

Original Article

Effects of PDCA management mode on rehabilitation of patients with ureteral calculi complicated with urinary tract infection

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Abstract: Objective: To evaluate the application value of PDCA (Plan-Do-Check-Action) Management Mode in patients with ureteral calculi complicated with urinary tract infection. Methods: A total of 92 patients with ureteral calculi complicated with urinary tract infection were selected in this study. They were divided into the observation group (n=46) and the control group (n=46) according to the random number table. Both groups of patients received urological routine nursing care. On this basis the observation group was given PDCA Management Mode for clinical nursing. Results: The success rate of lithotripsy in the observation group was higher than that of the control group. And the fever ratio and the bacteriological rate of urine routine in the observation group were lower than those of the control group at 3 and 5 days after operation ($P<0.05$). The recovery rate of bladder in the observation group was 86.96%, which was higher than 67.39% of the control group ($P<0.05$). The postoperative exhaust time, bowel sound recovery time and length of hospital stay in the observation group were shorter than those of the control group ($P<0.05$). Before intervention, the difference in the activities daily living (ADL) scale score was not statistically significant ($P>0.05$) between these two groups. After implementation of PDCA Management Mode, the ADL scores of the patients in the observation group were significantly higher than those of the control group ($P<0.05$). Conclusion: PDCA Management Mode can effectively avoid nursing risks, change the patients' bad behaviors, reduce postoperative infection, accelerate their recovery, and improve their activities of daily life.

Keywords: PDCA management mode, ureteral calculi, urinary tract infection, rehabilitation, bladder function

Introduction

Urolithiasis is a common disease, and its morbidity of men is higher than that of women [1]. Calculi are usually located in the ureters, urethra and kidneys, etc. The patients with ureteral calculi complicated with urinary tract infection may have symptoms such as local pain, dysuria, urodynia and elevated body temperature, which may affect quality of life [2, 3]. The current treatment methods include conservative and surgical treatment. Surgical treatment may cause certain trauma during operation. Therefore, the postoperative nursing care should be carefully carried out in order to prevent complications and promote the recovery of bladder function [4]. Nevertheless, because the nursing services are complicated and de-

tailed, while the traditional nursing mode lacks of systematic workflow and standardized management mode, it's not always possible to take care of everything at work. This requires us to improve the current nursing methods. In the recent years, the proposal and implementation of PDCA Management Mode have to a large extent made up for the drawbacks of many traditional nursing models [5, 6].

PDCA Management Mode, a quality management theory proposed by Edward Deming, is composed of four stages, including PLAN, DO, CHECK and ACTION. If it is successful in implementation, it will be included in the standard; otherwise, it will enter into the next cycle. Therefore, quality management will continue to be improved in the cycle, showing a spiral esca-

lation. It is a new type of management mode, which can turn the nursing workflow into standardization and routinization. It is more beneficial to improve the quality of nursing care and the effect of nursing quality management in departments. The main purpose of PDCA in the nursing quality management is to improve the quality of nursing management and promote the nursing effect. The study results have shown that the application of PDCA Management Mode in clinical orthopedic practice and teaching could significantly improve the theoretical knowledge and operational skills of nursing students and reduce the incidence of adverse events [7]. Some scholars have applied PDCA Management Mode in the administration of Pharmacy Intravenous Admixture Service (PIVAS) [8]. After the implementation of PDCA cycle management, the error rate of PIVAS decreased to 0.581‰ in 2012 from 0.985‰ in 2010. The results suggest that PDCA cycle can effectively improve the management level of PIVAS, minimize the risks, and ensure the safety of intravenous drugs in patients. However, there are few reports about PDCA management implemented in ureteral calculi complicated with urinary tract infection at present. From January 2015 to January 2017, a total of 92 patients with ureteral calculi complicated with urinary tract infection were enrolled in this study in order to discuss the application value of PDCA Management Mode. It is reported as follows.

