

Intervention to reduce unnecessary urinary catheter use in a large academic health science centre: A theory-based process evaluation

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Abstract

Background: Inappropriate use of urinary catheters can increase the risk of catheter-associated urinary tract infections (CAUTI) leading to increased morbidity and increased costs. The overall purpose of this study was to evaluate an intervention to reduce unnecessary urinary catheter use and prevent CAUTI in hospitalized patients across a large academic health science centre.

Methods: This was a two-phase study, which took place between 2017 and 2019. Phase 1 was a pre- and post-intervention design to test the impact of a CAUTI protocol across the organization. Audits on 4 units pre and post were conducted, and data were analyzed descriptively. Phase 2 was a theory-based process evaluation to understand the barriers and enablers to the implementation. Semi-structured interviews were conducted and then analyzed using a systematic approach.

Results: Phase 1: All inpatients with urinary catheters admitted on the four selected units during the study period (n=99, pre) and (n=99, post) were included. CAUTI prevalence rate was 18.2% pre vs 14.1% post (p=.563). Phase 2: participants (n=18) who worked during the study period on the four audit units were interviewed, and a total of 13 barriers and 19 enablers were found across the participant groups.

Conclusion: No statistically significant difference in CAUTI prevalence rates were noted. The theory-based process evaluation provided insights into barriers and enablers to the implementation which may help reformulate the intervention in the future.

Background

Catheter associated urinary tract infections (CAUTI) are common hospital acquired infections [1, 2], and are a major patient safety concern. CAUTI pose a high risk for increased morbidity, mortality, costs, and length of stay [3]. Approximately 25% of all hospitalized patients are catheterized during their stay, and almost half of those are catheterized unnecessarily [3]. In addition, approximately 10% of the catheterized population are diagnosed with a CAUTI [4]. The cost per-case for CAUTI is estimated at 1,000\$ US per patient [5].

Many studies have examined the implementation of evidence-based interventions on catheter use and on CAUTI rates [6–10], and multiple guidelines have been developed by several organizations such as the Society for Healthcare Epidemiology of America (SHEA)/ Infectious Diseases Society of America (IDSA) [11, 12], the Centers for Disease Control and Prevention (CDC) [13], and the Association for Professionals in Infection Control (APIC) [12]. These evidence-based guidelines need to be embedded into all practice settings.

Protocol

The CAUTI protocol was derived from the Centers for Disease Control (CDC) Prevention CAUTI toolkit [14] and consisted of four evidence-based components of care to prevent the risk of CAUTI: (1) the avoidance

of unnecessary urinary catheters, (2) the insertion of catheters using aseptic technique, (3) the care and maintenance of urinary catheters based on recommended guidelines, and (4) the review of urinary catheter necessity daily and prompt removal.

Previous pilot work on the general internal medicine units at a large academic health science centre showed a decrease in the incidence of catheter use from approximately 25% of patients down to 12–15% after implementation of a standardized protocol [15]. This was also associated with decreased antibiotic prescribing for catheter-associated bacteriuria on these units, which was sustained for over a year [15]. Based on these positive pilot study results, this intervention was expanded across the organization. The overall purpose of the current study was to evaluate an intervention to reduce unnecessary urinary catheter use and prevent CAUTI in hospitalized patients across a large academic health science centre.

Methods

This two-phased study took place between 2017 and 2019. Phase 1 was a pre- and post-intervention design to test the impact of the intervention to reduce CAUTI in hospitalized patients. Phase 2 was a theory-based process evaluation to understand the barriers and enablers to the implementation. All participants in phase 2 provided written informed consent. Research Ethics Board approval was obtained.

Setting

A total of four inpatient units (A, B, C and D) not originally part of the pilot were selected to participate. These four units were selected because they had the highest rates of indwelling catheters in the hospital. The population on each unit was primarily as follows: vascular surgical patients (unit A), orthopedic surgical patients (unit B), thoracic surgical patients (unit C) and general surgical patients (unit D).

