Efficacy Evaluation of Smartphone-based Stent Tracking Application in Follow-up Patients with Ureteral Stents: A Prospective Study

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ABSTRACT

Objective: Our objective was to determine how effectively our smartphone app improved follow-up compliance in ureteral stent patients.

Materials and Methods: Two groups of patients who underwent double-j stent placement were compared. For the traditional program (i), retrospective data from January 2021 to June 2021 was collected. We randomly selected 72 patients from the overall 121 patient data. For the smartphone-based stent tracking program (ii), a smartphone application was used from July 2022 to January 2023 to track 72 patients.

Result: The rate of poor compliance in group (ii) (4.2%), was significantly lower (p=0.004) than the rate of poor compliance in group (i) (19.4%). Differences in diagnosis between the two groups were not found to be related to the compliance rates. Surprisingly, kidney transplant patients in both groups had perfect compliance.

Conclusion: Smartphone-based stent tracking application increased patient compliance to appointments in patients who underwent double-j stent placement. This study is a demonstration of how technology can assist patients to better health care and can prevent complications.

Keywords: Forgotten ureteral stents; smartphone-based stent tracking application (Siriraj Med J 2023; 75: 466-472)

INTRODUCTION

Ureteral double-J (DJ) stents are routinely used to treat urolithiasis. They are inserted temporarily to relieve blockage of the ureter, prevent ureteral strictures, promote healing, and control urine leakage.[1] The duration of DJ stent placement depends on the material of which the stent is made. To prevent complications, they must be removed, but some patients neglect to follow up for removal. One study found that 12% of DJ stents placed had not been removed as scheduled. As per data collected from patients who were hospitalized at Thammasat University Hospital in the year 2020, 16 out of a total of 134 patients (8.9%) did not come on the appointed date to either change or remove their stents. Another 24 out of 121 patients (20%) missed their appointments between the months of January to June of 2021.

A study by El-faqih found stent encrustation in 9.2% of stents removed within 6 weeks, 47.5% of stents implanted 6 to 12 weeks, and 76.3% of stents older than 12 weeks.[2,3] Indwelling ureteral stents increase the incidence of urinary tract infections, the risk of DJ stent mispositioning, ureteric stone formation encircling the stents, and acute renal failure. These complications may lead to unnecessarily extensive care. Some patients might need further surgical treatment, possibly nephrectomy, especially in those with non-functioning kidney.[2,3] Thus, although DJ stent insertion is advantageous, proper care and punctual stent removal is essential to prevent future morbidity and mortality. Punctual stent removal would also help reduce overall healthcare costs.

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As aforementioned, removing a DJ stent on the appointed date has the advantages of lower healthcare expenses and lower morbidity rates. Past measures to ensure punctual removal include paper based or electronic appointment cards and text messages delivered to mobile devices. However, these media are limited to the hospital grounds and necessitate further medical expenses.[4-6]