Materials and methods

Patients

A total of 92 patients with ureteral calculi complicated with urinary tract infection were treated in Xiaolan People's Hospital of Zhongshan from January 2015 to January 2017 and selected as study subjects. These patients were divided into the control group (n=46) and the observation group (n=46) according to the random number table. Inclusion criteria were as follows: (1) Patients who met the diagnostic criteria for ureteral and urinary tract infections: Urinary tract ultrasound or CT scans indicated that ureteropelvic dilation with definite ureteral calculi at the affected side. The count of urinary culture colony was more than 10^5 /mL [9]. (2) Age: 18.0-75.0 years old; (3) Patients who had not experienced other major operations within half a year; (4) Body temperature $\geq 38.5^\circ\text{C}$; (5)

Patients who signed the written informed consent. Exclusion criteria were as follows: (1) Patients who suffered from organic lesions of the heart, liver and spleen, etc. (2) Patients who had a history of drug allergy; (3) patients who had concomitant uremia. (4) Patients who had past mental illness and communication problems. (5) Patients who had surgical contraindications. This study was approved by the Medical Ethics Committee of Xiaolan People's Hospital of Zhongshan.

Methods

Routine nursing was carried out in the control group. Health education was given before operation, and the changes in vital signs including body temperature, respiration, pulse, blood pressure, blood oxygen saturation and heart rates were closely observed during and after the operation. The patients were advised to have a balanced diet and adequate nutrition, as well as early ambulation after operation to speed up the recovery.

PDCA Management Mode was implemented in the observation group and divided into four steps: (1) Plan (P): Nurses were trained in PDCA management, so that they could master the steps of PDCA. The implementing process of PDCA was supervised by all the nurses involved. The patient's physical conditions, symptoms of hematuria and pain, stone excretion and psychological condition were carefully evaluated by the primary nurse before operation in combination with the patient's age, calculi condition, past medical history, and other general information to know the nursing care problems and make corresponding solutions. If a patient was present with hematuria and aggravated pain, bed rest and reduction of physical activities would be advised before operation; if a patient had severe pain, the physician should be informed of in time and the antispasmodic and analgesic drugs should be prescribed. Patients were told to eat food that was nutritious, light taste, and easy to digest, as well as drink adequate water, about 2,000-3,000 mL every day. This would help dilute the urine and promote the discharge of stones. If the patient's pain and colic location moved down, it suggests that the stones were going down and might enter into the bladder. Therefore, the patient was advised to urinate and promote the discharge

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Table 1. General information

Group	Observation group (n=46)	Control group (n=46)	t	P
Gender (male/female)	28/18	27/19	0.045	0.832
Age (year)	53.7±6.9	54.2±7.1	0.332	0.748
Disease location (case)			0.278	0.870
Bilateral	10	8		
Left side	21	22		
Right side	15	16		
Surgical procedures			0.176	0.916
Laparoscopic surgery	20	22		
MPCNL	12	11		
Ureteroscopic holmium laser lithotripsy	14	13		

Note: MPCNL: mini-percutaneous nephrolithotomy.

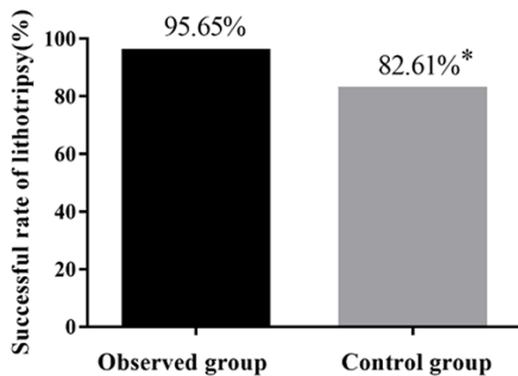


Figure 1. Comparison of the successful rate of the two groups of patients with lithotripsy. *P<0.05.

