

# Training effect on knowledge of new interns regarding urethral catheterization

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## Research Article

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# Abstract

## Introduction

Complications from urethral catheterization (UC) increase hospital stay and costs. We aim to assess the knowledge of new interns at a university hospital and to study the effect of training in the short and long terms.

## Methods

New medical interns (n = 40) at a university hospital were included. Using a pre-training survey, interns' needs and their confidence level (CL) about UC were assessed. They were divided into small groups. The workshop was divided into three educational parts (PowerPoint presentation, video demonstration, and simulation with peer feedback) and a final examination. At the end of the session, an evaluation questionnaire assessed satisfaction of interns, and their new CL about UC. A distant evaluation 6 months later, evaluated the number of UC performed, the failure and the complication rates, and the need for further training. Descriptive statistics and paired t-test were used with a confidence interval of 95% and a significant p-value < 0.05.

## Results

Before the training 16% of new interns felt prepared to correctly perform UC, and the mean confidence level about the skill was  $6.60 \pm 1.79$  over 10. Knowledge of participants about the different steps of UC was variable. At the end of the training 92% were highly satisfied. All of them rated the quality of training as good, and 97% stated that the training responded to their needs. A statistically significant improvement in CL of 2.05 points over 10 (SD = 2.03, 95% CI, 1.39 to 2.72,  $p < 0.05$ ) was observed on paired samples t-test. A distant assessment 6 months later showed that 274 UC were performed from which 7% failed and 4% were complicated. Further training was requested by 42% of new interns.

## Conclusion

The UC training conducted at our institution helped our interns become more confident regarding UC. Continuous training is necessary for skill optimization of interns.

## Introduction

Urethral catheterization (UC) is a routine procedure performed during hospital stay [1]. Iatrogenic urethral trauma occurs in 0.3% during the insertion process. It is caused most commonly by false passage creation or balloon inflation in the urethra. Although complications from UC increase hospital stay and costs, mechanisms to prevent catheter-related injuries receive little attention [2]. Multiple studies showed

that a significantly higher UC-related morbidity is caused by interns especially at the beginning of their internship [1, 3]. More studies are demonstrating the insufficient training and knowledge in junior doctors which raises the need to implement educational strategies and proper training [4].

This study aims to assess the knowledge of new interns in a university hospital regarding UC and to study the effect of training on their confidence level (CL) regarding UC in the short-term, and the rates of failure and complication in the long-term.

## **Methods**

### **STUDY POPULATION**

The study included new medical interns (n = 40) at our university hospital for the academic year 2020–2021. All had completed five years of medical education at the same medical school. In the concerned UMC, urethral catheterization is not performed by nursing staff and so training in catheterization is included in the medical curriculum.

### **TRAINING DEVELOPMENT**

Before the workshop, we analyzed the experience, knowledge, and need of the trainee and set the goals of each session based on a pre-training survey. It contained 11 questions, covering 4 areas: the preparedness and the level of confidence performing UC on a scale from one to ten, the previous experience, the best way to acquire theoretical knowledge and skills, and theoretical knowledge of the different steps of UC (taking the history, ruling out contraindications, the best location to apply the lube, the best way to handle the penis during catheterization, the depth of catheter insertion and the importance of observation of the volume drained). The elements of the questionnaire were focused on the factors that increase the risk of urethral injury rather than aseptic technique and were based on previous similar work done by Thomas and colleagues [3] and Manalo and colleagues [4]. The questionnaire was reviewed by a consultant urologist in the institution to evaluate its adequacy in the evaluation of theoretical and practical knowledge relating to correct UC. It was then piloted with 2 medical interns who were thereafter excluded from the study. Modifications were made based on their feedback. It was then administered to all medical interns between the second and the third week of September 2020 (their first month of training in the university hospital). Responses were collected anonymously and analyzed using Microsoft Excel. The workshop was designed based on the data collected. We chose to use multiple learning styles: lecture, demonstration by a video, and simulation with a final examination to assess the mastery of the skill. Training materials were selected from the Campbell-Walsh Urology, 11th edition [5]. We picked audiovisual aids demonstrating the skill on the same dummies available at the center, from the provider's website [6, 7]. We established a checklist for skill evaluation, and created and validated surveys for training evaluation in the short and long term. The course was then implemented and ran in 5 sessions. The evaluation of the training was conducted immediately after the workshop for objectives, satisfaction, and rating of the materials and trainer. Long-term evaluation, rates of failed

catheterization and complications, and the assessment of the need for new training was done 6 months later.