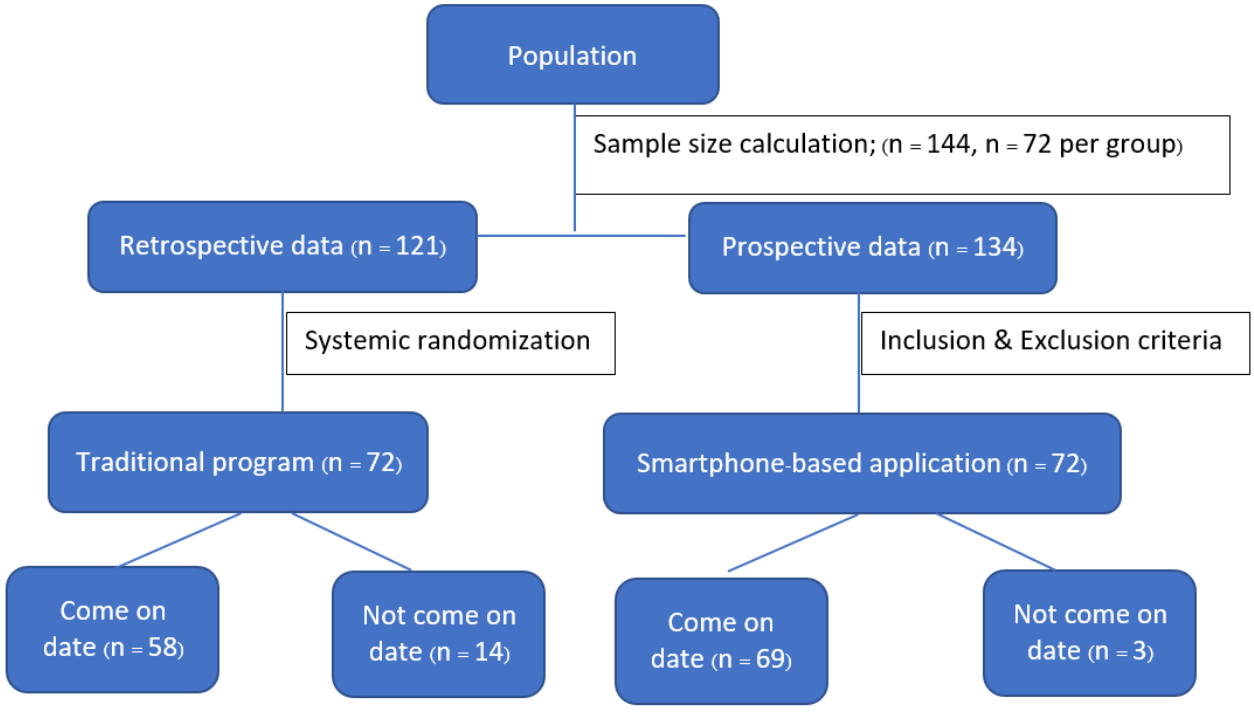
In the present day, as smartphones have become more widespread and globally accessible, several new options to ensure regular hospital visits are available. In the years 2019 to 2021, several studies were conducted to evaluate the efficacy of using applications on smartphones to establish routine follow ups. Results have shown that using tracking applications reduced patients' odds of forgetting to remove their ureteral stents[7,8] and decreased overdue times to scheduled appointments.[9] Research conducted by M. Zeeshan Hameed et al. took advantage of this application to not only track patients' stent placements but also to communicate with them during the pandemic of COVID-19. This tool may provide more than its tracking ability by improving communication between physician and patients. All of these studies reached the same conclusion: smartphone DJ stent tracking applications decrease the likelihood of patients forgetting about their stent insertion, lessening the incidence of retained ureteral stents, which in turn reduces the need for unplanned hospitalizations and medical expenses.[10] DJ stent tracking applications on patients' smartphones can lead to better healthcare. However, a limitation is that these tracking applications are offered only with the English language, limiting their generalizability to other populations. Thus, it was our aim to develop an application in the Thai language for the Thai population. Our assumption is that once patients with inserted DJ stents are using this tracking application, the rates of missing their appointments will be lower when compared to those using traditional appointment methods.

MATERIALS AND METHODS

This study is a prospective cohort study conducted to evaluate the efficacy of a smartphone-based stent tracking application to ensure that patients come for regular follow-ups for stent removal. The ethics committee approval was granted by The Human Research Ethics Committee of Thammasat University (Medicine) (reference MTU-EC-SU-1-286/64). The study population was patients who received double-J ureteral stent placements at Thammasat University Hospital.

Sample size calculation

From retrospective data review on patients hospitalized at Thammasat University Hospital between January and June of 2021, it was seen that 20% of the patients with stent insertion did not come to follow up on the scheduled date. We hypothesized that if patients used our application, it would reduce the proportion of patients with stent insertion who did not come to follow up on the scheduled date to 5%. Our research team set the standard deviation at 5% with the power at 80%. The sample size was 72 patients per group for a total study population of 144 patients.



The first study group was patients who used a traditional appointment program. We collected retrospective data between January 2021 to June 2021 (n = 121), then systematically randomized the data into 72 patients. For the second study group, data from 72 patients who used a smartphone-based stent tracking program were collected. This data was recruited prospectively from July of 2022 and onwards with inclusion and exclusion criteria as follows:

Inclusion criteria: Patients aged above 18 years who underwent DJ stent placement in our clinic from January 2022 onwards

Exclusion criteria: Patients who could not communicate in Thai language or did not use a smartphone android system (version > 5.0)

A total of 72 patients were successfully recruited. There were a total of 134 patients who received DJ stent placement within the designated study time period.

