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Original Article

Effects of quality control circle on patients with neurogenic urination disorder after spinal cord injury and intermittent catheterization

Xiaoliang Huang, Wenqing Hu, Yuhong Guo, Wei Li

The First Department of Rehabilitation, The Third Hospital of Hebei Medical University, Shijiazhuang, Hebei Province, China

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Abstract: Objective: To investigate the effects of quality control circle (QCC) activity on patients with neurogenic urination disorders after spinal cord injury and treated with intermittent catheterization. Methods: A total of 80 patients with neurogenic urination disorders after spinal cord injury and treated with intermittent catheterization were selected as research objects and randomly divided into the QCC group and the control group, with 40 patients in each group. The QCC activity was carried out on patients in the QCC group, and health education of intermittent catheterization was conducted in the control group. After 3 months of intervention, the awareness rate of neurogenic bladder, incidence of urinary tract infection and hydronephrosis, recovery of bladder urinary function, self-management ability, and nursing satisfaction were compared between the two groups. Results: Patients in the QCC group had higher awareness than those in the control group, with a statistically significant difference (P=0.006). Patients in the QCC group had significantly lower rates of urinary tract infection and hydronephrosis than those in the control group, with a statistically significant difference (both P<0.05). The self-management ability, recovery of bladder urinary function and nursing satisfaction of the QCC group were better than those of the control group, with statistically significant differences (all P<0.05). Conclusion: For patients with neurogenic urination disorders after spinal cord injury and treated with intermittent catheterization, the QCC activity significantly reduces the incidence of urinary tract infection and hydronephrosis, andsignificantly improves the awareness rate of intermittent catheterization, self-management ability, recovery rate of bladder urinary function and nursing satisfaction.

Keywords: Quality control circle, intermittent catheterization, spinal cord injury, neurogenic urination disorder

Introduction

Spinal cord injury is a common and severe disabling injury in clinic, mainly caused by nerve conduction pathway injury. Neurogenic bladder urination disorders caused by spinal cord injury last for a long time and even the whole life, which are prone to resulting in urinary tract infection, kidney stone and hydronephrosis. Patients with severe spinal cord injury may suffer from renal insufficiency or even die [1, 2]. Studies report that approximately 22% of patients with acute spinal cord injury have urinary tract infection within 2 months after admission, and approximately 20% of patients with chronic spinal cord injury are subjected to it every year [3, 4]. The 1-year mortality of patients with spinal cord injury hits 6% [5]. There has been no specific treatment for neurogenic bladder urination disorders after spinal cord injury. At present, intermittent catheterization, which is widely used in patients with neurogenic bladder urination disorders, can maintain the bladder in a nearly normal physiological state, reduce residual urine and prevent urinary tract infection, thereby promoting its function recovery [6, 7]. However, the traditional nursing care of intermittent catheterization has many shortcomings, such as varied nursing expertise of nurse teams, unreasonable timing of catheterization, deviation in the understanding by patients and their families, improper selection of urinary catheters, irregular hand disinfection and lack of bladder training. All of them adversely affect patients' quality of life.

Proposed by Doctor Ishikawa Kaoru in Japan in 1962, the quality control circle (QCC) is an

improvement measure that a group of grassroots personnel, with similar work at the same job site, conduct quality control activities automatically and spontaneously to improve quality and efficiency, by persisting to improving in the work and inspiring individual potential [8-10]. Studies report that the QCC activity in the operating room and ICU helps improve the quality of departmental infection control, as well as patients' hand hygiene compliance [11, 12]. However, few reports are about the effect of the QCC activity on patients with intermittent catheterization. Therefore, in this study, 80 patients with neurogenic urination disorders after spinal cord injury were selected as research objects, and the QCC activity was carried out on patients with intermittent catheterization, to provide experimental basis for improving patients' quality of life and nursing service quality.

