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ORIGINAL RESEARCH

Application of Quality Control Circle in Improving Early Rehabilitation Intervention Rate of Stroke Patients

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Purpose: Early rehabilitation after stroke can improve the prognosis of patients and enhance the effectiveness and quality of rehabilitation. Whether Quality Control Circle (QCC), as a quality management method, can be used to improve the early rehabilitation intervention rate of stroke patients has not been reported. This study aimed to investigate the effectiveness of QCC in increasing the early rehabilitation intervention rate of stroke patients, providing a reference program for quality improvement in rehabilitation medicine.

Methods: The study was conducted based on a repeated measurement design. QCC was applied to improve the early rehabilitation intervention rate of stroke patients at Zhongshan Hospital (Xiamen), Fudan University from August to December 2023. The QCC activities were conducted following the standardized sequence of theme selection, activity planning, current situation grasping, goal setting, analysis, countermeasure formulation, countermeasure implementation and review, effect confirmation, standardization, review and improvement. The effect of the QCC was evaluated by comparing the changes in the early rehabilitation intervention rate of stroke patients before and after the QCC in 9 months.

Results: The early rehabilitation intervention rate of stroke patients before QCC was (45.23 ± 12.10) %, the rate after QCC was (59.55 ± 18.17) %, and demonstrated statistically significant improvement (t=3.667, P=0.006).

Conclusion: Applying the method of QCC can improve the early rehabilitation intervention rate of stroke patients, which will help to improve the quality of rehabilitation medicine.

Keywords: quality control circle, stroke, early rehabilitation, medical quality improvement

Introduction

QCC was created by Dr. Ishikawa in 1962. It is a kind of activity team spontaneously formed by people working in the same, similar or complementary fields. It is a method that solves problems and issues occurring in the workplace, management, and culture through cooperation and brainstorming, following a certain activity procedure, and applying scientific statistical tools and quality control techniques.[1] QCC was introduced to mainland China from Japan in the late 1970s and increasingly applied in medical quality improvement around 2008.[2] In recent years, QCC has been applied to quality management research in nursing and medical care and has achieved good application results.[3–5] Some studies have shown that QCC has positive effects in reducing medical costs, reducing medical errors, improving work quality, improving patient satisfaction and economic effects.[6] However, fewer studies have been reported on the application of QCC in quality improvement in rehabilitation.

Stroke is the leading cause of disability among adults in China, with about 70–80% of stroke patients suffering from disabilities that prevent them from living independently.[7] A meta-analysis revealed that early rehabilitation, compared to late rehabilitation, can improve clinical efficacy and enhance patients' self-care, activity, and neurological function when appropriate rehabilitation doses are used.[8] Early rehabilitation intervention in stroke can make full use of the brain's plasticity mechanism for rehabilitation treatment when the recovery potential of brain tissue is maximized, improve the

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prognosis of motor and neurological function of patients, reduce the occurrence of disability, and thus improve the quality of life of patients and reduce the financial burden of medical care,[9] and save significant societal costs.[10] According to the "Compendium of Medical Quality Management and Control Indicators" published by the National Institute of Hospital Administration, "early rehabilitation intervention rate of stroke patients" is defined as

> The proportion of hospitalized stroke patients receiving early rehabilitation intervention to the total number of hospitalized stroke patients in the same period.

With the development of rehabilitation medical quality improvement in China, the early rehabilitation intervention rate of stroke patients has gradually increased, but it is still at a low level compared with the international level.[11] For this reason, the National Health Commission of the PRC issued the "Medical Quality Control Indicators for Rehabilitation Medicine", and the "early rehabilitation intervention rate of stroke patients" was included as one of the quality control indicators for rehabilitation medicine. However, due to the differences in staff composition, medical technology, and patient composition, different rehabilitation institutions have different paths to implement rehabilitation medical quality improvement, and the direct application of specific improvement measures may also encounter difficulties in implementation and suboptimal clinical effects.

Previous studies have shown that the application of QCC in health education for stroke rehabilitation nursing can improve patient satisfaction,[12] but no studies have reported on the application of QCC for quality improvement in rehabilitation medicine. Starting from the index of early rehabilitation intervention rate of stroke patients, this study improved the early rehabilitation intervention rate of stroke patients by applying QCC in Zhongshan Hospital (Xiamen), Fudan University from August 2023 to December 2023, compared the changes of the early rehabilitation intervention rate of stroke patients before and after the QCC, and preliminarily discussed the application effect of QCC in the rehabilitation medical quality improvement.