The smartphone-based stent tracking program was developed by the author in Thai language and could be downloaded through Google Play. Registration data included each patient's name, medical record number and telephone number. Appointments for stent removal were set by the physician. (Fig 1).

We collected the patient's data through an electronic website, where the account usernames and passwords were determined by the patients themselves.

After receiving DJ stent placements, the enrolled patients were required to download the application through Google Play. They received a session explaining how to browse and utilize the application. This application allowed users to review their diagnosis, position of stent placement (left or right side or both), appointment date and future care plan after stent placement (Fig 2). Patients could change their telephone numbers by themselves to continuously update their contact information. During their session of using the application, patients were able to contact the author directly to inform about their symptoms or possible complications following stent insertion. The author was always reachable by enrolled patients if they had any inquiries.

After initiating the application, the smartphone-based stent tracking program's visual dashboard was reviewed by the physician on a daily basis (Fig 3). The application reminded patients two days prior to their stent removal appointment. Patients who missed their appointments were contacted by phone, and a new appointment was scheduled within 12 weeks of stent placement. The two study groups were compared in terms of punctuality for appointments.

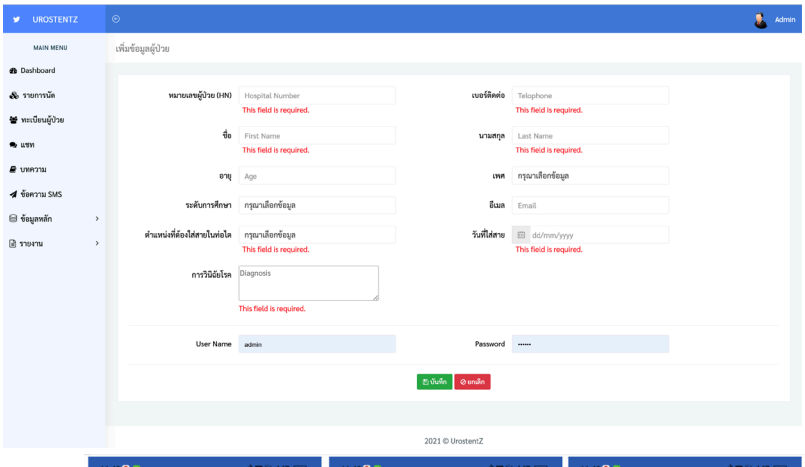


Fig 1. Registration data

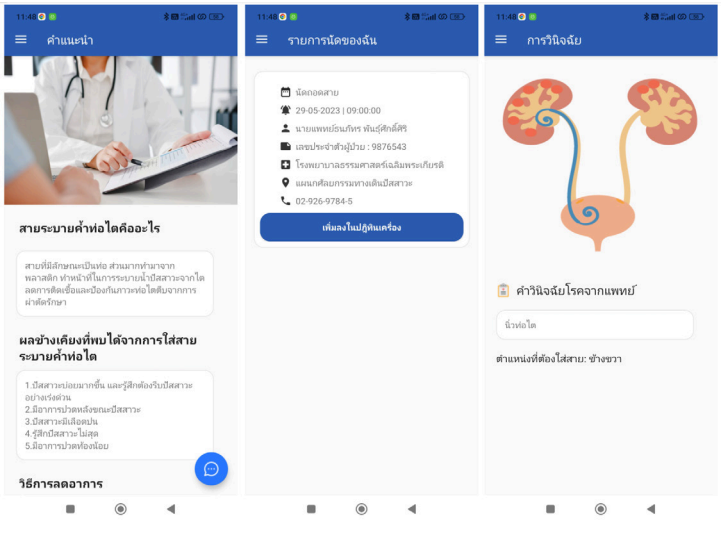


Fig 2. Future care plan, Appointment date and Patient's diagnosis

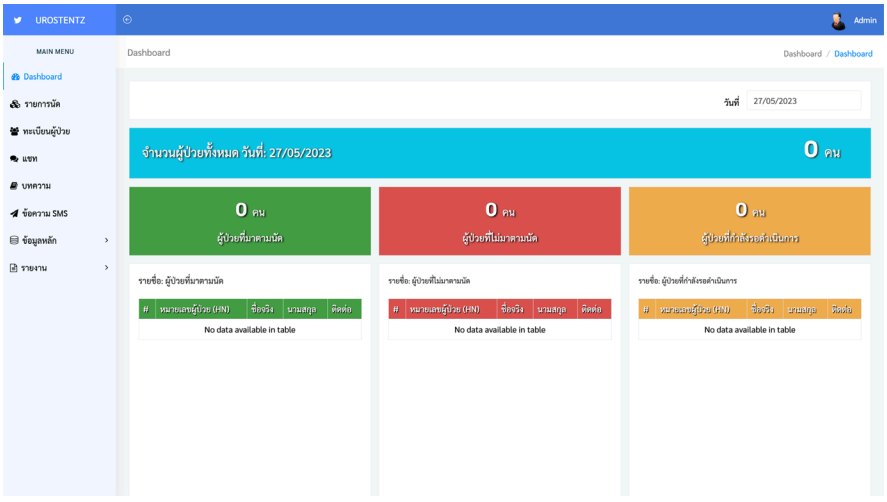


Fig 3. Daily visual dashboard

Statistical analysis

Statistical analysis was performed using STATA software (version 15). For continuous data, we compared the two study groups using T-test. For categorical data, we used Chi-square test and fisher's exact test to analyze patients' characteristics and for dependent variable analyses. Differences were considered statistically significant when the p-value was less than 0.05 ($p < 0.05$)

RESULTS

Group 1 was defined as the traditional program group. Group 2 was defined as the smartphone-based application group. The two groups' characteristics were indistinguishable from each other in terms of age, gender, and educational status. However, the primary diagnoses were different between the two groups, as displayed in Table 1.

TABLE 1. Demographic data.