## **WORKSHOP**

Interns were divided into five small groups of eight individuals each. Each group received the same training. The workshop was divided into three educational parts of twenty minutes each and a final examination. The first part consisted of a short interactive PowerPoint presentation that highlighted key points in UC. The second part consisted of two videos demonstrating the skill and the steps with verbal descriptions using female and male dummies. The third part was the simulation in which each intern performed UC on male and female dummies at our simulation center, with the supervision of the urology fellows that commented on their skills and outlined their weaknesses. At the end of the session, each trainee underwent examination with peer feedback. All teaching sessions were given by an experienced urologist with more than 5 years of teaching experience. The main points discussed in the lecture were the anatomical considerations of the urethra and urethral meatus in males and females, indications and contraindications of UC, catheters types and selection criteria, catheterization technique and steps, technical considerations in males and females, the importance of documentation, complications, and mechanisms of iatrogenic urethral injury. Trainees were encouraged to seek help in specific situations. We also focused on the importance of the "one gentle attempt only" rule, in reducing the likelihood of iatrogenic false passage [2].

## **EVALUATION**

At the end of the session, an evaluation questionnaire was filled by all the participants to assess their satisfaction from the training, the response to their needs, the need for further training, the usefulness of the learned skills, and the CL performing UC after the training session. A distant evaluation was conducted 6 months later using a survey to evaluate the number of UC performed by the trainees, the failure and the complication rates, and the need for further training. All methods were carried out in accordance with relevant guidelines and regulations.

## **STATISTICAL ANALYSIS**

Descriptive statistics were used to report interns' experience, perceptions, and knowledge concerning UC. Data from surveys were collected and analyzed using Microsoft Excel. Paired t-test was used to compare the mean confidence levels performing UC before and after the training session with a confidence interval of 95% and a significant p-value < 0.05. The statistical analysis was conducted using SPSS 26.0.

## **Results**

Two interns were excluded from the analysis after participating in the pilot studies. Of the 38 remaining new interns, 100% (n = 38) completed all the questionnaires from which 34% (n = 13) were men and 66% (n = 25) were women. At the time of the study, 74% (n = 28) have already performed at least one UC, but only 16% (n = 6) felt prepared to correctly perform this manipulation.

Concerning the best method of UC training (Table 1), 53% (n = 20) interns considered the live demonstration at the simulation center the best, and 47% (n = 18) considered a supervised catheterization at the patient bed superior. None voted for learning via a lecture or by video watching.

Table 1  
Interns' perception on the best way of urethral catheterization training

Method of training	n	%
Live demonstration at a training center	20	53%
Supervised catheterization at the patient bed	18	47%
Video	0	0%
Lecture	0	0%

The knowledge of the new interns was assessed using 6 multiple choice questions covering the different steps of UC: history taking, recognition of contra-indications before catheterization, proper use of lubricant, proper depth of insertion of the catheter, and the importance of the assessment of the drained volume (Table 2).