Materials and Methods

Research Subjects

This study was conducted based on a repeated measurement design, with variables before and after the QCC, and the subjects of the study were the monthly "early rehabilitation intervention rate of stroke patients" in Zhongshan Hospital (Xiamen), Fudan University. Data from December 2022 to August 2023 were included before the QCC, and data from December 2023 to August 2024 were included after the QCC for comparative study.

When counting the "early rehabilitation intervention rate of stroke patients", hospitalized patients with discharge diagnoses consistent with stroke are included, and patients who have rehabilitation consultation intervention within 48 hours after the stabilization of vital signs and neurological deficit symptoms are considered as early rehabilitation intervention cases. The calculation formula is Early Rehabilitation Intervention Rate of Stroke Patients = (number of hospitalized stroke patients who received early rehabilitation intervention in the month / total number of hospitalized stroke patients in the month) × 100%.

Research Methods

The QCC process and methods[1] were used to organize medical quality improvement activities, and the QCC process is briefly described below:

Organize the QCC

A QCC team was organized in August 2023, consisting of 3 rehabilitation physicians and 4 rehabilitation therapists, and the counselor was the executive director of the rehabilitation department. The circle name ("Morning Dew Circle") and logo were determined by voting, and the circle members' self-ability evaluation was completed before the QCC. The QCC meetings were organized regularly for feedback and discussion during the QCC.

Identify Problem Points and Theme Selection

The theme of this QCC activity was set as "Improving Early Rehabilitation Intervention Rate for Stroke Patients".

Develop the Activity Plan

The completion time for each step was planned and arranged according to the requirements of the QCC. The steps of theme selection, plan development, current situation analysis, goal setting, problem analysis, and countermeasure formulation accounted for approximately 30% of the activity time, countermeasure implementation and review accounted for approximately 40% of the activity time, effect confirmation and standardization accounted for approximately 20% of the activity time, and review and improvement accounted for approximately 10% of the activity time. The Gantt chart method was used to plan and follow up on the progress of QCC activities.

Current Situation Analysis

A flow chart of the early rehabilitation intervention process for stroke patients was drawn, and the circle members discussed possible problems that may affect the early rehabilitation intervention of stroke patients based on the steps in the flow chart. The discussion results included "Incorrect judgment of disease stability", "The patients without dysfunction", "The physician of the stroke patient did not request a rehabilitation consultation", "The patient had contraindications to rehabilitation", "The rehabilitation physician did not conduct the consultation", "The rehabilitation physician did not complete the consultation record within 48 hours", and "The statistical calculation error of indicators". A check sheet was created based on the above problems, and the number of times each problem occurred in clinical practice was recorded through a 2-week check of stroke inpatients in the neurology department. During the check, there were 8 times of "The physician of the stroke patient did not request a rehabilitation consultation" and 3 times of "The rehabilitation physician did not complete the consultation record within 48 hours", the cumulative percentage of the above two occurrences in the total was 73.33%. The QCC determined the item with the cumulative percentage closest to 80% as the key item (80/20 principle), so the above two problems were the key problems that need to be addressed in this QCC.

Goal Setting

The target value of this QCC was set based on the following formula: Target value = current value + (1 - current value) × improvement focus × circle capability. Circle capability refers to the capability of QCC members to improve the theme of the QCC. With 1 point (0–50%), 3 points (51–75%), and 5 points (76–100%) as the evaluation standard, the circle capability of this QCC was scored by the QCC members. The formula for calculating the circle ability is: circle capability = average score/full score x 100%. After calculation, the circle capacity of this QCC was 65.8%, and the target value for this QCC was set at 73.23%.

Analysis

The cause-and-effect diagram (fishbone diagram) method was used to analyze the possible causes of "The physician of the stroke patient did not request a rehabilitation consultation" and "The rehabilitation physician did not complete the consultation record within 48 hours" through brainstorming by circle members. Fishbone diagrams are shown in Figures 1 and 2.

