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Resident Performance in Complex Simulated Urinary Catheter Scenarios

Short title: Performance in Catheter Scenarios

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Abstract:

Introduction: Urinary catheter insertion is a common procedure performed in hospitals. Improper catheterization can lead to unnecessary catheter associated urinary tract infections and urethral trauma, increasing patient morbidity. To prevent such complications, guidelines were created on how to insert and troubleshoot urinary catheters. As nurses have an increasing responsibility for catheter placement, resident responsibility has shifted to more complex scenarios. This study examines the clinical decision making skills of surgical residents during simulated urinary catheter scenarios. We hypothesize that during urinary catheterization, residents will make inconsistent decisions relating to catheter choices and clinical presentations.

Methods: Forty-five general surgery residents (PGY 2-4) in Midwest training programs were presented with three of four urinary catheter scenarios of varying difficulty. Residents were allowed 15 minutes to complete the scenarios with five different urinary catheter choices. A Chi Square test was performed to examine the relation between initial and subsequent catheter choices and to evaluate for consistency of decision making for each scenario.

Results: 82% of residents performed scenario A; 49% performed scenario B; 64% performed scenario C and 82% performed scenario D. For initial attempt for scenario A-C, the 16 French Foley catheter was the most common choice (38%, 54%, 50%, p 's<.001), whereas for scenario D, the 16 French Coude was the most common choice (37%, p <.01). Residents were most likely to be successful in achieving urine output in the initial catheterization attempt (p <.001). Chi-Square analyses showed no relationship between residents' first and subsequent catheter choices for each scenario (p 's >.05).

Conclusion: Evaluation of clinical decision making shows initial catheter choice may have been deliberate based on patient background, as evidenced by the most popular choice in scenario D. Analyses of subsequent choices in each of the catheterization models reveal inconsistency. These findings suggest a possible lack of competence or training in clinical decision making with regards to urinary catheter choices in residents.

Keywords: Surgical Education, Urinary Catheterization, Surgical Assessment

Introduction:

Every one in four hospitalized patients require a urinary catheter. The most common hospital acquired infection comes from poor urinary catheterization insertion technique or catheter management (1). Increased focus on the education of urinary catheterization aims to significantly decrease morbidity and health care costs associated with these hospital acquired infections (2, 3, 4). Hospitals have adopted stricter indications, reminder systems to remove catheters, standardized algorithms for catheter insertion, and alternative, less invasive urinary catheter types (5, 6). These evidenced based guidelines result in decreased urinary tract infections. Nursing, residents, and staff physicians are instructed to follow these guidelines while inserting and managing urinary catheters (5, 6).

Resident adoption of the guidelines is yet unclear. With increased emphasis on patient safety and the thoughtful public concern of medical errors, surgical education is placed under the scrutiny of excellence and expectations for competency (7). In response, surgical education incorporates simulation in order to provide trainees a safe, patient-free environment to develop procedure-related skills and minimize errors. Additionally, in an effort to standardize education and ensure competency, the American College of Surgeons and Association of Program Directors in Surgery (ACS/APDS) created the Resident Skills Curriculum (8). This curriculum includes a wide variety of basic and advanced skills that are considered essential for the surgical trainee to learn. In this curriculum, urinary catheterization is identified for surgical residents as a phase 1, basic/core skill and task.

While the curriculum sets the expectation that surgical residents achieve competency in urinary catheterization, it appears that surgical residents often defer this task to a Urological service when asked to troubleshoot (9). Catheter insertion is often designated as a nursing task, and residents are often not called until a nurse fails a difficult catheterization scenario. Often when called to attempt urinary catheterization, physicians will prematurely consult a Urology service with no attempt to place a catheter themselves (9). Often times, Urology services, though willing to catheterize, view some of these consults as unnecessary (9). The suggested algorithm developed for the ACS/APDS Resident Skills Curriculum states that for an uncomplicated male or female, a 16 French (Fr) Foley catheter is an appropriate first choice (10). This curriculum then moves forward to provide some suggestions to prevent common errors and maximize success. With premature consultation to Urological services for urinary catheter insertion, it is uncertain if surgical residents have achieved competence.