of stones. (2) Do (D): The main contents of training for the nursing staff were to identify the indications, operations, maintenance and management of indwelling catheters. Relevant management system and forms have been made with respect to PDCA Management Mode, and strictly implemented. Nursing care interventions were implemented by the nursing staff specific to the solutions established. In the process, a third party reviewed the formulation and implementation of the protocol. And they also supervised whether the operation was standardized to ensure that the nursing protocol was implemented. (3) Check (C): The audit methods and standards were established and the implementing results of nursing protocol were reviewed. Assessments were made to the nurses' theoretical knowledge and practice ability of aseptic technique, the nursing skill level of indwelling catheter,

etc. Patients' suggestions and opinions were collected, summarized, sorted out and reached the main points necessary to be implemented in the nursing services. (4) Action (A): Combined with the nursing audit results, the existing and potential problems in the nursing care were analyzed, optimized and rectified for the next step of nursing care, and the nursing problems and mea-

asures were reassessed to continuously improve and perfect the nursing protocol; new nursing plans were made; and the cycle of DO, CHECK and ACTION were executed to constantly improve the quality of nursing care [10].

Outcome measures

Main observation indicators: (1) The efficacy of lithotripsy, postoperative fever, the presence of bacteria in urine routine tests, and bladder function recovery were evaluated in both groups. Successful lithotripsy: Successful lithotripsy means no stones >4 mm. Postoperative fever: Body temperature >38.5°C. (2) Postoperative exhaust time, bowel sound recovery time, the time to ambulation and length of hospital stay were recorded. (3) The recovery of bladder function was observed. The daily residual urine volume in the bladder was measured by transabdominal B-ultrasound. Excellent: Residual urine volume <80 mL; Good: Residual urine volume 80-150 mL; Poor: Residual urine volume >150 mL. The bladder function is recovered when the residual urine volume of the bladder is excellent and good. Recovery rate = (number of excellent + good cases)/total number of cases * 100%.

Secondary observation index: The activities daily living (ADL) scale scores before and after interventions were observed in both groups. The ADL Scale was used to evaluate 10 items, such as eating, bathing, decorating, going up and down stairs and so on. The total scores were 100 points. The higher the score was, the better the ADL would be [11].

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Table 2. Comparison of postoperative fever, n (%)

Group	1st day before operation	3rd day after operation	5th day after operation
Observation group (n=46)	16 (34.78)	5 (10.87)	1 (2.17)
Control group (n=46)	15 (32.61)	14 (30.43)	8 (17.39)
χ^2	0.049	5.373	4.434
P	0.825	0.020	0.035

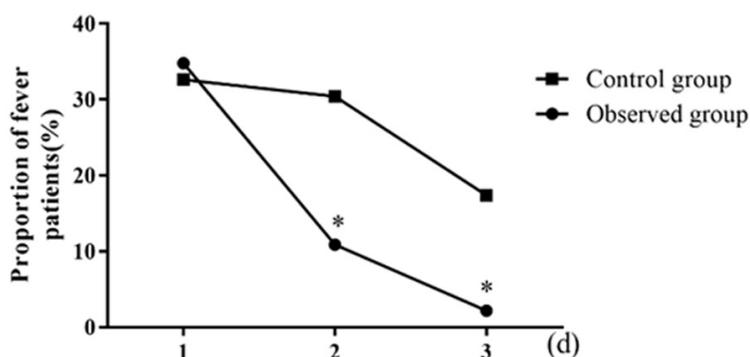


Figure 2. Comparison of postoperative fever in the two groups. Compared with the control group, *P<0.05.

