the operation. Once receiving the call, the ward nurse recorded the patient's name, bed number, admission number, type of operation, time of operation, etc. and prepared to pick up the patient.

According to the condition of patients, two handover procedures were applied. For patients who underwent normal selective operation, the operating room nurse sent the contact nurse information including vital signs, skin condition and intubation condition of the patients; for patients who underwent high level operation, the information included intraoperative transfusion, vital signs, protective posture, intubation condition, intraoperative accident and whether first aid should be conducted. To avoid adverse events, nurses managed the patients in order of priority according to their condition. Training for nurses both in the operating room and the ward was conducted by the head nurse of the ward. The training course included theoretical teaching and operation patient handover drill to clarify their roles and to ensure the nurses know the procedures of operation patient handover.

Comparison of time-related indexes before and after improvement in the operating room

Respectively, 1178 and 1260 cases were randomly selected before and after the improvement for comparison and operation time indexes were determined. Total time spent on sending and delivering patients was shortened after the implementation of improvement measures. Time between two successive surgeries was shortened by about 10 min (25.5±4.5 min to 15.5±5.5 min). These results showed that the preoperative preparation, medical records, and surgery efficiency were enhanced and number of adverse events decreased after improvement. Data were shown in **Table 3**.

Comparison of qualified rate before and after improvement in the operating room

Number of qualified preoperative preparation, qualified surgical site mark, qualified preoperative medical records, qualified equipment preparation and intraoperative nursing records in the ward were significantly increased after improvement compared with those before improvement (**Table 4**).

Comparison of adverse events before and after improvement in the operating room

As shown in **Table 5**, before the implementation of improvement measures in patient transfer, there were 5 cases of cannula falling out and 6

Table 4. Comparison of quality related index before and after improvement in neurosurgical patient transfer

Group	Case number	Qualified preoperative preparation number	Qualified surgical site mark number	Qualified preoperative medical records number	Qualified equipment preparation number in the ward	Intraoperative qualified nursing records
Before	1178	1126	1113	1054	1064	1138
After	1260	1259	1259	1258	1260	1260
X^2		56.832	71.429	139.739	127.917	7.460
P value		0.002	0.001	0.001	0.000	0.006

Table 5. Comparison of adverse events in patients transfer before and after improvement in surgery patient

	Amount	Cannula falling	Cannula obstruction	Total
Before	1178	5	6	11
After	1260	0	0	0
X^2		5.359	6.433	2.388
P value		0.021	0.011	0.098

cases of cannula obstruction on the way the patients were sent back to the ward. After the implementation of improvement measures, no such adverse events occurred.

Comparison of satisfaction before and after improvement in the operating room

After the implementation of measures above, the satisfaction of patients, doctors and nurses improved as a whole. Average grades of patients, doctors and nurses increased by 9.22, 7.89 and 5.71 respectively. The difference was statistically significant (P<0.05). Data were shown in **Table 6**.

Discussion

Improving the management of surgical patients transfer contributes to accelerating the operation turnover, promoting quality, reducing adverse events and improving the satisfaction with operating room nursing quality. It is directly related to the safety of surgical patients. Preoperative preparation is a critical part of operating room nursing quality. Sufficient preoperative preparation ensures a successful surgery while inadequate preoperative preparation causes procedural, economic, and mental problems for patients as well as medical professionals. Also, well-planned preoperative operation reduces surgery-related morbidity, shortens hospital stay, expedites the restoration of organ function, and finally facilitates the patient's return to normal life [5]. Handover of patient care before and after surgery is critical in the transfer of information during transitions in patient care. However, due to the increasing patients' number and heavier burden of medical staff, the handover process is often unstructured and unstandardized, resulting in accidents and harm to patients potentially. Studies showed that improvements in information transfer can be achieved by using checklists in surgical handover [6, 7]. Other studies also found that adverse events can be traced back to the inadequate communication during handover of patients [8]. A lot of research and improvement efforts also focused on the information transfer function of patient handover [7, 9]. In a word, handover quality is more than correct and complete transmission of patient information [10]. Furthermore, taking the initiative to make some improvements in the nursing process or method can achieve better outcome in improving the nurse-patient relationship. Patient satisfaction is regarded as one of the most important goals for the work of operating room nurses. Nurses play an important role in the provision of care to the patients who undergo surgeries, especially in the handover of patients. Patients' satisfaction with the services provided during transference by the practitioners plays a key role in the development of services. In addition, enhanced patient satisfaction is also related to higher degree of job satisfaction for the health care professionals [11]. We therefore focused on the improvement in handover of patients.

