

Reducing the Rate of Unplanned Extubation of Venous Access in Perioperative Patients

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Abstract: *Objective:* To investigate the application effect of quality control circle activities in reducing the rate of unplanned extubation of venous access in perioperative patients. *Methods:* The quality control circle method was used to analyze the causes, identify the actual causes of unplanned out-of-control, take corresponding measures, formulate corresponding countermeasures, implement standardized management, and carry out continuous improvement. *Results:* Following the implementation of quality control circle activities, the rate of unplanned extubation of venous access in perioperative patients decreased from 27.35% before improvement to 3.42% after improvement. *Conclusion:* The use of quality control circle activities in the safety management of venous access in perioperative patients is conducive to reducing the rate of unplanned extubation of venous access in perioperative patients.

Keywords: Quality control circle; Unplanned extubation

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1. Introduction

Quality control circle (QCC) refers to a group of personnel from the same unit or work nature. This group automatically and spontaneously organizes, scientifically uses quality control tools, and continuously carries out activities that improve efficiency, reduce costs, and improve product quality. Among the many hospital quality management tools, the quality control circle has become one of the most widely used management tools in China's medical institutions due to its strong standardization and practicality. The application of QCC has also increased the participation of front-line medical personnel as well as the enthusiasm and creativity for the continuous improvement of the hospital quality^[1]. Intravenous infusion is a commonly used treatment method for patients in the perioperative period. It is mainly used for preoperative, intraoperative, and postoperative rehydration or intravenous drug treatment^[2-7]. Unplanned extubation (UE) means that the indwelling time did not reach the expected requirements and the indwelling needle had to be removed in advance due to various reasons (some human factors or complications)^[8]. Intravenous access is the basic life support for patients during the perioperative period. Unplanned extubation increases not only the medical expenses and the risk of patients during surgery, which endangers their lives, but also the difficulty for nursing staff and the local trauma to patients. With the development of venipuncture technology and product improvement, indwelling venous needles have been widely used in clinical practice^[9,10]. Intravenous infusion, as the most widely used treatment method in clinical practice, is an important part of nursing work. The scientific nature and safety of intravenous infusion directly affect

the quality of nursing work and patient satisfaction. How safe, effective, reasonable, and scientific medicines are used by nurses in the operation process plays a vital role in the treatment and safety of patients [11]. Unplanned extubation may lead to increased risk of nosocomial infection, pain, and burden, prolonged hospital stay, doctor-patient disputes, and other adverse consequences; it may even endanger the patient's life [12]. During the use of catheter, complications such as catheter prolapse, phlebitis, tube blockage, extravasation, and catheter-related bloodstream infection may occur. Once serious complications occur, the catheter is often removed [13,14]. Therefore, in March 2018, a quality control circle, "Life Source Circle" group, was set up to analyze the causes of unplanned extubation of venous access in perioperative patients, use the methods of quality control circle to analyze, formulate improvement measures, and achieve better results.

2. Materials and methods

2.1. Establish a quality control circle group

The QCC group consists of eight members, including a deputy chief nurse, two nursing supervisors, four nurses, and a nurse. Two nurses have a master degree, while the other six nurses have a bachelor degree. Two of them are over 40 years old, another two are 30–39 years old, and the other 4 nurses are 20–29 years old. In addition to a counselor who is responsible for guiding and supervising the direction of the whole process as well as addressing difficult questions, there is also a circle leader, who is responsible for activity planning, the implementation of quality management, the distribution and coordination of various tasks, and data proofreading. The circle members are responsible for data sorting, data collection, meeting minutes, and so on.

The circle meets twice a week, ranging from 10 minutes to 60 minutes. The form of the meeting adopts methods such as discussion, informatization, *etc.*, including WeChat, Fetion, YY Voice, *etc.*

2.2. Select the circle name and its meaning

2.2.1. Formation of "Life Source Circle"

A total of four candidate names were collected. After brainstorming by all the members, the 5-3-1 scoring method was used. The name "Life Source Circle" received the highest score, so "Life Source Circle" was agreed on to be the name of this QCC.

2.2.2. Meaning of the name

The significance of the name "Life Source Circle" is as follows: the lifeline of surgical patients during surgery is the venous access; being uninterrupted and continuous, it ensures the safe and smooth transition of surgical patients through the perioperative period.