The aim of this study is to assess the surgical trainee's ability to insert and troubleshoot difficult urinary catheterization scenarios in the setting of common and complex urinary pathology. We hypothesize that during urinary catheterization, residents will make inconsistent decisions relating to catheter choices and clinical presentations.

Materials and Methods:

Setting and Participants

This study took place across seven Midwest general surgery training programs located at tertiary care hospitals. Recruitment focused on surgical residents who were entering their first year of dedicated laboratory research. Clinical residents and research residents in their second year who wished to participate were also allowed to participate. Resident participation was completely voluntary. Data collection occurred either in simulation centers or rented halls of the respective hospital's surgical department. Data was collected from residents over a period of four months. The University of Wisconsin Hospitals and Clinics (UWHC) Institutional Review Board approved this study.

Research Protocol

Residents filled out an initial survey with basic demographic information. After completion, they were directed to the urinary catheter station where a researcher read a standardized introduction to the urinary catheter task. Participants were encouraged to perform the urinary catheterization as they would with a real patient, and were told to verbalize any actions or choices that they would normally perform but could not due to the limitations of the simulation. Residents were presented with a clinical scenario and asked to catheterize three of four simulated urinary catheter models in less than 15 minutes.

Each clinical scenario was common and of varying difficulty: A) female trauma patient with a bladder injury who had bloody urine output with successful urinary catheter insertion, B) a pre-operative female who had labial constriction, C) an elderly male who had complete urinary tract obstruction of unknown etiology, and D) a male patient with partial blockage of the urinary tract secondary to benign prostatic hypertrophy (BPH).

Residents were provided with a full urinary catheterization kit and were told to assume the patient was appropriately prepped and draped. They were allowed five different urinary catheters to catheterize the models, including a 16 French (Fr) Foley, 16 Fr Coude, 16 Fr Three-way, 14 Fr Foley, or 12 Fr Foley catheter. There was no limit to the number of catheter attempts or catheter choices participants were allowed.

Study data were collected and managed using REDCap (11) electronic data capture tools hosted at the University of Wisconsin-Madison, School of Medicine and Public Health. REDCap is a secure, web-based application designed to support data capture for research studies. Data collection focused on the catheter choices, number of catheters used, total attempts at catheterization, attempt number that led to successful urine return.

Data Analysis

Data analyses were performed in SPSS (12). Descriptive statistics and chi-square analyses were performed to explore the relationship between initial and subsequent catheter choices and to evaluate the consistency of participants' decision making for each scenario. A logistic regression was performed to explore the relationship between post graduate year and success of urine return on scenario A.

Results:

A total of forty-five general surgery residents (55.6% female) between post-graduate year two and four ($M = 2.7$, $SD = 0.9$) participated in the urinary catheter simulation. Residents varied in the stage of training they were in: 44.4% of individuals were entering their first research year, 22.2% were entering their second research year, and 33.4% were in their clinical year. 82% of participants performed the scenario with female trauma, 49% performed the scenario with the pre-operative female, 64% performed the scenario with the male with complete blockage, and 82% performed the scenario with the male with BPH.

The 16 Fr Foley catheter was the most popular initial choice for scenario A, B, and C at 38%, 54%, and 52%, respectively ($X^2_{(4)}=13.95$, $p=.007$; $X^2_{(3)}=16.18$, $p=.001$; $X^2_{(3)}=11.69$, $p=.009$). In contrast, the most popular initial choice for scenario D was the 16 Fr Coude at 37% ($X^2_{(4)}=16.92$, $p=.002$). The analyses did not reveal a pattern for subsequent catheter choices after initial catheter failure as one might expect if participants were using a decision tree (Figure 1).

Success rates associated with scenarios

Participants had the highest success rate of bladder catheterization with the pre-op female at 82%. Participants were then most successful in catheterizing the male with BPH at 40%, followed by the female trauma patient at 33%. The male with the complete blockage had no participants with successful bladder catheterization (Figure 2). Successful urine return on the female trauma patient showed a trend of being associated with resident post graduate year (PGY) ($X^2=3.75$, $p=.053$).