PHASE 1: Pre- and post-intervention

Design and study population

To evaluate the effectiveness of the protocol, a pre- and post-intervention study design was used. The study population included all inpatients with urinary catheters admitted on the four units during the study period.

Procedures and data collection

The CAUTI protocol was implemented using the 4 Es (Engagement, Education, Execution and Evaluation) of Translating Evidence into Practice model [16] as a framework. Resources such as pre-printed order forms and a variety of education materials (i.e., posters, presentations) were developed. Two registered nurses (LF and LD) from the Nursing Professional Practice Department conducted train-the-trainer workshop for CAUTI champions focused on the risk factors associated with indwelling catheters, recommended prevention and dissemination interventions, and competency-based catheter insertion

technique. The workshop was held during a Nurse Educator Forum. Physician co-investigators (KW and DH) presented the protocol at the Resident Orientation Day. Nurse Educators incorporated the education through their unit specific in-services. Registered nurses (LF, LD) also conducted targeted education strategies for clinical staff to support the Nurse Educators as requested. An article was also published in the hospital journal and educational posters were placed on all the units to help create awareness of the protocol. The urinary catheter protocol was made widely available for use in emergency department and the units hospital-wide.

Weekly catheter audits took place pre- and post-implementation to ensure a regular review of catheter necessity for all inpatients with urinary catheters. Data were collected from patients' charts by two trained research assistants (DCY and LCB). Data collected included documented evidence of: (1) a CAUTI protocol in the chart, (2) a urinary catheter in place, (3) signs and symptoms such as fever (38 degree celcius and above), rigor, altered mental status, malaise, etc, and (4) urine culture results. The specific data elements can be found in Supplementary file 1.

Data analysis

Patient characteristics (including service, age, sex, acute length of stay, Elixhauser score, presence of post-operative UTI, UTI diagnosis, urine test positive culture) during the audit periods were compared pre and post using the hospital administrative database. Descriptive statistics including mean, median and/or standard deviation were used to summarize the patient characteristics. Independent t-tests were used for continuous data (e.g., age) and chi square was used for dichotomous data (e.g., pre- and post-intervention CAUTI prevalence rates) to make comparisons on outcomes. A p-value of ≤ 0.05 was considered statistically significant. Data was analyzed in the Statistical Package for the Social Sciences version 26.0 (IBM Corp. Released 2019. IBM SPSS Statistics for Macintosh, Version 26.0. Armonk, NY: IBM Corp.).

PHASE 2: Theory-based process evaluation

Design and study population

We conducted a descriptive qualitative study with physicians and staff to assess barriers and enablers to the implementation of the indwelling urinary catheter intervention. All nurses, physicians, Unit Managers, Nurse Educators and Clinical Care Leaders who worked during the study period on the four audit units were invited to participate.

Data collection

The Unit Managers and the physician leads (KW, DH) sent a recruitment email to the staff and physicians, respectively. The research assistant (DCY) also visited the units during daytime working hours to recruit potential participants. Individuals who expressed an interest in participating were approached by the research assistant to further explain the study. After informed consent was obtained, 30 to 45-minute audio-recorded semi-structured interviews were conducted by the trained research assistant (DCY). The

interviews, guided by the 14 domains in the Theoretical Domains Framework (TDF) [17–19], were conducted either in person or by phone. The semi-structured interview guide can be found in Supplementary file 2.

Theoretical Domains Framework

The Theoretical Domains Framework (TDF) is a robust and integrative theoretical framework, developed by health psychologists and health services researchers, based on a synthesis of 33 behaviour change theories, clustered into 14 theoretical domains [17, 18]. The TDF was developed for implementation research across multiple disciplines, and use in behaviour change research [17–19]. The framework was validated with behaviour change experts [18] and has been used to investigate barriers and enablers to intervention implementation in variety of clinical situations including: blood transfusion [20], pre-operative testing [21], hand hygiene compliance [22], screening in the emergency department [23], and electronic fetal health surveillance [24]. The TDF, to our knowledge, has not been used in implementation studies addressing CAUTI.

