

# The application of quality control circle to improve functional exercise execution rate of orthopaedic surgery patients

## A SQUIRE-compliant quality-improving study

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### Abstract

Since its application in medical institutions in China, quality control circle (QCC) has gained achievements in medical care and thus earned more attention from the administrative department of health. This paper focuses on the application of QCC (bone-strength test circle) as a new management concept and tool circle in improving the implementation rate of functional exercise in patients undergoing orthopedic surgery, which further effectively improve the accuracy and compliance of functional exercise in patients undergoing surgery, and further effectively promote the rehabilitation of patients.

From July 2018 to November 2018, the management tools and statistical methods of QCC were used to compare the promotion effect of functional exercise execution rate of orthopedic surgery patients before and after QCC activities.

The checklist investigated 6 key causes of functional exercise in patients undergoing orthopedic surgery, the operative rate of orthopaedic surgery in all aspects changed significantly. Among them, the factors of inadequate propaganda and education were compared before and after the improvement, which decreased by 71% after the improvement. The incorrect factors of exercise decreased by 69% after improvement, the effect was more obvious, the difference was statistically significant ( $P < .05$ ). The improvement rate was 59.4%.

Through this activity, functional exercise education process and functional exercise paths, and corresponding standards for various orthopedic diseases were established. At the same time, the measures such as health education for patients were strengthened, and the expected goals were effectively achieved.

**Abbreviations:** PDCA = plan, do, check, and act, QCC = quality control circle.

**Keywords:** execution rate, functional exercise, quality control circle

## 1. Introduction

Quality control circle (QCC) originated from the statistics and management courses by Professor Deming and Professor Juran in the 1950s. In the 1990s, it was used for quality management in the medical and health fields in Taiwan.<sup>[1]</sup> In 2001, QCC was introduced to medical institutions in China, aiming to improve

the quality of medical service by raising the awareness of the medical workers to spot and solve problems in their work.<sup>[2–5]</sup> So far, QCC has achieved good results in clinical application of many hospitals across China, and more and more attention has been paid to it.<sup>[6–8]</sup> QCC refers to the people who share the work in a certain field. They spontaneously work as a team to solve the actual problems using the quality control methods like Pareto and fishbone diagrams, in order to improve efficiency and personnel quality.<sup>[9–11]</sup>

The purpose of functional exercise in orthopaedic patients can promote the decrease of swelling, prevent joint adhesion and stiffness, muscle atrophy. At the same time, functional exercise also promotes blood circulation, prevents deep vein thrombosis, reduces complications, and promotes fracture healing.<sup>[12]</sup> However, in practice, the idea that medical staff attach importance to surgery and neglect exercise has a serious impact on the postoperative surgical results of patients. If orthopaedic patients can have the right amount of functional exercise after surgery, it can promote patients as early as possible, the maximum range of recovery of the injured limb function, promote the body to recover as soon as possible. In order to improve the implementation rate of functional exercise after surgery of orthopaedic surgery patients in our hospital, the department of orthopaedic surgery in our hospital used the method of QCC activity to analyze and improve, and achieved good effect.

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All data generated or analyzed during this study are included in this published article [and its supplementary information files].

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**Figure 1.** Circle theme: care for patients, care for the joint.

## 2. Methodology

### 2.1. Ethic statement

The present study obeyed the Helsinki Declaration and was based on the standards for quality improvement reporting excellence (SQUIRE, version 2.0).<sup>[13,14]</sup> The institute's review board waived a requirement of written informed consent because only anonymous secondary data were retrospectively analyzed. The privacy of patients and staffs involved were adequately protected. Only validated data retrospectively retrieved from our institute's quality-improving and accreditation database were used for analysis. All data used were reported.