Table 3. Comparison of bacteria in urine routine after lithotripsy, n (%)

Group	1st day before operation	3rd day after operation	5th day after operation
Observation group (n=46)	17 (36.96)	7 (15.22)	1 (2.17)
Control group (n=46)	19 (41.30)	16 (34.78)	9 (19.57)
χ^2	0.183	4.696	7.180
P	0.669	0.030	0.007

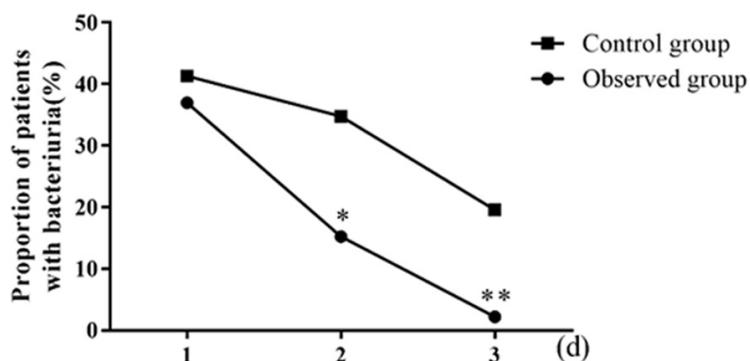


Figure 3. Comparison of postoperative urine routine bacterial counts in the two groups. Compared with the control group. *P<0.05; **P<0.01.

Statistical analysis

The data of this study were analyzed by SPSS statistical software, version 19.0. Measurement data are expressed as mean \pm standard deviation

($\bar{x} \pm SD$). The means between two groups were compared using two independent samples t tests and the comparison in the same group using pair t tests before and after interventions. Enumeration data are expressed as n (%) and the ratio by χ^2 test. P<0.05 means the difference is statistically significant.

Results

Comparison of general data

According to the random number table, the patients were divided into the control group (n=46) and observation group (n=46). The differences in gender, age, disease location and surgical procedures between these two groups were not statistically significant (all P>0.05), thus with comparability (See Table 1).

Comparison of success rate of lithotripsy

The success rate of lithotripsy was 95.65% (44/46) in the observation group and 82.61% (38/46) in the control group. The difference was statistically significant ($\chi^2=4.039$, P=0.044) between these two groups (See Figure 1).

Comparison of postoperative fever

The fever rate in the observation group was significantly lower than that of the control group on the 3rd and 5th days after operation (both P<0.05), as shown in Table 2 and Figure 2.

Comparison of bacteria in urine routine after lithotripsy

The difference in the bacteriological ratio of urine routine was not statistically significant (P>0.05) on the 1st day after operation between

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Table 4. Comparison of postoperative recovery and length of hospital stay, $\bar{x} \pm SD$

Group	Exhaust time (h)	Bowel sound recovery time (h)	Time to ambulation (d)	Length of hospital stay (d)
Observation group (n=46)	18.35±4.28	19.14±8.41	2.98±1.82	7.19±2.05
Control group (n=46)	24.16±4.97	24.67±6.63	3.87±1.53	8.22±2.13
t	6.008	3.502	2.539	2.363
P	0.000	0.001	0.013	0.020

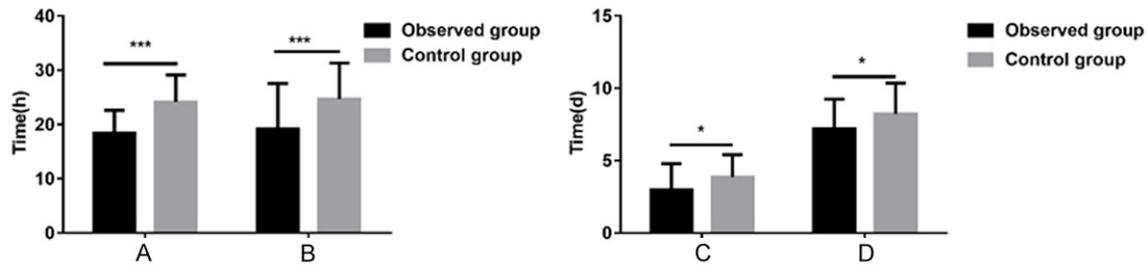


Figure 4. Comparison of postoperative recovery and hospitalization time between the two groups. A: Exhaust time (h); B: Recovery time of bowel sounds (h); C: Activity time (d); D: Time of hospitalization (d). *P<0.05; ***P<0.001.