Table 2  
Interns' knowledge about urethral catheterization

Field	Answers	n	%
Taking history on previous catheterization or surgery	Important	38	100%
	Not important	0	0%
Contra-indications to UC	Yes	38	100%
	No	0	0%
Lubrication before catheter insertion is best applied to	Catheter	19	50%
	Urethra	10	26%
	Urethral meatus	9	24%
The angle at which the penis is stretched before catheterization	Perpendicular to the body	32	84%
	Parallel to the body	6	16%
	No particular angle	0	0%
The depth of catheter insertion	Past the mid-point of the shaft of the catheter	5	13%
	To the hub (where the connection for a drainage tube and the inflation port meet)	24	63%
	No particular level: the balloon is inflated as soon as the urine passes from the catheter	9	24%
The volume of urine drained	Important	34	89%
	Not important	4	11%

All participants (n = 38) considered history taking and contra-indication recognition as important steps before UC. Half of them (n = 19) considered correct the application of lubricant to the catheter and 24% (n = 9) chose the urethral meatus. Only 26% (n = 10) would deliver the lube inside the urethra. All students agreed that the penis should be stretched before catheterization. Only 16% (n = 6) maintained the penis parallel to the body, and 84% (n = 32) agreed that the penis should be stretched perpendicularly to the body to allow easier insertion. Students didn't agree on the depth of catheter insertion. Nine students considered there is no particular level, and the remaining answers were past the mid-point of the shaft of the catheter in 13% (n = 5) or to the hub of the catheter in 63% (n = 24). Most of the interns (89%, n = 34) considered the volume of urine drained important.

Table 3  
Immediate training assessment

Field	Answers	n	%
Satisfaction from training	Good	35	92%
	Fair	3	8%
Training quality	Good	38	100%
	Fair	0	0%
Response to trainees' needs	Good	37	97%
	Fair	1	3%
Usefulness of the skill learned in daily work	Yes	37	97%
	No	1	3%
Recommendation of this training to others	Yes	37	97%
	No	1	3%

At the end of the training (Table 3), the survey showed that 92% (n = 35) of the trainees were highly satisfied. All of them (n = 38) rated the quality of training as good, and 97% (n = 37) stated that the training responded to their needs and that the skills gained are useful in their daily work routine. Nearly all the interns (97%, n = 37) recommended this training to others. Interns were asked to rate their confidence level (CL) concerning UC in the before and immediately after training on a scale from 1 to 10, where 10 is the highest. Before the training, CLs varied from 1 to 10, with a median of 7 and a mean of  $6.6 \pm 1.79$ . After the training session, the levels varied exclusively between 7 and 10. The mean confidence level rose to  $8.66 \pm 0.94$ , with a median of 9 (Fig. 1).

Interns were more confident about UC (mean CL  $8.66 \pm 0.94$ ) after the training session than before (mean confidence level  $6.60 \pm 1.79$ ) (Table 4). A statistically significant improvement of 2.05 points over 10 (SD = 2.03, 95% CI, 1.39 to 2.72,  $p < 0.05$ ) was observed on paired samples t-test (Table 5).

Table 4  
Mean confidence levels of interns concerning urethral catheterization before and after training

Status	n	Mean confidence level	SD
Before training	38	6.60	1.79
After training	38	8.66	0.94
SD: standard deviation			

Table 5  
Comparison of mean confidence levels of  
interns concerning urethral catheterization  
before and after training using paired samples  
t-test

Paired Differences				
Mean	SD	95% CI		p-value
		Lower	Upper	
2.05	2.03	1.39	2.72	.000
CI: Confidence interval				

A distant assessment was conducted 6 months later. It showed that 42% (n = 16) requested further training. Of the 38 interns included, 37% (n = 14) encountered failure during at least one UC (Table 6).

Table 6  
Distant assessment showing rates of trainees who  
encountered failure during catheterization or requested  
further training

Description	n	%
Total number of trained interns	38	
Trainees who encountered failure	14	37%
Trainees who requested further training	16	42%

Over 6 months, 274 UC were performed by our new interns, from which 7% (n = 19) failed. The most common causes of failure were (Table 7) urethral meatal stenosis in 32% (n = 6) and difficulty identifying the urethral meatus in females in 32% (n = 6). The other reported causes were an inadequate exposition of the genitals due to patient disability (associated with hip fracture) in 26% (n = 5) and phimosis in male patients in 10% (n = 2).