### 2.2. Formation of QCC

The "bone-strength test circle" composed of 9 medical technicians (including 1 secretary) from the department of orthopedics of the hospital was formed to solve the problems in hospital work in July 2018. Among them, there are 3 nurses in charge, 85% with bachelor degree or above. "Bone-strength test circle" representing the meaning of positive ("Bone strength" shares the same pronunciation with encouragement, which means positive, encouraging and encouraging) (Fig. 1). Four candidate questions were proposed by a spontaneous group of most quality control specialists through brainstorming. From the 4 aspects (superior policy, importance, urgency, circle ability) about the topic was scored. According to the score, "improving the functional exercise implementation rate of orthopaedic surgery patients" is finally determined as the theme that needs to be solved urgently at present. The main reasons for selecting the topic are as follows:

- 1) To improve the accuracy and compliance of functional exercise of surgical patients, to ensure the safety of patients in hospital, and to promote the rehabilitation of patients,
- 2) To ensure the continuity and pertinence of nursing work, and to improve patient satisfaction, and
- 3) Improve the ability to observe the disease, communication ability with patients and self-management ability.

### 2.3. Planning and implementation

According to the plan, do, check, and act (PDCA) procedure, the group discussed and formulated a detailed activity schedule, evaluated the implementation steps, select the person responsible for each step, draw Gantt chart (Fig. 2), and carry out the

activities according to the plan. The schedule of the activity will be decided by the circle members, and the duration of the activity will be 20 weeks from July to November, 2018.

### 2.4. Confirmation of effectiveness

The duration of this QCC activity was set as 5 months (From July 2018 to November 2018). The basic steps of QCC activity generally followed the Deming cycle (PDCA cycle). The 4 stages (PDCA) were realized through 10 basic steps (Fig. 3). The effect, including tangible and intangible results, was evaluated after the implementation of the strategies. The tangible results included achievement rate and improvement rate. The intangible results were presented by multiple indicators in a radar map.

### 2.5. Investigation of the status quo and goal setting

Through mapping to improve the work flow chart before making it homemade (Fig. 4)

- 1) Design questionnaires and set up inspectors,
- 2) Checklist for functional exercise execution rate before improvement, and
- 3) Regular circle meetings were held, timely information feedback was provided, functional exercise examinations in the previous months were improved, and problems such as inadequate education, incorrect exercise, uncooperative patients, inadequate publicity, uncooperative family members and inconsistent medical care were selected as the main objects of improvement according to the 80/20 principle. Achievement rate = [(data value after improvement - data value before improvement) / (data value before improvement - target index)] × 100%; Improvement rate = [(data value after improvement - data value before improvement) / data value before improvement] × 100% by 100%

### 2.6. Strategies and implementations

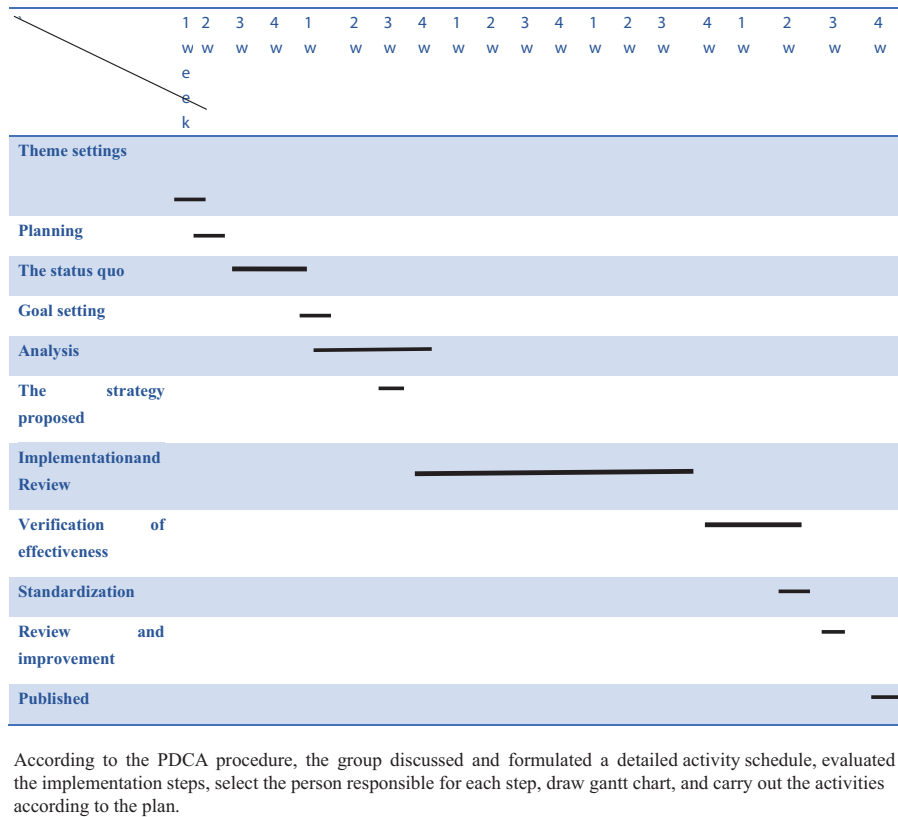
Countermeasure I: Develop the process of functional exercise education, propagandize the teaching and training of education process.