Materials and methods

General information

A total of 80 patients with neurogenic urination disorders after spinal cord injury who were treated in The Third Hospital of Hebei Medical University from January 2016 to December 2017 were selected as research objects. Based on the Frankel Spinal Cord Injury Classification of American Spinal Cord Injury Association, they were divided into grade A or B [13]. Grade A was complete injury, with no sensory or motor function retention in saddle area S4-S5. Grade B was incomplete sensory injury, with no motor function but sensory function retention below the nerve plane including the saddle area S4-S5, and with no motor function retention more than 3 segments below the motion plane on either side of the body. Inclusion criteria: Patients older than 18 years old and confirmed with spinal cord injury by MRI examination [14]; patients with a disease duration of more than 2 months who have lived through the period of spinal shock; patients with normal functions of the upper limbs; patients diagnosed with low tension bladder with a residual urine volume of more than 100 mL by urodynamic examination; patients and their families agreed to receive intermittent catheterization treatment. Exclusion criteria: Patients in the period of spinal cord shock; patients with high paraplegia accompanied by upper limb disorders; patients accompanied by abnormal autonomic nerve reflex of the bladder; patients accompanied by abnormal urethral anatomy; patients complicated with urethral neoplasm, urethral injury and significant hydronephrosis; patients with upper urinary tract infection; patients accompanied by coagulation disorders; patients with severe liver and kidney dysfunction; patients with no acute or chronic infection within the past 1 month; patients with a history of mental illness; or patients contraindicated to intermittent catheterization [15]. Patients enrolled in the study signed written informed consent. The study was approved by the Ethics Committee of The Third Hospital of Hebei Medical University.

The above patients were divided into the QCC group and the control group according to a random number table, with 40 patients in each group. The health education was routinely conducted on patients with intermittent catheterization as the control group, and the QCC activity was carried out on them as the QCC group.

Research methods

Routine health education: Routine health education was conducted on patients in the control group. Patients and their families were informed that intermittent catheterization (materials were purchased from Jiangsu Huadong Medical Device Industrial Co., Ltd., China) was designed to intermittently empty the bladder to avoid excessive bladder inflation and obstruction of bladder blood circulation, and also reduce the resistance to bacteria and injury to the upper urinary system, thereby preventing vesicoureteral reflux, hydronephrosis and urinary tract infection. They were also informed of the instruments and articles to be prepared before catheterization, specific intermittent catheterization procedures and attention to problems during catheterization such as hematuria, turbid or odorous urea and abnormal body temperature. Meanwhile, education booklets for intermittent catheterization and bladder muscle function training were distributed to enable patients and their families to master them. A drinking plan was formulated, with the drinking amount controlled in the range of 1,500-2,000 mL, and no drinking from 8:00 pm to 6:00 am. The catheterization was arranged 4-6 times a day, once every 4-6 h. Bladder diary was recorded that included the daily and each drinking volume, each catheterization time and urinary volume, as well as

residual urine volume. Patients and their families were encouraged to master the skills and knowledge of intermittent catheterization, as well as enhance nursing diuresis. They were correctly guided to participate and learn. Clean intermittent catheterization was demonstrated to them 1-2 times in a relatively aseptic condition, and they were guided until they could operate independently. In order to reduce urinary tract infection, they were instructed to wash their hands according to the clean hand washing diagram for more than 5 minutes.

QCC activity: QCC group formation: Eight medical personnel from this department were selected to form a QCC activity group. One circle leader was set up headed by the head nurse, 1 counselor by the associate chief physician of the rehabilitation department, and 6 circle members by the nurses. Circle name and emblems were determined by vote with brainstorming.

Determination of topics: Through evidence-based method, the group found relevant literature on intermittent catheterization at home and abroad, and encouraged circle members to propose problems in intermittent catheterization linked with actual work conditions, thereby analyzing and summarizing the proposed problems. As a result, the theme of QCC was determined as "Reducing the incidence of urinary tract infection and hydronephrosis in patients with intermittent catheterization".

Analysis of reasons for problems in intermittent catheterization: Members of the QCC activities group analyzed reasons for problems in intermittent catheterization, including improper hand washing, lack of attention to asepsis, casual catheterization operations, bladder training errors and poor personal hygiene, self-immunity and self-management ability. The cause was determined through "the two-eight Principle", and finally the real cause was determined through physical examination.

Countermeasure development and implementation: The training of health education knowledge on intermittent catheterization was strengthened on members of the QCC group to enhance their subjective management awareness and sense of responsibility. Urine routine was detected weekly; patients and their families were regularly guided to conduct intermittent catheterization; their master degree was assessed. The bladder diary was recorded, and its implementation was taken seriously. The education of aseptic knowledge was strengthened such as maintaining good habits of personal hygiene. Patients' self-immunity was enhanced to prevent infection through rehabilitation exercise. Their bladder self-management ability was improved with the help of physicians, nurses and patients and their families. Through simulation training and theoretical examination, circle members' on-site operation levels of intermittent catheterization and communication skills were improved.