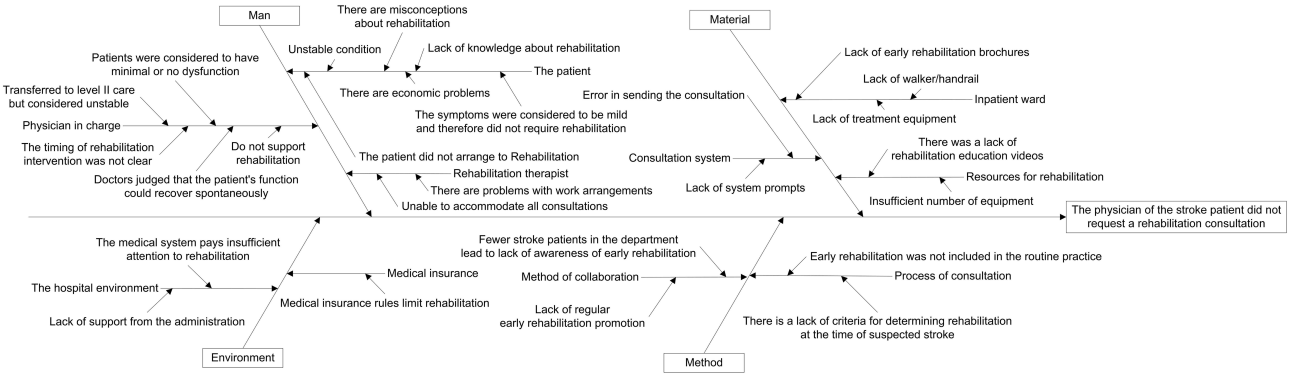

Figure 1 The Fishbone Diagram of "The physician of the stroke patient did not request a rehabilitation consultation".

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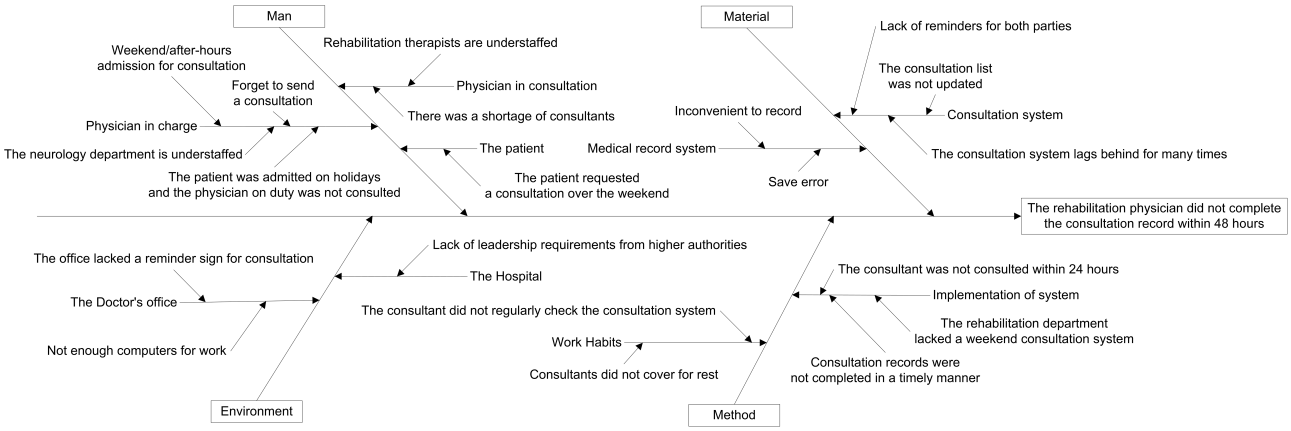

Figure 2 The Fishbone Diagram of "The rehabilitation physician did not complete the consultation record within 48 hours".

The circle members rated the importance of the small causes in the fishbone diagram on a scale of 0-1-2-3, and the top 20% of the small causes were considered to be the important causes, including: the patient's condition was unstable, the patient lacked the knowledge of the role of early rehabilitation, the patient had a misunderstanding of rehabilitation, the patient thought that the symptoms were mild and did not need rehabilitation, the patient's family lacked the knowledge of the role of early rehabilitation, the physician on duty did not request rehabilitation consultation on holidays, there is no weekend consultation system in the rehabilitation department, consult patients admitted on weekends or after work, consultation physicians did not complete the consultation record in time, the consultation system lacks reminders for both parties, shortage of rehabilitation therapists, some departments have few stroke patients and lack awareness of early rehabilitation, lack of reminder signs for consultation in the neurology office, lack of leadership from the superior department, and early rehabilitation has not been included in the treatment process or clinical pathway.

To identify the true causes, a questionnaire was used to list the above causes. The attending physicians of patients who had "The physician of the stroke patient did not request a rehabilitation consultation" or "The rehabilitation physician did not complete the consultation record within 48 hours" in the past two weeks were surveyed to identify the true causes of the problems. After statistical analysis of the survey results, "the patient thought that the symptoms were mild and did not need rehabilitation", "the physician on duty did not request rehabilitation consultation on holidays", and "the patient's condition was unstable" were the top three causes, with a cumulative percentage of 83.33%. According to the 80/20 principle, these three were considered as true causes for further countermeasure formulation.