2.2.3. Meaning of the emblem

Green represents hope, which means that each surgical patient would have a successful surgery; "source" and "circle" refer to uninterrupted fluid, and the hands represent the medical staff; the green leaves held up in both hands refer to the hope of life being held with the hands of the medical staff.

2.3. Determine the theme

2.3.1. Theme selection

A brainstorming session was held to come up with a theme. The circle members brainstormed on the issues that required urgent attention and came up with five themes. The circle members evaluated each theme based on four perspectives: importance, urgency, circle ability, and superior policy. Each theme was scored according to 5-3-1 scoring method. The theme with the highest total score through anonymous voting was

to be the activity theme that must be addressed this time. The theme of the activity with the highest score was “Reducing the Rate of Unplanned Extubation of Venous Access in Perioperative Patients.”

2.3.2. Reasons for theme selection

2.3.2.1. For patients

Intravenous access for patients during the perioperative period is the most basic and important work content. Indwelling needle slips may cause surrounding skin infection ^[15], secondary puncture of the indwelling needle ^[16], and catheter leakage ^[17]. With patient discomfort, any abnormalities seen at the puncture site, or any dysfunction, the catheter is removed ^[18]. It is considered a life support and guarantee for surgical patients. Reducing the rate of unplanned extubation of venous access in perioperative patients is a means to ensure patient safety and reduce the risk of infection and accidental injuries.

2.3.2.2. For colleagues

Paying attention to unplanned extubation of venous access in perioperative patients can enhance work responsibility and reduce patient care disputes and extra work. The concept of safety culture was first proposed by Singer *et al.* ^[19]. There are four aspects to safety culture, namely reporting culture, fair culture, flexible culture, and learning culture. Positive safety culture is the soul of safety management and an important factor for the success of safety management ^[20]. In the traditional safety management concept, managers tend to focus on analyzing the unsafe factors in personal care behaviors, punishing individuals, and overlooking the defects in management systems or processes when analyzing and dealing with nursing errors or accidents. In order to prevent the occurrence of errors, it is not only necessary to treat the symptoms, but also the root causes ^[21].

2.3.2.3. For the hospital

It may help increase income and reduce expenditure of the hospital. According to the price standard of the National Health and Family Planning Commission, a series of low-value consumables in the operating room are not allowed to be charged, including intravenous infusion sets. Therefore, improvements were made on the original basis to improve nursing safety and reduce hospital losses.

2.3.3. Thematic metrics of this issue

Rate of unplanned extubation of venous access in patients during perioperative period = number of unplanned extubation of venous access/number of surgical cases × 100%.

2.4. Develop a schedule of activities

The activity time was from March 2018 to November 2018. According to the activity steps, a group activity plan was drawn into a Gantt chart. The activities were implemented according to the plan, and the activity content and tasks were assigned to individuals.

3. “Grasp the status quo”

“Grasp the status quo” is the stage of analyzing the theme of quality control circle activities and the focus of improvement. It belongs to the baseline investigation period of improvement activities, and each process has strict operational requirements. Flow charts, checklists, and Platonic methods were used to calculate the current status value and improvement focus of the theme; the formula method or benchmarking method was used to determine the target value of the theme improvement, so as to analyze the reasons, factors, and actual causes based on the improvement focus in the subsequent stage of analysis. It can be seen that by ensuring the effectiveness of the steps in grasping the current situation, the application effect of the quality

control circle can be ensured [22]. Patients undergoing surgery with general anesthesia will be affected by anesthetic drugs over a duration of time following surgery, in which their consciousness and physical function cannot be restored that quickly; this may lead to nursing safety events [23]. Intravenous infusion is a common type of nursing procedure; hence, we should attach great importance to the safety management of intravenous infusion in the anesthesia recovery room [24].

3.1. Thematic-related workflows

Dislodged intravenous line → assess cause → handled by nurses → end (Table 1).

