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Application of a New Urine Collection Device and Stirring System in the Collection of 24h Urine Specimens from Patients

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Abstract

Objective: To use a new type of urine collection device and stirring system to retain 24h urine specimens from patients, and to explore the effect of its application in the process of clinical 24h urine specimen retention.

Methods One hundred patients admitted to Nephrology Department I of Guangdong Provincial People's Hospital from September 2022 to February 2023 who needed to retain 24h urine protein quantitative specimens were selected as study subjects. The control group used the traditional 24h urine specimen collection method, while the experimental group used a new urine collection device designed by our department to collect specimens. The passing rate of 24h urine specimen collection, the time of collecting 24h urine specimens, and the satisfaction of patients with this device were recorded.

Results: The nurses in the test group took less time to collect urine protein specimens than the control group $P<0.0001$, the number of specimens passed was higher than that of the control group $P<0.027$, and the patients' satisfaction with 24h urine specimens was higher than that of the control group $P<0.0001$.

Conclusion: The use of the new urine collection device and stirring system for 24h urine specimen collection and sampling can improve the 24h urine specimen collection rate and improve the patient's satisfaction rate. The use of the new urine collection device and stirring system for 24h urine specimen retrieval and sampling can improve the rate of patients' 24h urine specimen retrieval, reduce the time spent by nurses to collect 24h urine specimens, improve nurses' clinical efficiency, and increase patients' satisfaction with 24h urine specimens.

Keywords: Urine protein; Collection device; Stirrer; Specimen qualification rate; Time consuming; Satisfaction.

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Introduction

According to the Lancet, the global prevalence of chronic kidney disease is about 11%-13% [1], and there are about 150 million patients with chronic kidney disease in China, and the retention of 24h urine specimens for quantitative urinalysis is one of the mandatory clinical tests for patients with chronic kidney disease [2]. Properly obtained 24h urine specimens are not only an important indicator to reflect the severity of the disease and predict the development of the disease, but also provide a scientific basis for the formulation of treatment plans [3-5]. Therefore, the correct retention of 24h urine specimens is a key component of quantitative urine protein testing.

The retention time of 24-hour urine specimens is long and the process is complex [6-8]. This is the main reason why specimens are prone to get an error testing result. Failure to retain or preserve 24-h urine specimens will directly affect test results, leading to misdiagnosis as well as inappropriate treatment measures and increased patient burden [9]. Several studies [10-12] have shown that the reasons for specimen failure during 24h urine specimen collection include contamination of the specimen with stool or blood, failure to drain all urine into the collection device within 24h of specimen collection due to out-of-home examination, and deterioration of the specimen due to improper placement of urine; and in clinical practice, there are also problems such as incorrect recording of urine volume during specimen collection, inadequate mixing of urine during collection, and spillage of urine specimens during collection. The traditional 24h urine specimen collection method also requires the patient to record the urine volume in a measuring cup after each urination and then pour it into the urine collection bucket, which not only causes discomfort to the patient but also pollutes the ward environment, resulting in poor patient satisfaction with the operation of 24h urine collection. At the same time, the nurses may also have large testing errors due to uneven mixing and inadequate use of test tubes when collecting 24h urine.

To address these issues, existing studies have focused on improving the specimen retrieval process and developing new urine specimen retrieval containers. In terms of improving the 24h urine specimen collection process, the use of quality control circle tools [13,14], humanistic medicine skills [15], and new teaching methods, such as the graphic method [16], have been used with some success. In terms of developing new urine specimen retention containers, Zhang Suyi et al [17] developed a urine specimen collector for infants and children with a small capacity, and its scope of application was only for children who had a single urine test tube specimen retained. The urine specimen collection bag developed by Ji Huiqin et al. [18] is suitable for the retention of urine specimens that require the addition of preservatives. Some scholars have also developed an intelligent visualized 24h urine specimen collection container, which can solve the problems of inaccurate urine volume recording and uneven mixing of urine by manual operation, but it is only applicable to patients who can get out of bed for toileting and cannot solve the problem of 24h urine specimen collection for bedridden patients and urine leakage due to patients going out for examination [19].