Countermeasure Formulation

When formulating countermeasures, the true causes were further analyzed in combination with clinical practice. "the patient's condition was unstable" was a contraindication for early rehabilitation intervention, so it was not included in the further countermeasure discussion. Brainstorming was used in the QCC meeting to discuss improvement countermeasures, and 21 countermeasures were obtained after integrating similar countermeasures. The circle members scored each countermeasure on four dimensions: feasibility, benefit, economy, and achievability using 1-3-5 points, and adopted the countermeasures with total scores in the top 20%, which were "regularly remind the physician of the stroke patient to request consultation in time", "rehabilitation physician complete consultations before weekends", "remind on-duty physicians to request consultation in time", "rehabilitation physicians on duty are responsible for consultations during holidays", and "the assessment and guidance of mild patients are conducted by rehabilitation consultation physicians". These were further integrated into three countermeasures: "the assessment and guidance of mild patients are conducted by rehabilitation consultation physicians", "establish a rehabilitation consultation system on holidays", and "remind attending or on-duty physicians to request consultation in time".

Figure 3 Comparison of Self-Capability Evaluation of Members Before and After the Quality Control Circle.

Countermeasure Implementation and Review

The above three countermeasures were gradually implemented from September to November 2023. The implementation of countermeasures was based on the four stages of Plan, Do, Check, and Act (PDCA cycle).

Effect Confirmation

The change in indicators before and after the QCC is shown in the results section. After the activity, the self-capability evaluation of the members was conducted again, and the changes of the circle members' capabilities before and after the QCC were shown using the radar diagram method, as shown in Figure 3. The capabilities of the circle members improved in all aspects after the QCC activity.

Standardization

The optimized early rehabilitation intervention process for stroke patients based on the improvement countermeasures was further standardized, and the "Standardized Process for Early Rehabilitation Intervention Consultation of Stroke Patients" was prepared to implement countermeasures in clinical practice and maintain their continuous execution.

Review and Improvement

The QCC activities were summarized, and the parts that were done well in the activities were continued as experiences for the next activities. The shortcomings of the activities were discussed, and improvement methods were proposed to improve the effectiveness of QCC activities in the future.

Statistical Methods

The incidence and type of stroke are influenced by month and seasonal factors, and the early rehabilitation intervention rate for stroke patients may also be affected by such variables.[13] Therefore, data from the 9 months (December 2023 to August 2024) following the implementation of QCC countermeasures were paired with data from the corresponding months before the QCC (December 2022 to August 2023) for statistical analysis by the paired samples *t*-test. Statistical

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analysis was performed using SPSS version 26.0 software, and the mean and standard deviation were used for statistical description. A paired sample *t*-test was used to test the difference in the early rehabilitation intervention rate of stroke patients before and after the QCC for each month. Statistical significance was set at $P < 0.05$.

Results

The Shapiro–Wilk test was used to analyze the normality of the differences, and the data showed a normal distribution (P=0.692). A paired sample *t*-test was used to analyze the difference in the early rehabilitation intervention rate of stroke patients before and after the QCC activities each month, the correlation coefficient between the indicators before and after the QCC was 0.771, and the correlation was statistically significant (P=0.015), suggesting that the paired analysis of the results was reasonable. The early rehabilitation intervention rate of stroke patients before the QCC activities was 45.23±12.10%, whereas that after the QCC activities was 59.55±18.17%. The difference between the early rehabilitation intervention rate of stroke patients before and after QCC activities was 14.32±11.72%, and the 95% confidence interval of the mean of the difference was [5.32%, 23.33%]. There was a statistically significant difference in the early rehabilitation intervention rate of stroke patients before and after QCC activities (t=3.667, P=0.006). The early rehabilitation intervention rate of stroke patients after QCC activities was higher than that before QCC activities.

Discussion

This study investigates the application effect of QCC in improving the early rehabilitation intervention rate of stroke patients, and briefly introduces how QCC guides the development of rehabilitation medical quality improvement work through the steps of grasping the key problems, analyzing the causes of the problems, and formulating countermeasures. The results showed that the early rehabilitation intervention rate of stroke patients increased from 45.23% before the QCC to 59.55% after the QCC. Given that the hospital did not recruit more rehabilitation doctors and rehabilitation therapists during this period, improving the workflow through QCC enabled more stroke patients to receive early rehabilitation interventions and effectively improved the efficiency of rehabilitation, suggesting that QCC can be applied to the medical quality improvement work in the field of rehabilitation, given that the existing rehabilitation resources remain unchanged.