Table 1. Thematic-related workflows

Part	Transport process		At rest	
	Operation bed ←→ transport stretcher	Transport stretcher ←→ exit bed	Operation bed (operating room, intraoperative)	Transport stretcher (recovery room, awakening)
Medicine – needle	A1	B1	C1	D1
3-way stopcock – port	A2	B2	C2	D2
3-way stopcock – 3-way stopcock	A3	B3	C3	D3
3-way stopcock – extension tube	A4	B4	C4	D4
Extension tube – puncture needle	A5	B5	C5	D5
Puncture needle – skin	A6	B6	C6	D6

3.2. Data collection before improvement

- (1) Data collection: Objective data on unplanned extubation of venous access in perioperative patients
- (2) Collection time: May 4, 2018 – June 4, 2018 (continuous collection for 30 days)
- (3) Collection location: Operating room-operating room, recovery room, and transport room
- (4) Data collection personnel: All circle members
Collection object: surgical patients
- (5) Reasons for collection: Objective reasons for unplanned extubation of venous access in perioperative patients
- (6) Collection method: Data recording method (117 surgical patients were included within 30 days, of which 32 surgical patients were excluded)

4. Data collection form for the QCC group in the operating room of the former center

4.1. Pre-improvement data collection

Time: May 4, 2018 – June 4, 2018

Method: Self-made survey record form

Investigator: All circle members

Total number of cases: Total collected cases

Occurrences: 32 times

Formula for calculating the exclusion: $(A/B) \times 100\% = (32/117) \times 100\% = 27.35\%$

A refers to the number of occurrences of extubation, while B refers to the number of investigations.

4.2. Current situation and grasp data

The current situation and grasp data are shown in Table 2.

Table 2. Current situation and grasp data

Project	Missing number	Percentage (%)	Total percentage (%)
Transport stretcher and patient trolley (medicine and needle) B1	10	31.25	31.25
During surgery (medicine and needle) C1	9	28.13	59.38
During surgery (3-way stopcock and port) C2	5	15.63	75.01
During surgery (needle and skin) C6	3	9.38	84.39
Operation and transport stretcher (medicine and needle) A1	2	6.25	90.64
Transport stretcher and exit bed (puncture needle and skin) B6	1	3.13	93.77
During surgery (3-way stopcock and 3-way stopcock) C3	1	3.13	96.90
During surgery (extension tube and needle) C5	1	3.13	100
Total	32	100	100

4.3. Current value before improvement

Current value = 27.35% (incidence)

4.4. Goal setting

Target value = current value – improvement value
 = 27.35% – 16.41%
 = 10.94%

Improvement value = current value × improvement value × circle ability
 = 27.35% × 75.01% × 80%
 = 16.41%

5. Analysis

5.1. Feature factor diagram

Figure 1 shows a feature factor diagram.