Countermeasure II: The functional exercise map was developed, and the nurse in charge of the bed took the map to the bedside for teaching 3 unified combination (oral, map, demonstration).

Countermeasure III: Develop functional exercise pathways for common diseases, meanwhile, the nurse should pay attention to strengthen bedside guidance every day. Senior nurses communicate with bed doctors about functional exercise for key patients every day. They go to the bedside for guidance at a fixed time every day. Evaluate and record the performance of functional exercise.

Countermeasure IV: The specific content of standardized measures includes 5 aspects: functional exercise standard after hip replacement, functional exercise standard after knee replacement, functional exercise standard after knee arthroscopy, orthopedic functional exercise health education process, and orthopedic functional exercise standard map.

Countermeasure V: This functional exercise class is designed to strengthen the hip muscles and incorporates exercises commonly used in clinical practice. It is based on previous work that shows that such an exercise program improves pain and function.<sup>[15]</sup>



**Figure 2.** Active Gantt chart. According to the PDCA procedure, the group discussed and formulated a detailed activity schedule, evaluated the implementation steps, select the person responsible for each step, draw Gantt chart, and carry out the activities according to the plan. PDCA = plan, do, check, and act.

These exercises aimed to strengthen the quadriceps, hamstrings, and hip abductor muscles and improve functional balance will be taught to participants by the physiotherapist. At the end of the exercise session the physiotherapist will monitor proper form and exercise intensity and will progress the exercises as necessary.<sup>[16]</sup>

**2.7. Statistical processing**

The indices to evaluate achievements were calculated using the following formula: target index = present value - (present value × key improvement × ability of circle), the target index set as 0.49; improvement rate = [(data value after improvement - data value before improvement) / data value before improvement] × 100%. SPSS 16.0 (IBM, NY) was used for statistical analysis, chi-square value was calculated for the comparison between groups, and  $P < .05$  was considered statistically significant.

**3. Results**

**3.1. Comparison of functional exercise implementation rate of patients after orthopedic operation before and after QCC (Table 1)**