In this study, we have established the preoperative preparation list and surgical visit record sheet. Meanwhile, measures were taken to enhance the medical record quality. In the present study, one finding was that preoperative

Table 6. Comparison of satisfaction grades of patients, doctors and nurses before and after improvement

	Patients' satisfaction		Doctors' satisfaction		Nurses' satisfaction	
	Case number	Grade	Case number	Grade	Case number	Grade
Before	1178	59.57±4.03	145	55.34±7.58	32	51.45±3.63
After	1260	68.79±5.02	145	63.23±5.76	32	57.16±2.24
t	50.160		4.272		4.152	
P value	0.011		0.028		0.030	

preparation was more adequate, with clearer surgical site mark and higher quality in preoperative medical record compared with before. Similar results were also reported by Elizabeth [12]. With the rapid development of modern medicine and advanced technology being used, operations tend to be more complicated, specialized, and patients often expect to have better outcomes and more comfortable experiences in hospital [13], which proposes higher demand of working efficiency of the operating room in the management of surgery-related affairs. We thus took measures to arrange preoperative preparation reasonably to reduce the time between two successive surgeries to 15.5±5.5 min from 25.5±4.5 min with increased turnover rate of surgery and decreased time for patients to wait, so as to improve the satisfaction of patients, doctors as well as nurses. Comprehensive training and strict assessment of nursing staff before implementation of standardized preoperative preparation should be emphasized so as to make nurses understand the standard specification for qualified handover.

Reducing preoperative time is the key to improving operating room efficiency and reducing unnecessary costs. Retrospective reviews found that 80% of cases at tertiary care hospitals at most were delayed by 30 min on average, which means significant preventable costs for patients. Common causes for delays include delayed patient preparation, transportation issues, and congestion in the operating room. Several innovations have been made to improve the rate of on-time operation, including DMAIC (D = Define, M = Measure, A = Analysis, I = Improvement, C = Control), Team STEPPS (Team Strategies and Tools to Enhance Performance and Patient Safety) to improve communication before surgery and reduce errors [14, 15]. Our work to shorten the time spent on delivering patients to the OR and sending patients back to the ward has proved the effectiveness of patient transfer management. After implementation, time between two successive surgeries was shortened, thus increasing efficiency and decreasing unnecessary costs.

The responsibility of nurse staff is indispensable in improving the surgical patients transfer and patients' satisfaction in turn reflects the quality of OR nurse management [16]. In nursing crisis management, it is pointed out that the key point of surgical patient safety management is handover of patients. Before improvement, the handover process lacked strict regulations, which led to unclear task allocation. For instance, when visiting the patient before operation, the operating room nurses only tell the patient or the relatives what should be done in word, so the patients miss some information. Anesthesiologist, doctor, OR nurse and nurse in the ward only focus on their own work and accidents happens in handover, which leads to medical disputes. In the processing of improved patients delivery system, specialized measures for patients under certain situations are taken to avoid the occurrence of adverse events like cannula falling out and obstruction. Thus the comprehensiveness, effectiveness and safety of nursing care are ensured.

In present operating room, satisfaction of surgeons, nurses and patients is increasingly used as necessary indicators for evaluating healthcare service. In improving satisfaction, the most common complaint from neurosurgeons is the time waiting to be operated [17, 18]. During a simple operative day, a surgeon may actually spend less than 50% of the time to operate, which also decreased patient satisfaction [19]. For nurses, uncontrolled process spends too much time and energy and causes irritability in working, which is related to lower job motivation. Poor efficiency and long waiting time also affects patients' satisfaction [20]. By

improving operating room management, expectations of surgeons, nurses and patients are re-cognized and dissatisfactions are addressed. Finally, satisfaction of surgeons, nurses and patients improves.

A limitation of the project is the lack of feedback from patients in the long term follow-up therefore whether these improvements translate into long-term satisfaction of patients remains unclear. Also, the improvement should be shaped into a system to be implemented in the long run. Although this study significantly shortened the operation time, more details are yet to be improved including the work of the surgical and anesthesia teams. Still the work provides directions for patient transfer management. There are seven specialized operating rooms in our neurosurgery department. The management of patients transfer to the OR is a process of continuous improvement and requires continuous discovery, analysis and solution for various problems. Our future work will focus on probing into the causes of the problems and in the future, larger randomized controlled trials are required to discover more weak links in the management of neurosurgical patient transfer. Future study should also include the impact of these measures on the OR schedule, which may also be considerable.

Disclosure of conflict of interest

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