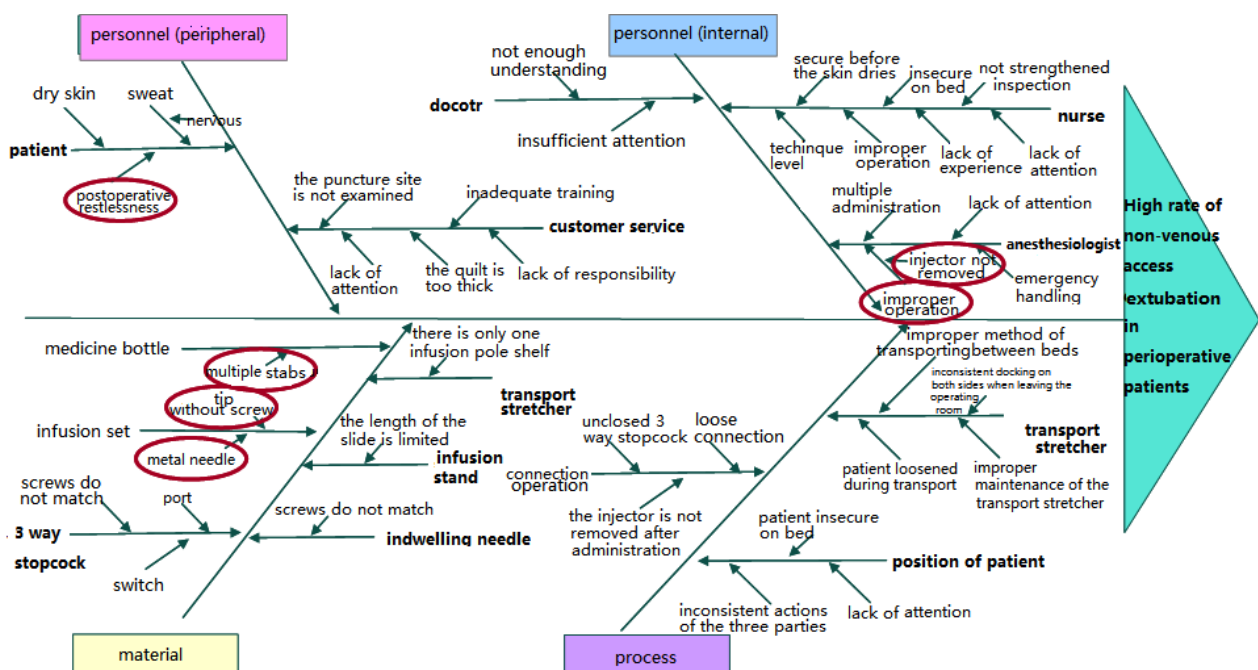


Figure 1. Feature factor analysis

5.2. True cause verification

5.2.1. True cause analysis (1)

Figure 2 represents true cause analysis (1).

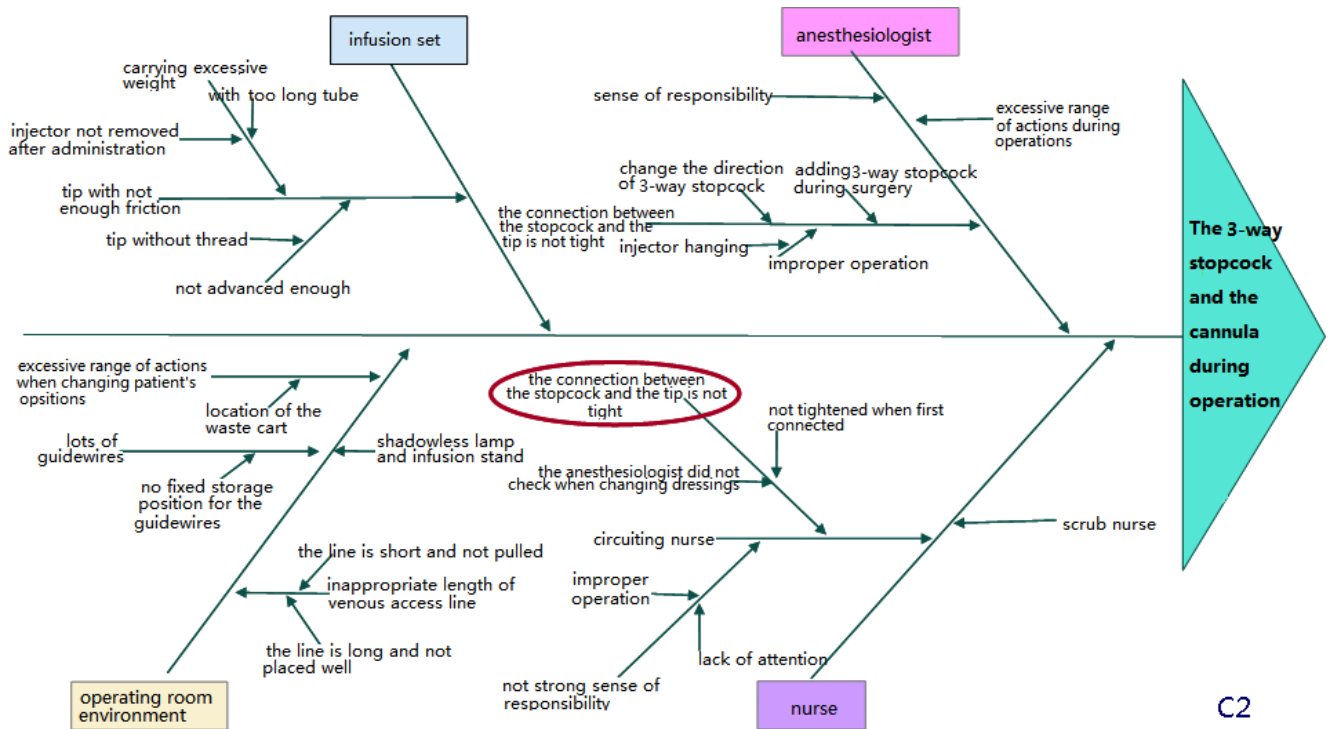


Figure 2. True cause analysis (1)

5.2.2. True cause analysis (2)

Figure 3 represents true cause analysis (2).