**3.2. Pareto compared before and after QCC (Fig. 5)**

**3.3. Radar map of Invisible results (Fig. 6)**

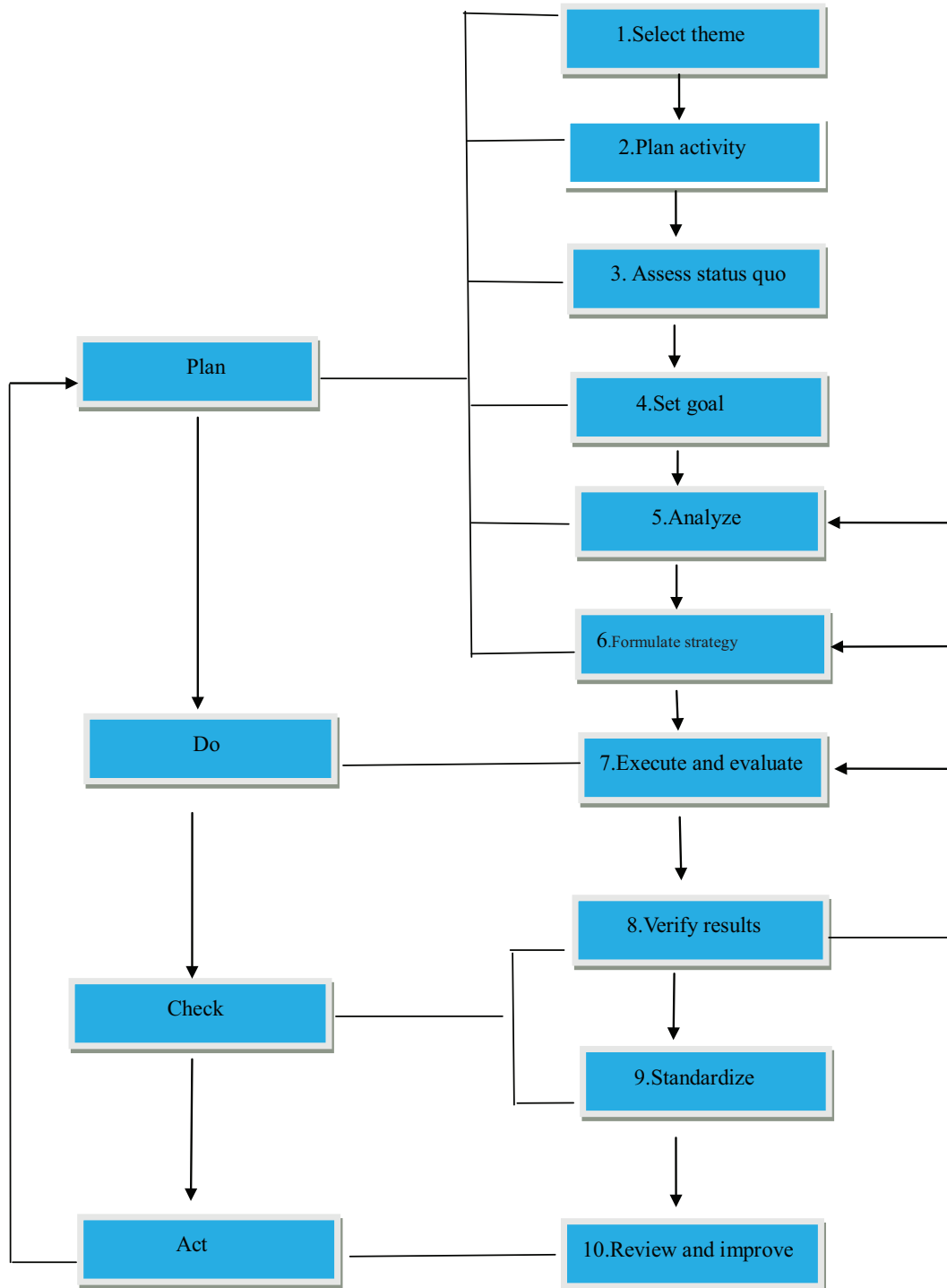
**3.4. Tangible results**

From July to December 2018, from the beginning of QCC activity, the postoperative execution rate of all aspects in orthopaedic ward has significantly changed. Among them, the propaganda and education were not in place, and the improvement was compared before and after, which decreased by 71% after improvement. Exercise is not correct, improved by 69%, the effect is more obvious. Before and after comparison, the difference was statistically significant ( $P < .05$ ). The improvement rate = (before improvement - after improvement) / before improvement × 100% =  $0.594 \times 100\% = 59.4\%$ .