Table 5. Comparison of ADL scores before and after interventions, $\bar{x} \pm SD$

Group	Before intervention	After intervention	Differences before and after intervention
Observation group (n=46)	27.43±9.52	76.38±11.53	48.95±6.51
Control group (n=46)	28.39±8.67	63.54±10.79	35.15±6.39
t	0.506	4.355	10.260
P	0.614	0.000	0.000

Note: ADL, activity of daily living scale.

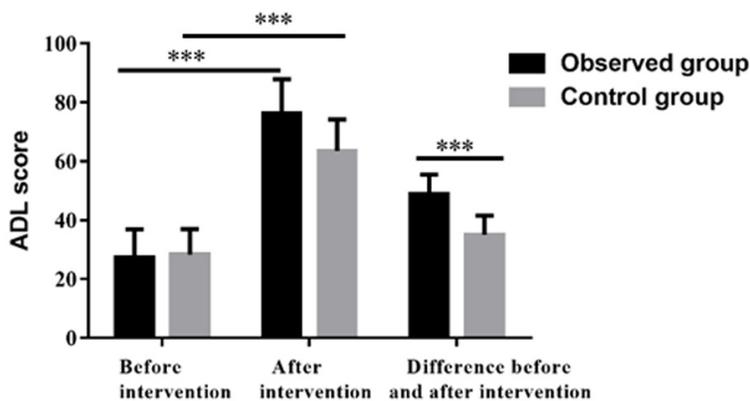


Figure 5. Comparison of ADL scores before and after intervention in both groups. ***P<0.001. ADL, activities daily living.

these two groups. The bacteriological rate of urine routine in the observation group was lower than that of the control group on the 3rd and 5th day after operation, as shown in **Table 3** and **Figure 3**.

Comparison of postoperative recovery and length of hospital stay

The exhaust time, time to ambulation, bowel sound recovery time and the length of hospital stay in the observation group were shorter than those of the control group. The difference was statistically significant (all P<0.05) (See **Table 4** and **Figure 4**).

Comparison of ADL scores before and after interventions

The difference of ADL scores was not statistically significant (P>0.05) before intervention between these two groups. The ADL scores increased after intervention in both groups, of which the ADL scores of the observation group were higher than those of the control group after intervention. The difference was statistically significant (P<0.05). The difference before and after interventions in the observation group was significantly lower than that of the control group (P<0.05) (See **Table 5** and **Figure 5**).

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Table 6. Comparison of the recovery effect of bladder, n (%)

Group	Excellent	Good	Poor	Recovery rate
Observation group (n=46)	27 (58.70)	13 (28.26)	6 (13.04)	40 (86.96)
Control group (n=46)	14 (30.43)	17 (36.96)	15 (32.61)	31 (67.39)
χ^2				4.998
P				0.025

Comparison of the recovery effect of bladder

The recovery rate of bladder was 86.96% in the observation group, which was higher than 67.39% of the control group. The difference was statistically significant ($P < 0.05$) (See **Table 6**).

Discussion

Ureteral calculi with urinary tract infection is a common disease in urology, with high incidence, acute onset and rapid development [12, 13]. This disease may cause pain and higher body temperature, etc., therefore, it needs treatment and nursing care in time [14]. But the routine nursing care measures mainly focus on the disease, and the nursing services are carried out by the nursing staff randomly, as well as lacking of effective supervision [15]. In those nursing services for the ureteral calculi with urinary tract infection, the nursing effect is easily affected due to the short of responsibility, aseptic operation concept and non-standardized operations in the nursing staff [16]. Some studies have showed that the patients with ureteral calculi cannot recover effectively because the conventional nursing care is not targeted, thereby resulting in complications such as urinary tract infection and not good for the rehabilitation of patients.