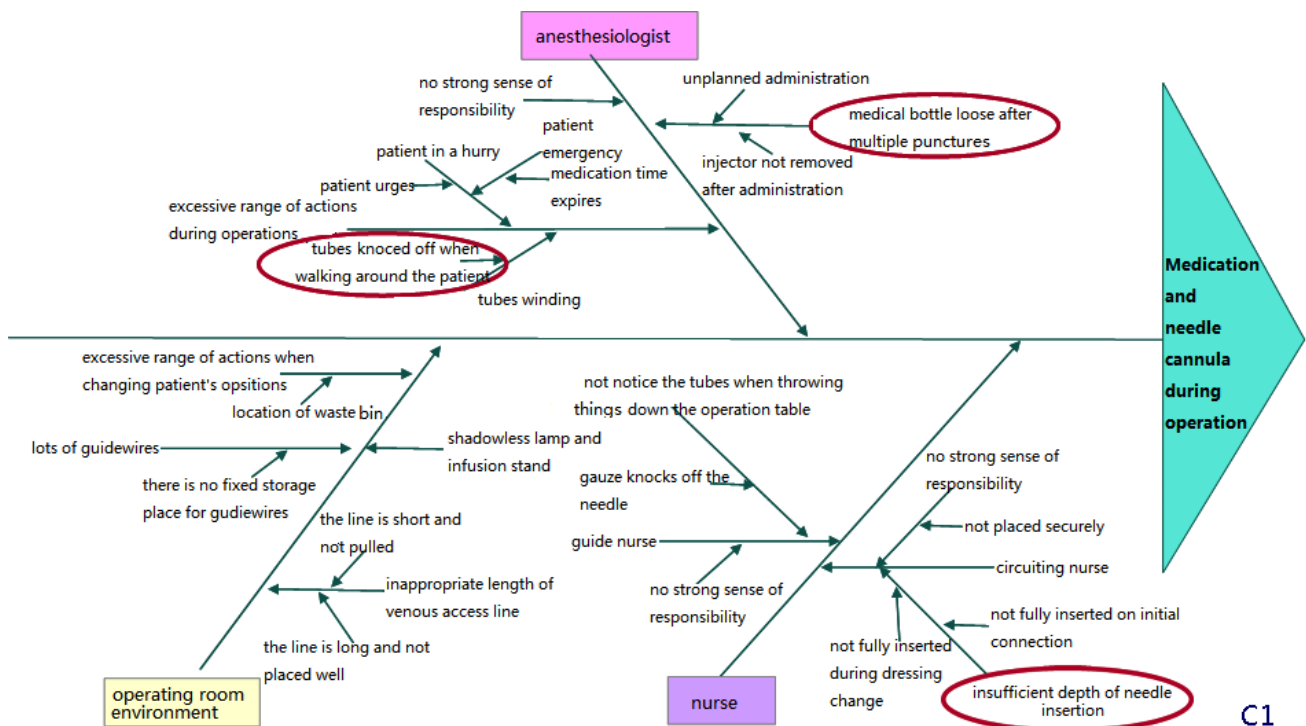


Figure 3. True cause analysis (2)

5.2.3. True cause analysis (3)

Figure 4 represents true cause analysis (3).