In a comprehensive analysis of the above new containers, all of them have narrow applicability and safety issues to be considered. Therefore, in this study, we developed a new urine collection device and its automatic stirring system consisting of urine jug, accumulation bag, sampling tube, magnetic stirrer and connecting pipeline, and transformed it into a practical finished product for clinical application, which has the advantages of bedside urine collection, direct urine volume reading from the accumulation bag scale and automatic urine mixing compared with the traditional urine specimen retention method. The device has the advantages of collecting urine at the bedside, reading urine volume directly from the accumulation bag scale and mixing urine automatically, reducing the steps of manual measuring and mixing, making urine specimen retention more safe, convenient and clean, and has obtained good application effect in clinical practice. At present, this device has obtained the national utility model patent (patent No.ZL201920738748.X).

Objects and methods

Subjects one hundred patients admitted to our department from September 2022 to February 2023 who required 24h urine protein quantification specimens were selected as study subjects. Inclusion criteria: ① age≥14 years; ② the patient who need to keep 24h urine specimens; ③ voluntary participation in this study. Exclusion criteria:① patients with cognitive or mental impairment that prevented them from cooperating; ② patients with urinary and fecal incontinence; ③ those who were allergic to the contact materials used in this device. The 100 patients who met the exclusion criteria were divided into a test group and a control group using the random number table method, with 50 patients in the test group and 50 patients in the control group. The purpose, procedure and precautions of this study were fully explained to the patients before the start of the study, and informed consent was obtained from the patients. There was no statistical difference between the two groups in terms of general information such as gender, age, education level, disease diagnosis, fall risk assessment, and the ability to take care of themselves (Activists of Daily Living, ADL) (P>0.05) (Table 1).

Methods

Control group 24h urine specimen collection was performed using the traditional way of retaining 24h urine specimens. After the doctor's order for 24h urine specimen collection, the nurse in charge gave the patient a warm reminder card for 24h urine specimen collection and explained the steps and precautions for collection to the patient or family. The patient prepares the urine bucket with lid and measuring cup, and stores each urine in the prepared urine bucket with lid within 24h after the bladder is emptied at 7:00 AM on the day of specimen collection. The 10 ml urine specimen was removed from the urine cup and poured into a urine test tube and sent for testing immediately.

Experimental group: The new urine collection device and its automatic stirring system (Figure 1), which was researched and designed by our department, were used for the retention and sampling of 24h urine specimens: all medical and nursing staff participating in this study were uniformly trained and familiar with the specific use of this device and the operation procedure, and when patients needed to retain 24h urine specimens, nurses instructed patients on site to use this collection device, with the following specific operation steps. ① explain to the patient the function of the device and the purpose of its use; ② instruct the

Table 1: Comparison of general information between the two groups.

Items		Groups		P-value
		Test group (n=50)	Control group (n=50)	
Gender	Male	29 (58.0%)	28 (56.0%)	0.840
	Female	21 (42.0%)	22 (44.0%)	
Education level	Primary School and below	15 (30.0%)	12 (24.0%)	
	Junior High School	13 (26.0%)	16 (32.0%)	
	High School	10 (20.0%)	12 (24.0%)	
	College / Bachelor	12 (24.0%)	9 (18.0%)	
	Graduate Student	0	1 (2.0%)	
Diagnosis	Chronic Nephrotic Syndrome	27 (54.0%)	31 (62.0%)	0.159
	Hematuria	1 (2.0%)	0	
	Acute kidney failure	1 (2.0%)	4 (8.0%)	
	Chronic Kidney Failure	10 (20.0%)	3 (6.0%)	
	Chronic kidney disease 5 stage	9 (18.0%)	12 (24.0%)	
	Fever	1 (2.0%)	0	
	Urinary tract infection	1 (2.0%)	0	
Falls risk assessment	low-risk	35 (70.0%)	44 (88.0%)	0.084
	mid-risk	9 (18.0%)	4 (8.0%)	
	high-risk	6 (12.0%)	2 (4.0%)	
ADL	Self Care	33 (66.0%)	43 (86.0%)	0.119
	Partial self-care	11 (22.0%)	5 (10.0%)	
	Medium help needed	5 (10.0%)	2 (4.0%)	
	Needs a lot of help with heavy dependence	1 (2.0%)	0	

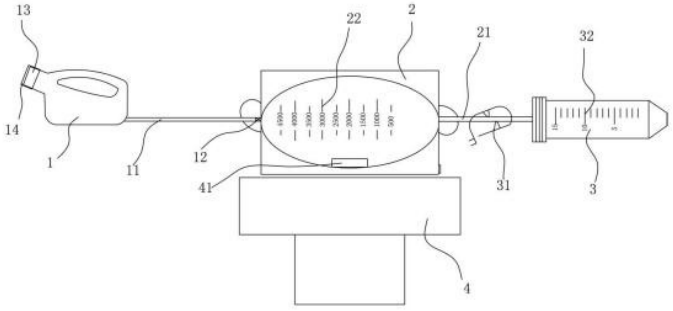

Figure 1: Schematic structure of the new urine collection device and its automatic mixing system.