Outcome measures

The awareness of neurogenic bladder was compared between the two groups of patients by questionnaire survey, which involved clinical symptoms, complications and their treatments, bladder training methods, drinking planning, residual urine measurement, rehabilitation therapy, intermittent catheterization, and bladder types. Each item had 10 points, with a total score of 80 points. More than 48 points was considered as known, less than 48 points as unknown. The awareness rate = the number of the known/total number of cases * 100%.

After 3 months of intervention, the rates of urinary tract infection and hydronephrosis were compared between the two groups of patients. Bacterial culture in the middle urine of patients was used. Bacterial colony counting more than 10^5 cfu/m was considered as urinary tract infection. B-ultrasound was used to examine the hydronephrosis of the two groups of patients. If the above complications occurred, regular catheterization was performed, and correct urination was guided according to the number of catheterization and the prescribed drinking volume. If necessary, levofloxacin could be used for anti-infection.

After 3 months of intervention, the recovery of bladder urinary function was compared between the two groups of patients. The residual urine volume less than 100 mL after spontaneous urination indicates that the urination function was basically restored, while the volume still more than 100 mL indicates that the urination function was not restored. The number of catheterization was continuously adjusted based on the residual urine volume until recovery, with no more than 6 times every day.

Table 1. Comparison of general information

Group	QCC group (n=40)	Control group (n=40)	t/χ^2	P
Age (year)	56.7±4.3	57.3±4.8	0.589	0.558
Male/female (n)	25/15	24/16	0.053	0.819
Body mass index (kg/m^2)	23.5±1.7	23.8±1.9	0.744	0.459
Spinal cord injury site (n)			0.621	0.892
Cervical vertebra	6	8		
Thoracic vertebra	9	7		
Lumbar vertebra	15	16		
Cauda equina nerve	10	9		
Hypertension (n)	11	13	0.238	0.626
Diabetes (n)	9	12	0.581	0.446
Spinal cord injury classification (n)			0.453	0.501
Grade A	17	20		
Grade B	23	20		

Note: QCC, quality control circle.

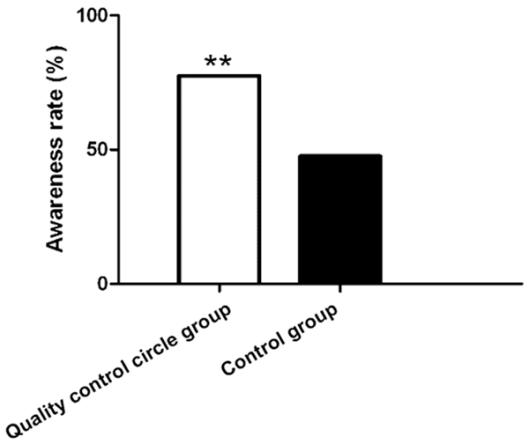

Figure 1. Comparison of awareness of neurogenic bladder. Compared with the control group, **P=0.006.

After 3 months of intervention, the self-management ability of patients was compared between the two groups. It included drinking management, residual urine monitoring, symptom management, adherence to bladder training, complication management, and correct intermittent catheterization. Less than 60 points was considered as poor, 60-79 points as general, and more than 80 points as good [16].

The nursing satisfaction was compared between the two groups of patients. The satisfaction questionnaire included nursing professional skills, service attitudes, and the procedures of intermittent catheterization, with a total score of 100 points. More than 90 points was considered as satisfactory, and less than 90 points as unsatisfactory [17].

Statistical processing

Statistical software SPSS 19.0 was used for data analysis. Measurement data are expressed as mean ± standard deviation ($\bar{x}$ ± sd), and an independent sample t test was used for comparison between the groups. Count data are expressed as case number/percentage (n/%), and a χ^2 test was used for comparison between the groups. When P<0.05, the difference is statistically significant.

Results

Comparison of general information

There were no statistically significant differences in age, gender, body mass index, spinal cord injury, spinal cord injury classification and underlying diseases between the two groups of patients (P>0.05). See **Table 1**.

Comparison of awareness rate of neurogenic bladder

The awareness rate of neurogenic bladder was 77.5% (31 patients) in the QCC group of patients, and 47.5% (19 patients) in the control group, with statistically significant difference between the two groups (χ^2=7.680, P=0.006). See **Figure 1**.