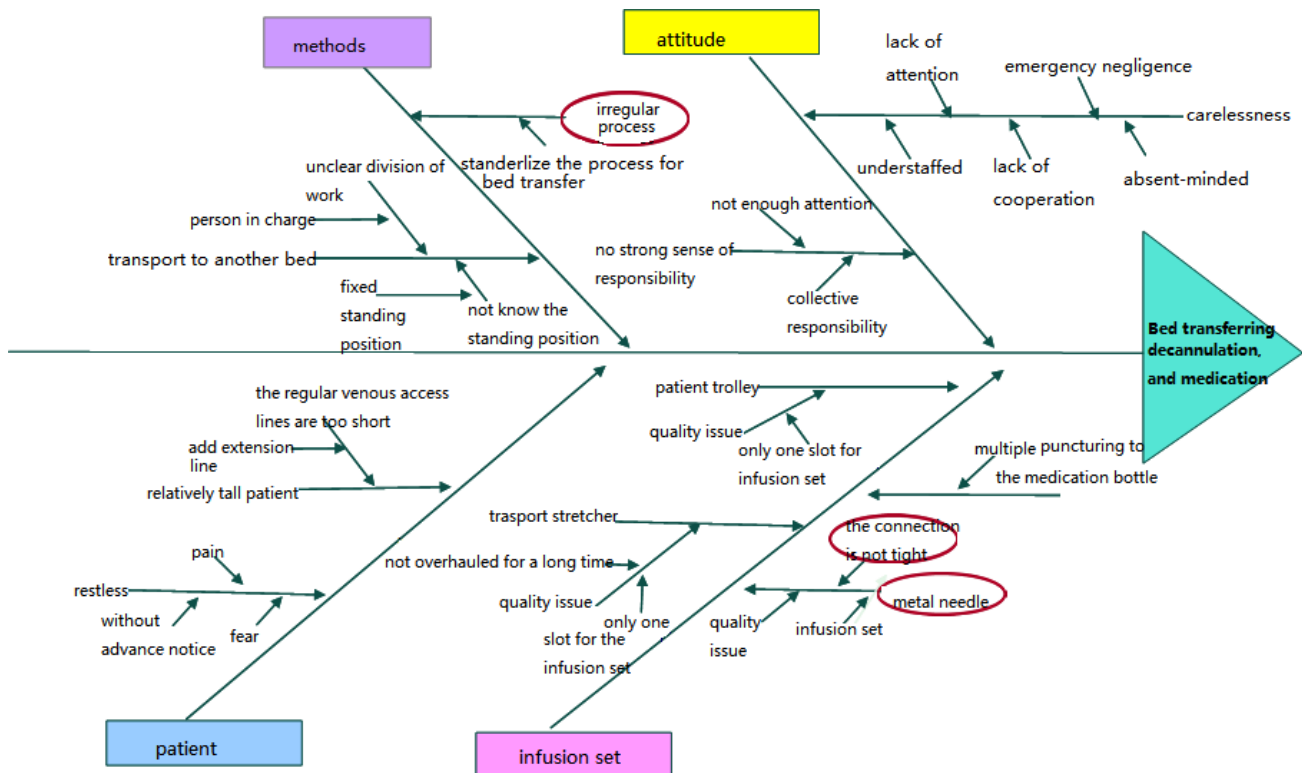


Figure 4. True cause analysis (3)

6. Countermeasures

6.1. Improvement countermeasure plan

The improvement countermeasure plan is shown in Table 3.

Table 3. Improvement countermeasure plan

Question point	Main reason (circled in the fishbone diagram)	Counter-measures	Evaluation			Total score	Selected	Proposer	Implementation plan	Person-in-charge	Counter-measure number
			Feasibility	Financial feasibility	Circle feasibility						
Fish bone diagram of issues	Irregular process	Standardize the station	35	35	35	105	☆	Zhang Guimei	09.30-10.30	All circle members	1
		Unified slogan	35	35	33	101	☆	Sun Yongliang	09.30-10.30	All circle members	2
		Strengthen training	33	29	29	91	☆	Pan Liang	09.30-10.30	All circle members	3
	Multiple punctures, and loose rubber stopper	Design an anti-drop connecting device	31	25	31	87	☆	Xu Ying	09.30-10.30	All circle members	4
		Identification of the puncture site	35	29	29	93	☆	Yao Ruru	09.30-10.30	All circle members	5
	Walking around to slack off at work	Standardize the placement of tubes	27	31	19	77		Jiang Lijun	09.30-10.30	All circle members	
		Increase the sense of responsibility	29	30	25	84		Liu Shujie	09.30-10.30	All circle members	

The evaluation scoring method is as follows: 5 points represent excellent; 3 points represent fair; 1 point represents poor. The number of votes in the circle is 7. Countermeasures with a total score of 85 points or more are implemented.