Tips: 1: urinal; 2: Accumulation bag; 3: Sampling tube; 4: Magnetic stirrer; 11: First line; 12: Anti-reverse flow design; 13: Urinal interface; 14: Seal (male urinal for urinal mouth cover, female urinal for urinal mouth plug); 21: Second line; 22: Accumulation bag scale; 31: Switch; 32: Sampling tube scale; 41: Magnetic rotor.

patient to discharge all urine into the accumulation bag through the urinal interface every time he urinates within 24h after emptying the bladder at 7:00 AM on the day the specimen is retained; ③ discharge the last urine into the device at 7:00 AM the next day and read the total amount of urine through the accumulation bag scale; ④ place the new urine collection device with 24-hour urine in the automatic stirrer, set a fixed time (15 sec), start the stirrer, and drive the magnetic rotor of the accumulation bag to rotate under magnetic force, so that the urine is fully stirred evenly; ⑤ Remove a 10ml urine specimen through the opening and closing port of the accumulation bag and pour it into a urine test tube for immediate delivery.

Evaluation indicators

Qualified rate of 24-hour urine specimen collection The trained and qualified nurses recorded the qualified situation of 24-hour urine specimen collection for each of the 2 groups of patients, and the collected data were statistically analyzed.

Time required to collect 24h urine The time required to automatically mix the urine after collection to collect the urine specimen was recorded separately for each patient, and the collected data were statistically analyzed.

Patient satisfaction survey of container use. A homemade satisfaction questionnaire was used to collect opinions by means of a questionnaire star after explaining the evaluation content and requirements to patients. The content of the satisfaction questionnaire included patient comfort, convenience of use, manipulation of the device, safety of operation and overall evaluation of the 24h urine specimen retention operation. A five-point Likert scale [20] was used, with 1 being very dissatisfied, 5 being very satisfied, and a total score of 4 to 20, the higher the score, the higher the satisfaction level. The satisfaction questionnaire scores collected were integrated in the back office and the data were statistically analyzed.

Statistical methods: The data were entered using Excel 2019

double-checked and statistically analyzed using SPSS 24.0. The t-test was used to compare the sample means of the two groups, and the χ-test was used to compare the sample rates of the two groups. p<0.05 was considered to be statistically different.

Results

In this study, among the 50 patients who collected 24h urine specimens by the traditional method, 43 specimens (86%) passed the test, while among the 50 patients who collected 24h urine specimens using the new urine collection device and its automatic stirring system designed by our department, 49 specimens (98%) passed the test, and there was a statistical difference in the passing rate of urine protein specimens between the two groups of patients (Table 2).

Table 2: Comparison of the passing rate of urine protein specimens retained by the two groups of patients.

Groups	Urine specimen passing rate
Test group (n=50)	43
Control group (n=50)	49
P-value	0.027

The time required for 24h urine specimen collection in both groups, the mean time required for urine specimen collection in the control group was 68.86 sec; the mean time required for urine specimen collection in the test group was 43.46 sec, the clinical time required for two different urine collection methods was significantly better in the test group than in the control group (P< 0.0001) (Table 3).

Table 3: Comparison of the time consumed by nurses collecting specimens in the two groups.

	Groups	Cases	Average time/s	Standard deviation	t	P-value
Time consumed by nurses collecting specimens	Test group	50	43.46	1.876	-43.471	<0.0001
	Control group	50	68.86	3.681		

Table 4: Comparison of satisfaction of 24h urine specimens retained by patients in both groups.