Comparison of incidence of urinary tract infection and hydronephrosis

There were 4 patients with urinary tract infection and 3 patients with hydronephrosis in the QCC group; in the control group, there were 13 patients with urinary tract infection and 10 patients with hydronephrosis. There were statistically significant differences in the incidence of urinary tract infection (χ^2=6.050, P=0.014) and hydronephrosis (χ^2=4.501, P=0.034) between the two groups of patients. See **Figure 2**.

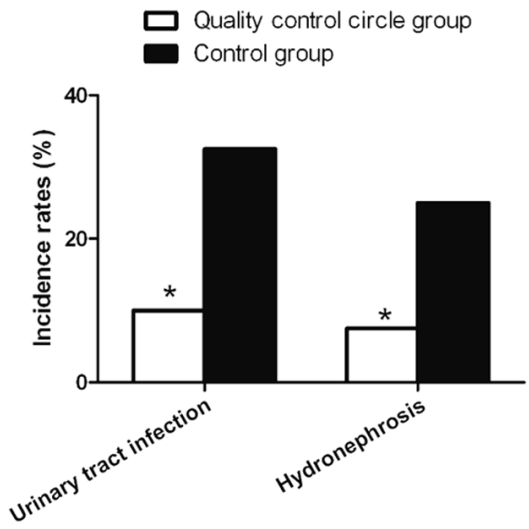

Figure 2. Comparison of the incidence of urinary tract infection and hydronephrosis. Compared with the control group, *P<0.05.

Table 2. Comparison of recovery of bladder urinary function (n, %)

Group	Residual urine volume	
	<100 mL	>100 mL
QCC group (n=40)	31 (77.5)	9 (22.5)
Control group (n=40)	14 (35.0)	26 (65.0)
χ^2	14.680	
P	<0.001	

Note: QCC, quality control circle.

Table 3. Comparison of self-management ability (n, %)

Group	Self-management ability		
	Good	General	Poor
QCC group (n=40)	22 (55.0)	15 (37.5)	3 (7.5）
Control group (n=40)	11 (27.5)	19 (47.5)	10 (25.0)
χ^2	7.906		
P	0.019		

Note: QCC, quality control circle.

Comparison of recovery of bladder urinary function

After 3 months of intervention, there were 31 patients with residual urine volume less than 100 mL and 9 patients more than 100 mL in the QCC group; in the control group, there were 14 patients less than 100 mL and 26 patients more than 100 mL. There was a statistically significant difference in the recovery rate of bladder urinary function between the two groups of patients (P<0.001). See **Table 2**.

Comparison of self-management ability

There were 22 patients with good self-management ability, 15 patients with general ability and 3 patients with poor ability in the QCC group, while in the control group, there were 11 patients with good ability, 19 patients with general ability and 10 patients with poor ability. There was a statistically significant difference in the self-management ability between the two groups of patients (P=0.019). See **Table 3**.

Comparison of nursing satisfaction

The nursing satisfaction was 92.5% (37/40) in the QCC group of patients, and 72.5% (29/40) in the control group, with a statistically significant difference between the two groups of patients (χ^2=5.541, P=0.019). See **Table 4**.

Discussion

Neurogenic bladder disorders, the most common complication after spinal cord injury, seriously affect patients' quality of life. More importantly, the risk factors, such as excessive bladder filling, increased intra-bladder pressure, vesicoureteral reflux and urinary calculi, can cause repeated urinary tract infection, even hydronephrosis and renal failure. Clean intermittent catheterization refers to regularly inserting the urinary catheter into the bladder through the urethra in a clean state, thereby regularly emptying the urine in the bladder. As a safe and reliable measure, it has been widely used in neurogenic urination disorders after spinal cord injury [18]. However, studies show that as an invasive operation, clean intermittent catheterization provides a way for bacteria to enter the body. Lacking of effective management measures, urinary tract infection has become one of the most common complications of intermittent catheterization [19]. In this study, the QCC activity was carried out on patients with intermittent catheterization. The results showed that patients in the QCC group had significantly lower incidence of urinary tract infection and hydronephrosis than those in the control group, with a statistically significant difference. It is indicated that the intervention effect on patients in the QCC group was significantly better than that in the control group.

Table 4. Comparison of nursing satisfaction (n, %)

	Satisfactory	Unsatisfactory	Satisfactory rate (%)
QCC group (n=40)	37	3	92.5
Control group (n=40)	29	11	72.5
X^2			5.541
P			0.019

Note: QCC, quality control circle.