QCC is different from the traditional top-down, command-based approach, but the front-line staff takes the initiative to analyze the problem, find the cause, formulate the countermeasure according to the actual situation, and finally achieve the goal of solving problem. QCC encourages the full participation of senior management and grassroots staff, and provides a method to promote active cooperation at all levels, thus leading to positive outcomes in most cases.[3] Previous studies have investigated the factors affecting the effectiveness of QCC application in medical institutions, and the results show that the circle members' awareness and participation in the QCC are the key factors, the attitudes and capabilities of QCC counselor and the guidance provided by medical institutions are also important factors.[14] All members of this QCC were doctors and therapists with the background in rehabilitation medicine, who were able to fully understand the significance of early rehabilitation of stroke patients and agreed with the goals of this QCC, thus increasing the motivation of individuals to participate in the QCC. The executive director of the Rehabilitation Department acted as the counselor to support the implementation of the QCC countermeasures and played an important role in inter-departmental cooperation and coordination. Additionally, the hospital established a Quality Management Department and organized systematic learning of QCC tools, which provided a foundation for the standardized implementation of QCC in this study. To a certain extent, the above factors can explain why this QCC activity effectively improved the early rehabilitation intervention rate of stroke patients. However, the QCC failed to achieve the predetermined target value of 73.23%, which may be related to the fact that it was the first time to apply QCC in the field of rehabilitation medicine, and the circle members were not skillful in the use of QCC tools. Furthermore, this QCC was only composed of rehabilitation professionals, if the attending physicians and nurses of the relevant departments participate in the QCC, it might be able to achieve better results in the implementation of countermeasures.

In the medical field, most QCC application studies only analyze indicator changes for a few weeks after the QCC, and fewer studies have been reported with more than 6-month follow-up, and most of the research data are transformed into count data for analysis when the statistical analysis,[5,12] which may lead to reduced reliability of the statistical results.

Meanwhile, there are fewer reports of QCC studies in the field of rehabilitation. This study focuses on the application of the QCC in the field of rehabilitation, in the process, all members of the QCC think together and provide suggestions, and use the QCC tools to standardize the analysis and implementation process. After the implementation of the countermeasures, the indicators were followed up for 9 months, and the follow-up data were statistically analyzed in a more standardized way, which reduced the impact of additional variables on the data and made the results of this study more reliable.

It is important to emphasize that the early rehabilitation intervention mentioned in this study refers to the early intervention treatment conducted by rehabilitation professionals after the onset of the disease, and the specific rehabilitation plan should still be based on evidence-based medicine. For example, previous studies have shown that high-dose activities within 24 hours after stroke are harmful,[15] so early rehabilitation interventions during this period generally only involves guidance on the prevention of complications such as decubitus ulcers and do not imply inappropriate very early activities. Given that this study focused on the improvement of rehabilitation quality control indicators by QCC and did not collect further information on patient recovery, conclusions should not be drawn about whether early rehabilitation in stroke patients is beneficial based on the results of this study alone.

This study still has some limitations. As the countermeasures were being implemented gradually from September to November 2023, the indicator data from September to November were affected by the incomplete implementation of the countermeasures and the unstable effect of the countermeasures. Therefore, the data from September to November 2023 were excluded from the statistical analysis to improve the reliability of the results. However, the excluding data from September to November also made it impossible to conduct a longer follow-up in this study (lack of data from September to November for pairing), which may lead to limitations in the generalization of the results of the study, so the maintenance of the QCC effect over a longer period still needs to be observed in studies with larger sample sizes. Since this study was a single-center study, it was not possible to set up a blank control, so a more precise evaluation of the effects of QCC in rehabilitation still needs to be clarified by a well-designed multicenter study.

Conclusion

This study demonstrated that the early rehabilitation intervention rate of stroke patients can be improved through the QCC, and the improvement can still be considered effective during the nine-month follow-up period after the QCC. Therefore, when aiming to improve the early rehabilitation intervention rate of stroke patients, QCC can be considered as a viable approach, but attention should be paid to the limitations mentioned in this article. When applying QCC, analysis and countermeasure development should be based on actual situations, rather than directly adopting the countermeasures mentioned in this study.

Ethical Statement

This study is exclusively dedicated to the management of rehabilitation quality control. It does not collect any patient-specific information, such as personal details, medical conditions, or treatment plans, and it does not modify the existing treatment plans of patients. Furthermore, the research data does not contain any identifiable patient information, and the project does not touch upon personal privacy or commercial interests. Therefore, ethical review was not required.

The masked datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Disclosure

The authors report no conflicts of interest in this work.

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