For all scenarios where bladder catheterization was achievable, participants were most likely to achieve successful bladder catheterization on their first attempt with their first urinary catheter choice. However, a few residents attempted as many as four catheters and up to five attempts with a single catheter. For the pre-op female, over 60% of participants successfully catheterized the model on their first attempt with their first catheter choice ($X^2_{(2)}=43.03$, $p<.0001$). For participants who failed and made a second attempt with the same catheter, the success was approximately 10%. Even fewer participants had success when switching to the second catheter choice at 5% or less (Figure 2).

Discussion:

As urinary catheterization responsibilities have shifted to nursing staff, resident physicians are often called only in the case of complex catheterizations. This study examined resident clinical decision making during complex urinary catheterization scenarios. We hypothesize that during urinary catheterization, residents will make inconsistent decisions relating to catheter choices and clinical presentations. Our analysis shows that first attempts at catheterization have consistent catheter choices, however, the second and third attempts have inconsistent urinary catheter choices. This suggests that for troubleshooting difficult urinary catheter scenarios, there was not a general logical decision tree amongst participants. For all of the models where catheterization is possible, we expected participants to initially try with a 14 or 16 Fr Foley catheter in the

female models and a 16 Fr Foley in the male model. With initial failures, we then expected upsizing of the catheter, or, request of a Coude. Finally, if the largest catheter offered was used, we hoped that participants would verbalize upsizing to an 18 Fr Foley or Coude (10, 13). These findings may be the product of limited resident skill and education with urinary catheters.

Evaluating Resident Skill

Our analyses do indicate a significant pattern in initial urinary catheter choices. In scenarios A - C, residents favored the 16 Fr Foley catheter first, whereas in scenario D, residents showed a significant preference for the 16 Fr Coude catheter. The size consistency across all urinary catheter scenarios suggests that this is a popular and widely accepted initial catheter size. Choosing a 16 Fr consistently may be the product of previous teaching while in medical school or standardized algorithms adopted by hospitals. We additionally determined that participants tailored their initial catheter type according to the anticipated pathology of a given model. In particular, residents most often chose the Coude catheter first with the patient with known BPH, the only patient with a known urinary tract obstruction. This suggests that residents do strategize their catheter choice given anticipated difficulties and maximize success.

Our data shows that the first catheterization attempt is most likely to predict successful urine return of all the models that were capable. For scenarios A and B, over 50% of participants were successful on the first attempt of catheterization, while follow up attempts with the same catheter showed less success. When participants moved to another catheter in these scenarios, urine return success was still 10% or less. In scenario D, while the initial success rates were not as high, we still saw the general trend that the first attempt was most successful and later attempts with either the same or different catheters being less successful. This observed trend may be a reflection of participant experience. The trend of successful urine return being associated with higher PGY for scenario A supports this hypothesis. More experienced individuals may have a more successful insertion technique compared to those who had multiple attempts with multiple catheters.

The scenario success rates came out differently than expected. Specifically, we did not hypothesize that the pre-op female would have the highest success in urine return. Instead, we expected the female trauma patient to have the highest success rate, followed by the pre-op female, then male with BPH, and finally the male with complete blockage. In the actual design of our study, our pre-op female was modified to enhance the stated pathology of labial constriction, whereas the female with pelvic trauma had no physical modifications. One possibility is that each model came from different manufacturers. There may be inherent differences in the internal design of either product leading to a higher chance of success while catheterizing.

Implications for Resident Training

With increased concerns for patient safety, significant changes have occurred to ensure resident competency in training. For example, in 2007 the ACS/APDS surgical skills curriculum was released and identified urinary catheterization as a phase 1 skill for surgical trainees, expecting that surgical trainees would learn and master this task early in training (10). Despite the expectation of this curriculum, it appears that our participants struggle in performance of this task.