Jiang et al. included 253 patients with granulocytopenia in hematologic disease for the QCC activity; the perianal infection rate of patients in the QCC group decreased from 17.2% to 5.93% [20]. This is similar to the results of this study. Similar studies show that the QCC activity can significantly improve the nursing measures of ventilator-associated pneumonia and reduce its incidence [21]. This suggests that the QCC nursing program does improve associated infection complications.

The QCC activity is a scientific and long-lasting management mode. During the activity, circle members constantly communicate with patients and their families, to discover actual problems in time and solve them. The QCC activity carried out in this study was reviewed and approved by the counselor, supervised and implemented by the circle leader. Assistance and guidance were given to patients with intermittent catheterization in terms of drinking management, residual urine monitoring, symptom management, adherence to bladder training, complication management and correct intermittent catheterization. The "assessment-planning-implementation-evaluation-reform" workflow was repeatedly performed to continuously improve quality management. Effective self-management maintains patients' satisfactory quality of life. Self-management ability, which plays an important role in the recovery of patients with neurogenic urination disorders after spinal cord injury, refers to management ability that changes and develops in response to chronic diseases [22]. Studies show that self-management is an effective treatment for chronic diseases, which is more economical than drugs [23]. The results of this study showed that the self-management ability of patients in the QCC group was significantly better than that in the control group, with a statistically significant difference. This may be due to the fact that the active education of intermittent catheterization, demonstration and guidance of clean catheterization and active communication with patients enable them to know and master disease knowledge. They also actively participate in nursing care of intermittent catheterization. As a result, their self-management ability is improved. Studies by Hartmann et al. report that the QCC activity can improve the self-management ability of diabetic patients, similar to the results of this study [24]. This suggests that the QCC activity can significantly improve patients' self-management ability.

The foundation of self-management ability is based on the perception of the disease knowledge. In terms of the awareness rate, the results of this study showed that patients in the QCC group had a higher awareness rate of intermittent catheterization than those in the control group, with a statistically significant difference. This may be due to the strengthening of patients' health education of disease-related knowledge during the QCC activity, which is conducive to improving their cognition. In terms of the recovery of bladder urinary function, the results of this study showed that patients in the QCC group had a higher recovery rate of bladder urinary function than those in the control group, with a statistically significant difference. This may be because the QCC activity can help to improve bladder function and the incompatibility between detrusor and external urethral sphincter after spinal cord injury, thereby establishing a certain urinary rhythm and promoting bladder emptying. This also indicates that patients and their families got the mastery of bladder function training methods out from the QCC activity. In addition, studies show that the participatory management method of QCC can significantly improve the job satisfaction and enthusiasm of nurses [25]. Other studies report that the QCC activity has a significant effect on improving nurse satisfaction [26]. It can improve nurses' job satisfaction and pride when giving full play to individual talents [27]. The results of this study showed that patients in the QCC group had higher nursing satisfaction than those in the control group, with a statistically significant difference. Studies by Hosseinabadi et al. showed that the QCC activity in emergency care can improve nursing satisfaction, which is similar to the result of this

study [28]. This indicates that the QCC activity applied in intermittent catheterization nursing can not only improve patients' awareness of the disease, but also contribute to the recovery of bladder urinary function and improvement of nursing satisfaction.

However, there are still limitations in this study, such as a small sample size and short follow-up. In order to better demonstrate the effect of the QCC activity on patients with neurogenic urination disorders after spinal cord injury and treated with intermittent catheterization, the sample size is needed to be further enlarged, and mid- and long-term follow-ups to be conducted.

In summary, for patients with neurogenic urination disorders after spinal cord injury and treated with intermittent catheterization, the QCC activity significantly reduces the incidence of urinary tract infection and hydronephrosis, and significantly improves the awareness rate of intermittent catheterization, self-management ability, recovery rate of bladder urinary function and nursing satisfaction.

Disclosure of conflict of interest

None.

Address correspondence to: Xiaoliang Huang, The First Department of Rehabilitation, The Third Hospital of Hebei Medical University, No.139 Ziqiang Road, Shijiazhuang 050051, Hebei Province, China. Tel: +86-0311-88603000; Fax: +86-0311-8860-3000; E-mail: huangxiaoliang7e9@163.com

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