Table 7  
Distant assessment measuring rate and causes of failed urethral catheterization

Description	n	%
Total UC performed	274	
Failed attempts	19	7%
Identification of urethral meatus in females	6	32%
Phimosis in males	2	10%
Inadequate exposition (patient disability)	5	26%
Urethral meatus stenosis	6	32%
UC: urethral catheterization		

Overall, 4% (n = 11) of the UC (n = 274) were complicated (Table 8). The most common complication was urethrorrhagia with spontaneous resolution in 55% (n = 6). It was followed by occurrence of false passage in 18% (n = 2), urinary tract infection in 18% (n = 2) and necessity of supra-pubic catheterization in 9% (n = 1).

Table 8  
Distant assessment measuring rate of complications following urethral catheterization

Description	n	%
Total UC performed	274	
Complications	11	4%
Urethrorrhagia with spontaneous resolution	6	55%
False passage	2	18%
UTI	2	18%
Necessity for SPC insertion	1	9%
UC: urethral catheterization; UTI: urinary tract infection; SPC: supra-pubic catheter		

## Discussion

Approximately 25% of hospitalized patients undergo UC. The incidence of iatrogenic urethral trauma varies between 0.3 and 0.67% during the insertion process [1, 2]. In one study, a complication Clavien-Dindo grade 2 or greater was reported in 81% of patients undergoing UC. Those complications lengthened hospital stay by  $9.4 \pm 10$  days, and increased costs by €335,377 over 6 months [2]. The manipulation,

particularly in men, is more challenging due to the tortuous anatomy of the urethra and the possibility of prostatic obstruction. Unsuccessful catheterization may result in complications in the short and long terms and may engender interventions like the percutaneous insertion of a suprapubic catheter (SPC) or cystoscopy with catheter insertion over a guidewire. Short-term complications from UC include among others urosepsis, obstructive uropathy that may predispose to acute kidney injury, hematuria requiring blood transfusion and or continuous bladder irrigation, repeat cystoscopy to catheterize to the bladder, epididymo-orchitis, and additional length of stay [2]. In the long-term, a persistent urethral stricture can necessitate lifelong self-urethral dilation or long-term indwelling SPC or urethral catheter [2]. Successful UC is operator dependent, even if patient risk factors (enlarged prostate, urethral strictures....) were present. The operator remains the main actor in the prevention of complications by early detection and correct decision taking during UC. A study in a large Irish teaching hospital reported that three-quarters of catheterization related morbidities occurred when the procedure was performed by interns [3]. A significantly higher UC-related morbidity was caused by newly qualified interns compared to interns in their last six months of training [1]. Therefore, to optimal patient care, it is essential that interns acquire the basic clinical skills at the beginning of their internship, so that they feel safe, confident, and competent in performing UC [4].

## **ADULT LEARNING THEORY**

To achieve successful training, adult learners have to be involved and need to see the relevance of the information delivered to their daily work [8]. Accordingly, the self-assessment questionnaire conducted before the training, helped the trainee identify their weaknesses, strengths, and confidence level regarding UC, creating an inner motivation to get the ultimate learning experience from the subsequent workshop.

## **TRAINING DEVELOPMENT**

We used the instructional systems development (ISD) model, being the most effective way of training [8]. At the beginning of the session, objectives and criteria for evaluation were clearly stated. At the end of the session, we evaluated trainee performance using an exam on the simulator. In a later period, we measured the effect of our intervention by the rate of complicated UC. We organized short learning sessions of 20 minutes to increase knowledge retention. And based on the fact that the brain remembers the first and the last parts of a training best (the primacy-recency effect) [9], we made the presentation and the simulation (the most important parts) the first and the last parts respectively. We chose small group learning with eight individuals in each group, to optimize the learning experience. This learner-centered approach actively involves the students, and allows them to test their ideas with their peers and to receive feedback [10]. We used a facilitative or participatory training style, in which the trainer guides the learners to discover what they need to learn. This approach was shown to be more appropriate than instructive-style learning for adult learners [8]. We based the content of our training on specific weakness points detected in the pre-evaluation survey (where the lubricant should be applied, the direction of the penis, the depth of catheter insertion, and the importance of the volume drained). The information was delivered using an interactive presentation that covered indications, contraindications, choice of catheters

with a rapid anatomical review. The skill was divided into small steps. We explained the purpose of each one, focused on key points and demonstrated it through a video. Trainees were allowed next to practice the skill using a male and female simulator with expert feedback about each step for every single trainee. At the end of the workshop, we encouraged further questions, designated reference for further assistance if needed.