Characteristic data	Group 1 (n =72)	Group 2 (n =72)	P-value
Age mean(sd)	57.61 (13.50)	52.72 (16.57)	0.054[1]
Sex			0.738[2]
Male	37/72	39/72	
Female	35/72	33/72	
Education level			0.168[2]
Primary school	15/72	11/72	
Secondary school	13/72	10/72	
Vocational certificate	24/72	18/72	
Bachelor or higher	20/72	33/72	
Stent side			0.120[2]
Left	41/72	29/72	
Right	27/72	39/72	
Both	4/72	4/72	
Diagnosis			0.008[2]
Ureteric calculi	22/72	21/72	
Renal calculi	30/72	24/72	
Kidney transplantation	3/72	16/72	
Gynecological condition	5/72	7/72	
Other*	12/72	4/72	

[1]Analyze by independent t-test

[2]Analyze by Chi-square

Comparing punctuality for appointments, 4.2% of Group 2 missed appointments, while a whopping 19.4% of Group 1 missed a follow-up date. This difference was statistically significant (p-value < 0.05), as displayed in Table 2.

In education level of Bachelor or higher, 3% of Group 2 missed appointment and 20% of Group 1 missed appointment. There are not statistically difference between two groups as displayed in Table 3.

When taking the patients' diagnoses into consideration, regardless of whether it was the experimental or the control group, the underlying condition did not influence punctuality, except for patients who had kidney transplants. All kidney transplant patients came to their appointments on schedule, as displayed in Table 4.

Comparing the overdue times between the two study populations, Group 2 had a median delay of seven days and an interquartile range of five days. On the other hand, Group 1 had an overdue median of seven days, but an interquartile range of 96.5 days, as displayed in Table 5.

DISCUSSION

Molina et al. did a retrospective study back in 2017 concerning the usage of a ureteral stent tracking application. Of the 194 patients inspected, 77% presented punctually for stent removal, 9% had not, and 1 patient was lost to follow-up. A subsequent study done by Ziemba et al. reported that three out of 115 patients (3%) who did not return for their scheduled stent removal could be identified only through the UST application. In a similar manner, our research found that characteristics between both study populations were similar in terms of age, gender, education level and side of ureteral stent insertion. The only differences between the two groups were the patients' underlying primary diseases. Complementary to results demonstrated in previous studies, our research has also shown that patients who used a stent tracking application had lower incidences of not returning to scheduled appointments on time when compared to those using traditional appointment methods (4.20% vs. 19.4%, respectively) with the data being statistically significant.