Through this activity, the process and corresponding map of functional exercise education, functional exercise paths and corresponding standards for various orthopedic diseases were developed, and measures such as strengthening patient health education were taken to effectively achieve the expected goals.

**3.5. Intangible results**

Quality management circle activity, not only improved our practical problems that exist in the orthopaedic nursing, and cultivate the circle part of the sense of responsibility and the ability to solve the problem, improve the member's work enthusiasm and harmony degree, increasing the team cohesion, and individual self-confidence. Through the operation of QCC", we realize the advantages of using this mode of management, and witness the effectiveness of using the thought of QCC management.



**Figure 3.** Protocol of the quality control circle. The basic steps of QCC activity generally followed the Deming cycle (PDCA cycle). The 4 stages (PDCA) were realized through 10 basic steps. PDCA = plan, do, check, and act, QCC = quality control circle.

#### 4. Discussion

The activity of QCC, started in Japan in 1962, has been widely applied in medical and health care fields in Germany, Austria, and Thailand.<sup>[9–11]</sup> Orthopaedic patients have long hospital stay and great postoperative pain. To a large extent, being unable to get out of bed for a long time after operation has brought

economic and psychological pressure to patients.<sup>[12]</sup> In addition, postoperative complications such as deep venous thrombosis of lower extremities lead to a longer overall rehabilitation process.<sup>[17,18]</sup> Therefore, it is necessary to carry out the activity of QCC for orthopaedic patients, strengthen postoperative understanding and education of orthopedics, which can enable patients to realize the importance of rehabilitation training for