6.2. Implementation of countermeasures

- (1) Standardize the station
- (2) Unified slogan
- (3) Identification of the puncture site
- (4) Design a connecting device
- (5) Strengthen training

7. Effect validation

7.1. Comparison of data before and after improvement results

The comparison of the number of cases of venous extubation before and after improvement is shown in **Figure 5**, and the effect validation data after improvement are shown in **Table 4**.

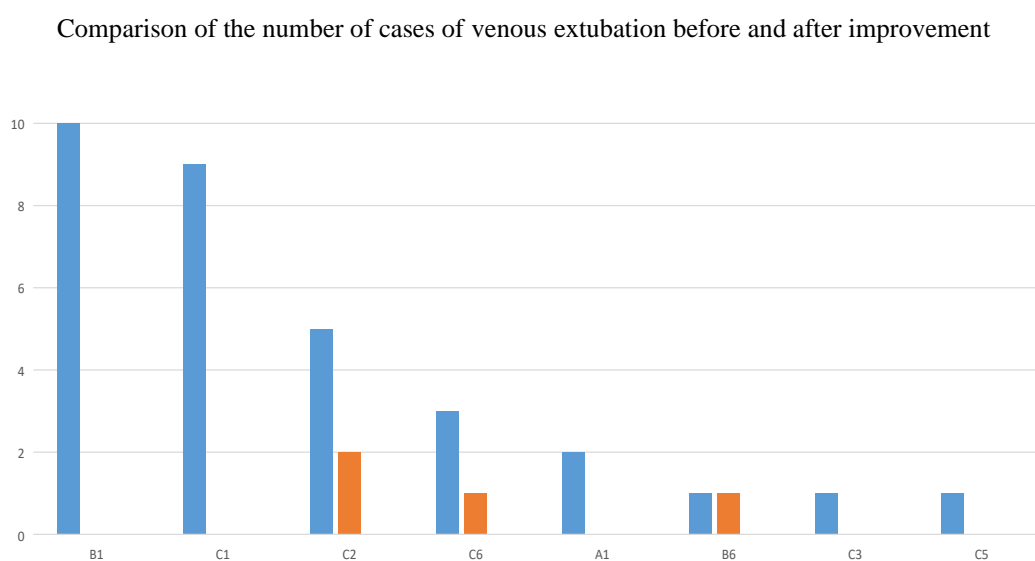


Figure 5. Comparison of the number of cases of venous extubation before and after improvement (blue represents before improvement; orange represents after improvement)

Table 4. Effect validation data after improvement

Project	Missing number	Percentage (%)	Total percentage (%)
Transport stretcher and patient trolley (medication and needle) B1	0	0	0
During surgery (medicine and needle) C1	0	0	0
During surgery (3-way stopcock and port) C2	2	50	50
During surgery (needle and skin) C6	1	25	75
Operating and transport stretcher (medicine and needle) A1	0	0	75
Transport stretcher and patient trolley (puncture needle and skin) B6	1	25	100
During surgery (3-way stopcock and 3-way stopcock) C3	0	0	100
During surgery (extension tube and needle) C5	0	0	100
Total	4	100	100

7.2. Formed results

7.2.1. Target compliance rate

$$\begin{aligned}\text{Target compliance rate} &= (\text{before improvement} - \text{after improvement})/(\text{before improvement} - \text{target value}) \times 100\% \\ &= \frac{27.35\% - 3.42\%}{27.35\% - 10.94\%} \times 100\% \\ &= 145.83\%\end{aligned}$$

7.2.2. Target progress rate

$$\begin{aligned}\text{Target progress rate} &= (\text{before improvement} - \text{after improvement})/\text{target value} \times 100\% \\ &= \frac{27.35\% - 3.42\%}{27.35\%} \times 100\% \\ &= 87.50\%\end{aligned}$$

7.3. Formless results

The formless results are shown in **Table 5**.