Simulation can be employed to improve resident performance in urinary catheterization in a risk free environment. Residents are allowed infinite chances to practice their technique with no injury to a patient in a self-teaching fashion. Simulation continues to be adopted as a means of teaching in surgical education. Several validation studies show that simulation based training can lead to improved performance and decreased patient morbidity (14, 15, 16). The implications of a decreased complication rate could translate into decreased healthcare spending. A study conducted at a tertiary care facility evaluated the rates of central line associated blood stream infections (CLABSI) after implementing a central line insertion simulation course (17). A significant number of CLABIs were prevented, resulting in a net annual savings of over seven hundred thousand dollars, resulting in a 7:1 return when considering the costs of the intervention (17). Considering the leading cause of hospital acquired infection current in the United States is the urinary tract infection, it follows that proper training with urinary catheterization simulation could translate into significant healthcare savings by decreasing infection rates and injuries resulting from improper technique.

Interestingly, efforts to improve physician education of urinary catheter insertion have increased due to the burden that is placed on Urological services for difficult catheterization scenarios. While urinary catheterization is considered a fundamental skill and often performed by nursing staff, it appears that the majority physicians consult a Urologist for difficult scenarios prior to attempting to place a urinary catheter themselves. In a single institutional study following Urology consultation for urinary catheterization, 72% of physicians had consulted a Urologist without attempting to place a catheter after a nurse failed. Interestingly, 66% of the consulted cases were successful by standard catheterization (9). It appears that the reason for pre-mature Urology consult is multifactorial, including limited experience and poor technique (18). In addition, as our study suggests, residents may have difficulty troubleshooting catheters after initial failure, resulting with a premature consultation to Urology. To prevent unnecessary consultation, a standardized algorithm could be adopted to guide primary service teams to attempt catheterization in straight forward cases, leading to improved efficiency and primary provider performance (9).

While some efforts have been implemented to guide residents and decrease the burden on consulting services for urinary catheterizations, these fail to address the underlying issue of poor technique and limited experience. Moreover, current curricula do not assess resident's skill in addressing difficult scenarios in catheter placement. With the establishment of the ACS/APDS surgical skills curriculum, a reasonable program for urinary catheterization exists for the development, improvement, and maintenance of catheterization skills. This pre-existing curriculum could easily be expanded to include complex and difficult scenarios. Training centers could use this curriculum to ensure competency prior to any patient contact, early in training at the internship level. The implications of this type of intervention could be studied to better understand the full effects on patients, trainees and healthcare outcomes. Of note other well performed studies already show the significant benefit of using simulation to improve performance and patient safety (14, 15, 16).

While successful in addressing the aims of the study, there were some limitations. Consulting Urologists have suggested that our catheter options were limited, and that large sized catheters

should have been made available due to current standard in practice. As we previously state, residents were encouraged to vocalize if they wanted to do something but could not. Only one resident asked for a larger size catheter. No other residents suggested that they would have used a larger catheter. In addition, while our analyses do look at success rates and their association to catheter choice, we are thoughtful of the fact that success also depends on technical skill. Future work may better test resident knowledge by allowing a wider range of urinary catheters that would be provided by verbal request. Doing so would provide further insight on the depth of surgical resident knowledge without the potential guidance of visual cues. Additional work should also focus on technical skill assessment as this may be directly related to participant success rate.

Conclusion:

This study suggests that surgical residents have limited understanding on how to trouble shoot a failed urinary catheterization. It appears that first attempts at catheterization may be well understood, but, troubleshooting in the setting of failure is a skill yet to be developed. Use of simulation and development of standardized algorithms to help develop and maintain resident skill could provide guidance in straightforward scenarios and increase the chances of success.

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Figure 1 Black and White

Figure 1. Most popular initial catheter choice followed by second and third most popular catheter choices when participants fail with initial catheter (* = $p < .01$)

Figure 1 Color

Figure 1. Most popular initial catheter choice followed by second and third most popular catheter choices when participants fail with initial catheter (* = p < .01)

Figure 2

Figure 2. Success rates for scenario performances