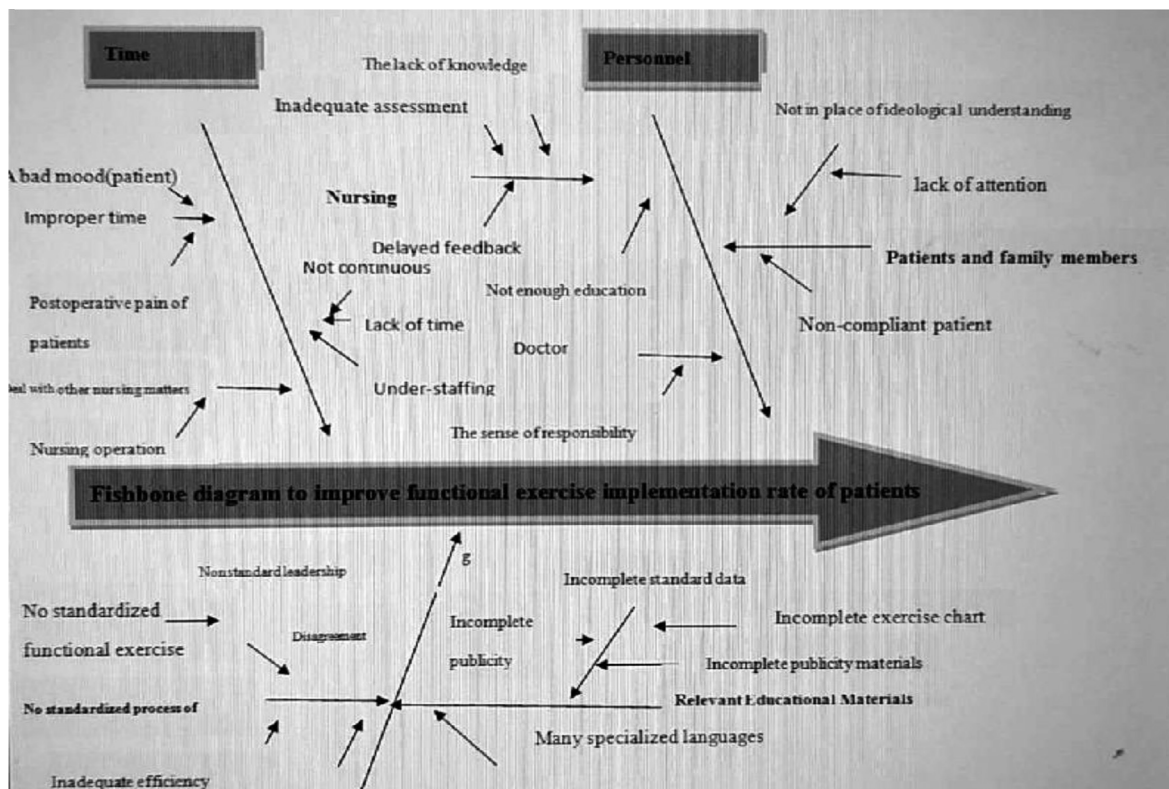


Figure 4. Fishbone diagram to improve functional exercise implementation rate of patients after orthopedic operation.

their own recovery.<sup>[10]</sup> It can effectively improve the compliance of patients with functional exercise, and promote better postoperative recovery.<sup>[19]</sup> In this QCC activity, various quality control tools were reasonably used to find out the real causes of the problems, formulated effective countermeasures and implemented one by one. Through improvement, the implementation rate of all aspects of the postoperative patients had changed significantly. Among them, the under-delivery of education and propaganda dropped by 71%, incorrect exercise condition reduced by 69%, all showed an obvious effect and effectively promoted the early recovery of patients. To a certain extent, the method improvement of functional exercise guidance, will affect the quality and efficiency of the whole nursing work. So, guiding patients to correctly implement postoperative functional exercise (such as ankle pump exercise) not only can prevent the deformation of ligament contracture deformation, muscle atrophy, prevent foot drop caused by joint stiffness, but also

can reduce the incidence of lower extremity deep vein thrombosis, reduce the length of hospital stay, and improve patient satisfaction.<sup>[20]</sup>

Combination for this study focused on the problems (such as the exercise is not correct) drawing up a preliminary solution to standard exercise:

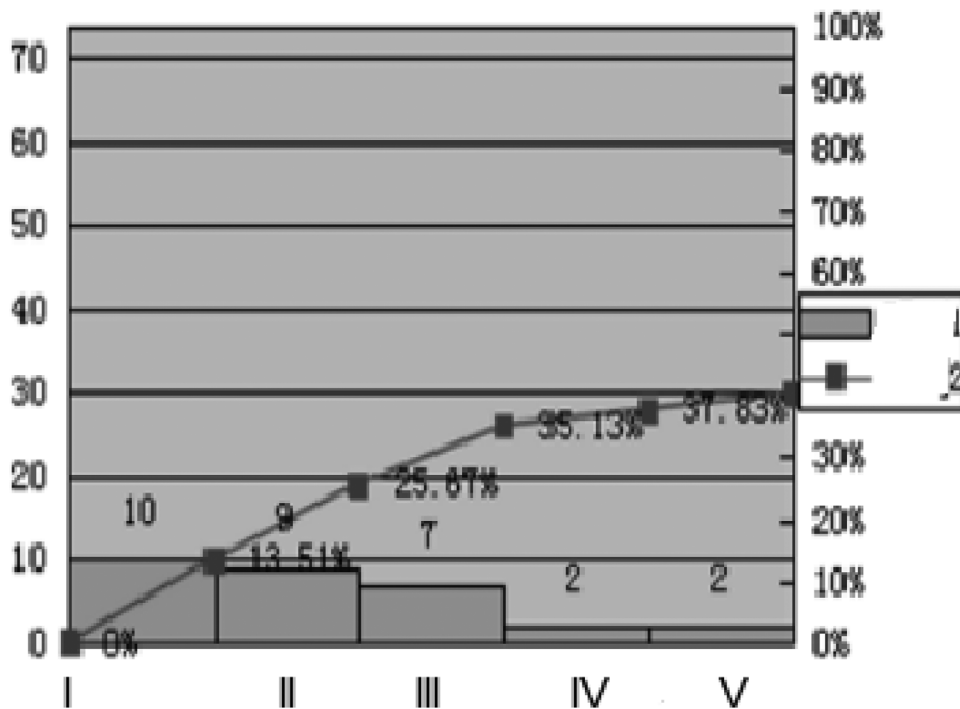
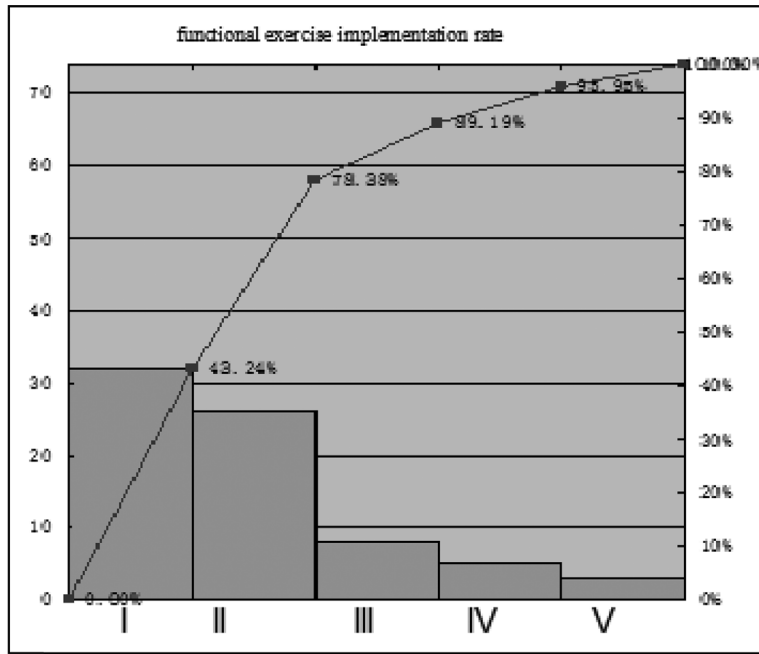
- 1) Ankle pump exercises: Ankle pump movement is divided into flexion and extension, circling. Flexion and extension action: The patient lies or sits on the bed, extends his lower limbs, relaxes his legs, slowly raises his tiptoes, and tries to make his tiptoes face to himself, holding 5 to 10 seconds at the maximum, and then slowly presses his tiptoes down, holding 5 to 10 seconds at the maximum before relaxation, so as to complete such a group of movements. Circling movement: patients lie or sit on the bed, lower limbs stretch, thigh relax, ankle as the center, tiptoes for 360° circling, try to maintain the

Table 1

Comparison of functional exercise implementation rate of patients after orthopedic operation before and after QCC.

Causes	Frequency before QCC, cumulative percentage before QCC		Frequency after QCC, cumulative percentage after QCC	
	Frequency	Percentage	Frequency	Percentage
Inadequate publicity and education	32	43.24	10	13.51
Incorrect exercise	26	78.39	9	25.67
Uncooperative patient	8	89.19	7	35.13
Not cooperating with family members	5	95.95	2	37.83
The doctor is inconsistent with the nurse	3	100%	2	40.53

QCC = quality control circle.



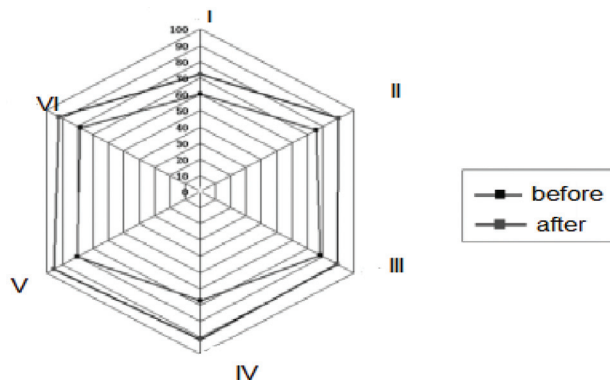
I. Inadequate education II. Incorrect exercise III. Uncooperative patient IV. Inconsistency of family members V. The doctor disagreed with the nurse