Table 5. Formless results

Project	Before improvement		After improvement		Activity growth
	Total score	Average	Total score	Average	
QC method application	28.00	2.8	66.00	6.6	+3.8
Harmony	30.00	3.0	65.00	6.5	+3.5
Problem-solving skills	32.00	3.2	66.00	6.6	+3.4
Communication and coordination	25.00	2.5	63.00	6.3	+3.2
Self-confidence	30.00	3.0	64.00	6.4	+3.4
Sense of responsibility	28.00	2.8	60.00	6.0	+3.2
Positivity	35.00	3.5	63.00	6.3	+2.8

8. Standardization

8.1. Bed transfer

- (1) Before improvement: Circuiting nurses and transport room staff.
- (2) After improvement: Doctor, anesthesiologist, circuiting nurse, and transport room staff.
- (3) Improve content
 - (A) Specified station
 - (B) Unified slogan
 - (C) Consistent action
- (4) Specific execution steps
 - (A) The anesthesiologist is responsible for the patient's head
 - (B) Circuiting nurses are responsible for venous access
 - (C) The doctor is responsible for the patient's foot side
 - (D) The transport room staff is responsible for the opposite side

8.2. Slogan

Circuiting nurses shout the slogans.

8.3. Transportation

After the three parties are ready, unified transporting is done.

- (1) Before improvement: Unclear venipuncture site, no connecting device, and extubation often occurs during transportation.
- (2) After improvement: Clear venipuncture site, and attention should be paid when transporting to another bed.
- (3) Improve the content
 - (A) Puncture site identification (color distinction between upper and lower extremity puncture sites)
 - (B) Design a connecting device (eye-catching logo that attracts enough attention)
- (4) Specific execution steps
 - (A) Upper limbs are pink, lower limbs are green
 - (B) Upper limbs are attached to the dripping pot, and lower limbs are attached to the dripping kettle
 - (C) Popularize the use of connecting devices

8.4. Circuiting nurse responsibilities

The responsibilities of a circuiting nurse must be developed for standardization.

8.5. Assistant nurse responsibilities

Work specifications for assistant nurses in the turntable room must be formulated.

9. Discussion

QCC is used by most hospitals in China as an effective method for continuous quality improvement due to its simplicity, scientificity, and staff enthusiasm mobilization [25]. Using QCC to address the rate of unplanned extubation in perioperative patients has many advantages, but there are also shortcomings. Selecting the theme “Reducing the Rate of Unplanned Extubation of Venous Access in Perioperative Patients” is beneficial as it may help improve the quality of daily nursing work and ensure the safety of patients. However, there are many links involved in the nursing of perioperative patients. Furthermore, it is difficult to collect data and grasp the controllable points. With regard to activity plan formulation, it is necessary to analyze the factors of unplanned extubation of venous access in patients during the perioperative period. However, there are too many clinical links; hence, time needs to be flexibly adjusted. In terms of grasping the status quo, data collection forms at different stages have been designed, but in terms of implementation, all the nurses must have a deeper understanding of the objective of the survey in order to obtain more accurate data. In terms of goal setting, it must be realistic. In order to achieve the set goals, the circle ability of all circle members must be maximized. In terms of formulating countermeasures, ideas are often presented, and brainstorming sessions are carried out, but we also hope to garner more opinions and suggestions from other staff in the department, so that the formulae can be more specific and closer to clinic practice, with less detours. In the process of implementing and reviewing countermeasures, they can be adjusted in time based on the situation as the circle members have significant leading roles. Due to the time limit and the need to lengthen the inspection time and increase the number of samples for different shifts, the data can be more convincing. In the process of validating the effect, the improvement effect is evident, but it is necessary to continue to adhere to the formulated countermeasures. In the process of standardization, timely summaries are conducive to long-term development, but they need to be consistent in order to achieve a normal and long-term effect.

Through QCC activities, all circle members have learned a lot in terms of quality control and mastered new methods and theories, which are of great significance to improving the efficiency and quality of their daily work. The implementation of QCC encourages everyone in the department to pay more attention to

the management of specific links and helps build the confidence of its members to improve the work environment. Through its activities, each member of the circle exerts his or her intelligence, thus improving the cohesion, enhancing their sense of responsibility, and exercising their ability to work as a team.

Disclosure statement

The authors declare no conflict of interest.

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