PDCA Management Mode is proposed by Deming of USA, which mainly forms a small cycle with PLAN, DO, CHECK and ACTION. It will enter into the PLAN stage again after the ACTION, thereby forming a large cycle [17, 18]. During the stage of PLAN, the main tasks are to assess the patient status, identify the nursing problems, and develop solutions. In the stage of DO, it is mainly to carry out the nursing care plan. In this process, it is reviewed and supervised by a third party, which is helpful to restrict the nursing staff, ensure the implementation of the nursing solutions, make the nursing services more purposeful, and reduce the randomness [19]. In the stage of CHECK, it mainly ana-

lyzes the existing and potential problems after the completion of the PLAN and DO. In the stage of ACTION, the nursing protocol is completed based on the problems discovered in the

stage of CHECK, in order to get into the next cycle of PLAN with better case solutions. Therefore, it creates a virtuous circle and makes the nursing care quality constantly improve. The results of this study have showed that the success rate of lithotripsy in the observation group increased significantly after the implementation of PDCA Management Mode, which indicates that it enabled the nurses to grasp the nursing care problems of patients quickly and solve them in implementation in patients with ureteral calculi complicated with urinary tract infection during the treatment. For the patients, the perioperative nursing care is more targeted and purposeful, which is helpful to improve the effect of treatment and promote the postoperative recovery.

The study results showed that the fever rate and the bacteriological rate of urine routine in the observation group were significantly lower than those of the routine nursing group on the 3rd and 5th days after operation under the PDCA Management Mode. Xia et al. found that, in the rehabilitation nursing, the effective number of lithotripsy in patients with ureteral calculi complicated with urinary tract infection treated in the PDCA cycle was significantly greater than that of the routine nursing group, which was consistent with the result of this study [20, 21]. This may be beneficial from preoperative targeted nursing care according to the patient's discomfort and actively preventive measures with respect to possible postoperative complications. For example, if a patient presents with postoperative symptoms of lumbar discomfort or pain, they may be associated with bladder overfilling and urinary reflux after placement of ureteral stents. Therefore, the patient should be encouraged to drink more water, urinate frequently, keep bowels open, avoid severe coughs, and give analgesics if necessary. If a patient experiences hematuria after operation, it may be considered as the mechanical injury of urethra caused by stone extraction. The color and appearance of urine should be observed. The physicians should be informed, and the

patients should be appeased and advised to drink more water and keep the urine volume of 2,000 mL per day. If the urinary tract irritation occurs, it may be considered as improper placement of ureteral stents or bladder and ureteral smooth muscle spasm caused by movement stimulation. Thus, the patient shall be advised to drink water over 2,000 mL per day; pay attention to self-adjustment of posture; apply hot compress in the bladder area; and take antispasmodics if necessary. The patients shall be advised to ambulate early after operation, drink more water and prophylactically use antibiotics, so as to reduce the occurrence of urinary tract infection.

In addition, after implementation of PDCA Management Mode, it can make the nursing care procedure more standardized. Every possible step shall be taken into account, which will effectively prevent the occurrence and aggravation of complications. This study showed that the recovery rate of bladder was 86.96% in the observation group. The postoperative exhaust time, bowel sound recovery time and length of hospital stay were also shorter. All the indexes were superior to the control group, which was similar to the previous literature [22-24]. It suggests that PDCA Management Mode can effectively prevent the occurrence of complications, improve the treatment compliance of patients, accelerate the postoperative recovery, and shorten length of hospital stay. In comparison of postoperative ADL, the observation group was superior to the control group. It suggests that PDCA Management Mode can improve the postoperative ADL of the patients.

However, as a preliminary clinical observation, it has not completed the stratified analysis specific to the factors such as age, sex and surgical methods. Because the sample size is relatively small, these above-mentioned factors will be included into further studies, and the sample size will be further expanded. Besides, the effect of PDCA Management Mode will be investigated under different surgical methods.

To sum up, PDCA Management Mode can effectively avoid nursing care risks, change the patients' bad behaviors, reduce postoperative infection, accelerate the patients' recovery, and improve the patient's activities of daily life. Therefore, it has a high clinical promotion value.

Disclosure of conflict of interest

None.

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