	Likert's five-point scale	Test group	Control group	P-value
Satisfaction with the urine collection device	strongly approve=5	33 (66.0%)	16 (32.0%)	<0.0001
	approve=4	16 (32.0%)	20 (40.0%)	
	undecided=3	1 (2.0%)	14 (28.0%)	
	disapprove=2	0	0	
	strongly disapprove=1	0	0	
Satisfaction with the convenience of the urine collection device	strongly approve=5	35 (70.0%)	12 (24.0%)	<0.0001
	approve=4	14 (28.0%)	21 (42.0%)	
	undecided=3	1 (2.0%)	16 (32.0%)	
	disapprove=2	0	1 (2.0%)	
	strongly disapprove=1	0	0	
Satisfaction with urine collection device handling	strongly approve=5	34 (68.0%)	15 (30.0%)	<0.0001
	approve=4	16 (32.0%)	20 (40.0%)	
	undecided=3	0	14 (28.0%)	
	disapprove=2	0	1 (2.0%)	
	strongly disapprove=1	0	0	
satisfied with the comfort of the urine collection device	strongly approve=5	37 (74.0%)	13 (26.0%)	<0.0001
	approve=4	13 (26.0%)	19 (38.0%)	
	undecided=3	0	17 (34.0%)	
	disapprove=2	0	1 (2.0%)	
	strongly disapprove=1	0	0	
satisfied with the safety of the urine collection device	strongly approve=5	35 (70.0%)	17 (34.0%)	<0.0001
	approve=4	14 (28.0%)	13 (26.0%)	
	undecided=3	1 (2.0%)	19 (38.0%)	
	disapprove=2	0	1 (2.0%)	
	strongly disapprove=1	0	0	

The results showed that patients in the test group were more satisfied with their comfort, ease of use of the device, ease of handling of the device, safety of device operation, and overall satisfaction with the 24h urine specimen retrieval operation than the control group (P<0.0001) (Table 4).

Discussion

Retention of 24h urine specimens for urine quantitative analysis is one of the mandatory clinical tests for patients with chronic kidney disease [1,2], and the correct retention of 24h urine specimens is a key part of urine quantitative testing [21], which has important significance for the diagnosis and treatment of clinical diseases. Studies have shown [22,23] that factors affecting the accuracy of urine specimen test results in clinical practice include urine specimen storage temperature, storage methods, preservatives, urine collection factors and clinical medication factors, and errors in test results of 24h urine specimens can lead to misdiagnosis and omission of the condition, cause improper diagnostic and treatment measures, increase the medical burden on patients, and reduce the quality of patient treatment. The results of this study found that the new urine collection device and its automatic stirring system can improve the qualified rate of patients' 24h urine specimen retention, reduce the error of urine specimen testing, and improve the accuracy of diagnosis and treatment compared with the traditional way of 24h urine specimen retention. In a survey of patients' satisfaction with 24h urine specimen collection using a homemade satisfaction scale, patients who used the new urine collection device and its automatic agitation system for 24h urine collection were significantly more satisfied with the device and the operation, and the closed nature of the device itself prevented the spillage of urine during the operation and the spread of odor during urine collection, which also This also helps to improve patient satisfaction during hospitalization, increase patient acceptance of the hospital, and promote the doctor-patient relationship.

Also, it was found in this study that the time required for nurses to collect 24h urine was shortened with the use of the new urine collection device and its automatic agitation system, which improved the clinical efficiency of nurses. During the case collection process, there was no statistical difference in the fall risk scores between the two groups, but some of the patients who used the traditional 24h urine collection responded that they were prone to the risk of slipping when they went to the toilet at night to retain urine specimens, so we expect that the improvement of the 24h urine specimen retention method will improve the safety of patients during hospitalization and reduce the occurrence of adverse events of patient falls.

The present study is still deficient in that during the 24h urine storage period, the delivery time and room temperature changes can also affect the metabolism of bacteria in urine, thus affecting the urine test results [24]. Free [25] has proposed the idea of cryopreservation of urine specimens, and some studies have shown that the urine retention method with a small number of samples without preservatives at (4±2)°C can completely replace the traditional method of urine retention [26]. In order to further improve the effectiveness of the new urine collection device and its automatic stirring system accumulation bag, and to improve the accuracy of 24h urine specimen testing, the device can be set up with a temperature-controlled outer bag to maintain the urine stored in the accumulation bag at (4±2)°C for 24h to ensure the quality of retained specimens. Therefore, we will modify and upgrade the device later to make it better for clinical use.

Summary

A new type of urine collection device and its automatic stirring system designed by our department can improve the qualified rate of 24h urine specimens retained by patients; reduce the time spent by nurses to collect 24h urine specimens, improve the clinical efficiency of nurses and increase the satisfaction of patients who have 24h urine specimens retained, which is worth promoting in the clinical application.

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