We incorporated different methods in our training (lecture, demonstration, and simulation) to maximize the teaching experience of our students. We used video-based learning because it has been related to increased levels of self-confidence [11] before skill practice. We also used simulation-based training with peer feedback. This method, by offering the trainees the opportunity to identify their errors before the clinical settings [12] is considered superior to other teaching methods and shows better attainment and retention of procedural skills [13], reduced learning curve, and less skill degradation over time [13].

In the pre-training survey, the majority considered that patient-based training in catheterization would be the most beneficial. Unfortunately, this is not practical due to the limited number of urology fellows and the high frequency of UC. Moreover, UC is frequently performed in urgent situations (retention, output surveillance in a shocked patient) that can't wait for the reunion of the intern on duty and the urology fellow. However, one important consideration that might resolve this issue, could be a mandatory core rotation in urology to address this training deficiency.

In the short-term, the training conducted at our center succeeded in increasing the CL of the new interns from a mean of 6.60 to a mean of 8.66 over 10, which was statistically significant ( $p < 0.05$ ).

In the long term, 4% of UC performed by our new interns were complicated 4% (Table 8). This rate is high compared to previous rates of the literature that ranged between 0.3 and 0.67% [1, 2]. This could be explained by the selectivity of our population, which included only new interns in their first 6 months of internship. Since UC is performed by medical students from different years and different specialties at our university hospital, the complication rate obtained in the actual study does not reflect the overall complication rates of UC in the hospital and is only specific for the current study population. The distant assessment showed that 42% ( $n = 16$ ) requested further training. This is consistent with the previous studies that showed also the necessity of continuous training for skill optimization [1], which would ideally be inspired from the most common causes of failed catheterizations in a given institute (meatal stenosis management and difficulty identifying urethral meatus in female in our case) (Table 7).

## **LIMITATION**

Despite using simulation with peer feedback which is considered superior to other conventional learning styles (lectures, videos, demonstration), a metric-dependent proficiency-based progression training is considered recently the most efficient way to optimize the learning experience and to improve performance [13] and will be our near future project.

## **Conclusion**

With more evidence revealing the insufficient knowledge and training in junior doctors, it is crucial to implement specific educational strategies. After assessment of knowledge of the concerned medical professionals and identification of gaps, a trainee based workshop specific for each institution has to designed and conducted. Simulation is superior to other teaching strategies. The UC training conducted at our institution helped our interns become more confident regarding UC. Continuous training is necessary for skill optimization.

## **Declarations**

### **a) Ethics Approval and Consent to Participate**

This study was approved by the ethics board of “Notre Dame des Secours” University hospital, and all methods were carried out in accordance with relevant guidelines and regulations.

Informed consent was obtained from all participants.

### **b) Availability of data and supporting materials**

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

### **c) Competing Interests**

Authors declare no competing interests for this article.

### **d) Funding**

Authors declare no sources of funding for this review article.

### **e) Authors' contributions**

All authors made substantial contributions to conception and design, acquisition of data and analysis and interpretation of data; Authors participated in drafting the article and revising it critically for important intellectual content.

Authors gave final approval of the version to be submitted.

Each author participated sufficiently in this work and takes public responsibility for appropriate portions of the content.

All Authors declare no conflict of interest

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Not applicable

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## Figures



**Figure 1**

Interns' confidence levels distribution regarding urethral catheterization, on a scale from 1 to 10, before and after the training