Although, the number of patients with Bachelor or higher in Group 2 was 33, that are higher than Group 1 which were 20 patients. When we compare between the two groups on their punctuality in returning on a scheduled appointment date. There is no statistically significant difference. This indicates that patients placed importance on making appointments to see physicians at all levels of education.

Thus, a presumption that using a tracking application

TABLE 2. Comparison between the two groups on their punctuality in returning on a scheduled appointment date.

Group	Came on appointed date		P-value
	Yes (%)	No (%)	
			0.004[2]
Group 1	58(80.60)	14(19.40)	
Group 2	69(95.80)	3(4.20)	

[2]Analyze by Chi-square test

TABLE 3. Comparison between the two groups on their punctuality in returning on a scheduled appointment date when further classified by Bachelor or higher.

Group	Came on appointed date		P-value
	Yes (%)	No (%)	
Bachelor or higher			0.061[3]
Group 1	16(80.00)	4(20.00)	
Group 2	32(97.00)	1(3.00)	

[3]Analyze by fisher's exact test

TABLE 4. Comparison between the two groups on their punctuality in returning on scheduled appointment dates when further classified by their underlying primary diagnosis.

Diagnosis	Came on to appointed date		P-value
	Yes (%)	No (%)	
Ureteric Calculi			0.512[3]
Group 1	21(95.50)	1(4.5)	
Group 2	21(100.00)	0(0.00)	
Renal Calculi			0.142[2]
Group 1	23(76.70)	7(23.30)	
Group 2	22(91.70)	2(8.30)	
Kidney transplantation			NA*
Group 1	3(100.00)	0(0.00)	
Group 2	16(100.00)	0(0.00)	
Gynecologic condition			0.222[3]
Group 1	2(40.00)	3(60.00)	
Group 2	6(85.70)	1(14.30)	
Other			0.529[3]
Group 1	9(75.00)	3(25.00)	
Group 2	4(100.00)	0(0.00)	

*No one did not come on appointment date

[2]Analyze by Chi-square test

[3]Analyze by fisher's exact test

TABLE 5. Overdue duration between two groups.

Group	Median (days)	Quartile 1 – 3 : (IQR)
Group 1	7 (n = 14)	6.25 – 102.75 : 96.5
Group 2	7 (n = 3)	5 – 10 : 5

can lower the rates of appointment dismissal can be made. A patient's underlying condition did not influence their punctuality for appointments, except for kidney transplant patients, who all came to appointments on schedule. This may be further explained by the pandemic of COVID-19, which reduced the amount of kidney transplantation procedures, which in turn decreased the number of patients who received appointment cards during the study period. On the other hand, the study of patients who utilized the stent tracking application was conducted when the pandemic was on its downward trend. Meanwhile, Thammasat University Hospital recruited a new transplant doctor, increasing the amount of kidney transplant cases within the period of interest. A patient who underwent a kidney transplant typically required a multidisciplinary team to care for the patient. The need to meet several specialists also reiterated the importance of punctuality for follow-up appointments in this group of patient.

Another noteworthy factor to consider is that the overdue duration was significantly shorter in the application usage group when compared to those receiving traditional appointment care (IQR:5 vs. 96.5 days, respectively). This result corresponds to the study done by Ulker et al in 2019, who found that application users had shorter overdue times (Mean 3.5 days, P = 0.001). Phoning patients who missed appointments had reduced the overdue times of application users. Moreover, using their application also allowed them to track each patient's due date for stent removal efficiently, which assists physicians to emphasize the importance of follow up to this group of patients.

Limitations

A limitation of this study is that the study population was small because the application was available only

to Android users.This study did not provided income and residence of the patient that may be risk factor for miss an appointment. Moreover, each patient's personal information and clinical data had to be manually transferred from the hospital database into the software, causing possible technical errors and excessive time consumption. Retrospectively collected data was compared to newly collected information, so the comparison was presumptive, not prospective, possibly causing bias during data collection.

Future direction

This tracking application was designed specifically for Thai users. A similar iOS version is planned. In addition to improving punctuality for appointments, this tracking device assists closer patient follow-up. Further potential may be revealed in future studies.

CONCLUSION

The usage of a mobile tracking application device for patients with indwelling ureteral stents has decreased the tendency of these patients to miss their appointments and reduced overdue time. The stent tracking application is superior to traditional follow up methods for ensuring punctual outpatient visits with this group of patients.

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