**Figure 5.** Pareto compared before and after QCC. I. Inadequate education II. Incorrect exercise III. Uncooperative patient IV. Inconsistency of family members V. The doctor disagreed with the nurse. Among them, the propaganda and education were not in place, and the improvement was compared before and after, which decreased by 71% after improvement. After the improper improvement of exercise, the decrease of 69% is more obvious. QCC = quality control circle.

maximum range of action, circling (can make more muscles get exercise) relax, such a group is completed, the best practice 1~2h/set, 10~20 actions/set, practice 5~8 sets/d.

2) The straight leg-raising exercise: Straighten lower limbs in the supine position and raise the heel 20 cm away from the bed. At

the beginning, Pause in the air for 5 seconds and relax for 5 seconds. 10times/each set, 5 to 10sets/d, then gradually increase the pause time. This exercise should be mainly active (supplemented by passive), the patient should not feel tired, and gradually increase the amount of exercise.



**Figure 6.** Radar map of invisible results. I. Ability to solve the problem II. Sense of responsibility III. Increasing the team cohesion IV. Quality control technique V. Team cohesion VI. Enthusiasm.

3) Hip flexion and knee flexion: With the patient in the supine position, hold the patient's knee with 1 hand and the heel with the other hand, and do hip flexion and knee flexion without causing pain, but the hip flexion is less than 45°.

The activity of QCC has been successfully carried out in business circles for decades and gradually extended to the field of hospital management in recent years. The participants can learn knowledge about scientific quality management, raise their own awareness of amending problems, and improve their work efficiency. QCC also helps to establish a harmonious work team, which can improve the quality of medical service and reduce the operating costs of the hospital.<sup>[21]</sup> The activity of QCC is continuous, scientific, and challenging. Regular meetings were held, and members of the circle actively discussed and gave suggestions.<sup>[22]</sup> QCC activities are guaranteed by QCC technologies such as brainstorming and evaluation methods, and put forward some countermeasures for patients. For functional exercise mission of standardized processes and functional exercise map to specifications related, it provides the specific content of multi-channel standard measures to cope with situations, such as the straight leg-raising exercise after orthopedic surgery, ankle pump exercise, quadriceps femoris, and other muscle exercises, so to obtain good effects. In short, through this activity, the application of communication skills, degree of harmony, enthusiasm, and team cohesion between members have been greatly improved. It also reduces the psychological burden of patients and reduces the possibility of medical disputes to a certain extent. The QCC also makes the process more standardized, the critical thinking of circle members is greatly improved, and the achievements of self-realization inspires the working enthusiasm.<sup>[23,24]</sup> At the same time, patients have more trust in our nursing team, which further improves the connotation of orthopaedic nursing quality and deepens the quality of nursing service.

This study also presents some limitation and suggestions. The data analysis in this study was based on the datasets from July to November, 2018, which mainly allowed descriptive analysis. Second, the QCC activity is a continuous activity that needs frequent optimization.

The improvement achieved does not mean the end of the activity. The QCC team should resume the work, pinpointing the new problems and setting new targets. Hopefully, after another

round of QCC activity, the quality of the specimens could be furthered improved.

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## Author contributions

CS and YYZ designed the study, CS and YYZ performed the study and wrote the manuscript, CS and YYZ collected the data and analyzed the data, CS and YYZ prepared the figures and tables, and all the authors reviewed the manuscript.

**Data curation:** Chuan Shi.

**Investigation:** Chuan Shi.

**Methodology:** Chuan Shi.

**Writing – original draft:** Chuan Shi.

**Writing – review & editing:** Chuan Shi, Yanyan Zhang.

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