Data analysis

Descriptive statistics, such as means and standard deviations were used to summarize the characteristics of the participants. Interviews were transcribed verbatim, and were analysed using NVivo qualitative data analysis software (NVivo qualitative data analysis software; QSR International Pty Ltd. Version 12, 2018). Interviews were analyzed using a 6-step approach [22]: coding, generation of specific beliefs, identification of themes, aggregation of themes into categories, assignment of barrier or enabler to each of the categories and analysis for shared, discipline-specific and conflicting barriers and enablers. Specifically, the approach consisted of the following steps. First, two reviewers independently (MC and KD) coded the participant transcripts by assigning text segments to relevant domains of the TDF. Discrepancies were resolved through discussion until consensus was met. Second, specific belief statements were generated within each domain of the TDF for the coded segments of text, and then similar belief statements were grouped together. Belief statements are short statements that summarize and represent the underlying themes. Third, themes were generated inductively from the grouped belief statements. Fourth, themes were then grouped into broad categories. Fifth, each theme was classified as either a barrier or an enabler to using the CAUTI protocol. Sixth, themes were examined in relation to whether they were shared barriers and enablers (shared was defined as a similar statement mentioned by two or more individuals), discipline-specific (e.g nurses, physicians, managers), or conflicting barriers and enablers. Theming was done first within and then across domains. Frequency scores were calculated for the number of participants describing each barrier and enabler.

Results

PHASE 1: Pre- and post-intervention

Patient characteristics

Using the hospital administrative database, we compared patient characteristics pre- and post-implementation of the protocol (Table 1). The demographics of participants were similar across the measurement periods except for greater number of patients on the medical service ($p < 0.001$), and a longer acute length of stay ($p = 0.005$) post-intervention. Approximately half of patients were female, and the average age of the participants was 64 ± 17 years old in both the pre and post-intervention group.

Table 1
Patient characteristics (audit units)

Variable	Pre-intervention 2017-05-01– 2017-06-30	Post-intervention 2018-01-01– 2018-02-28	p-value
Encounters (unique)	1166	971	
Patients (unique)	1117	934	
Service			
Acute Medical	<=5 (0.4%)	30 (3.1%)	< 0.001
Acute Surgical / Planned Surgery	1,161 (99.6%)	941 (96.9%)	
Age			
Mean ± SD	63.79 ± 17.16	64.12 ± 16.75	0.655
Median (IQR)	66 (53–76)	66 (55–75)	0.968
Sex			
F	600 (51.5%)	486 (50.1%)	0.517
M	566 (48.5%)	485 (49.9%)	
Acute Length of Stay			
Mean ± SD	5.32 ± 5.00	5.95 ± 5.34	0.005
Median (IQR)	4 (2–7)	4 (2–8)	0.001
Elixhauser Score*			
Mean ± SD	2.37 ± 5.02	2.67 ± 5.30	0.176
Median (IQR)	0 (0–2)	0 (0–4)	0.073
NSQIP Flag**	67 (5.7%)	66 (6.8%)	0.317
NSQIP Post-Operative UTI***	0 (0.0%)	0 (0.0%)	

* Overall score calculated based on the 31 comorbidity indicators [25]

** Cases available in the National Surgical Quality Improvement Program (NSQIP) database

*** Patients who developed a symptomatic urinary tract infection within 30 days after the principal operative procedure in the NSQIP database

**** Patients with post admit diagnosis of urinary tract infection during inpatient hospital admission

***** Patients who had a positive urine culture (colony count > 100,000/ml urine) during admission

Variable	Pre-intervention 2017-05-01– 2017-06-30	Post-intervention 2018-01-01– 2018-02-28	p-value
UTI Diagnosis****	<=5 (0.4%)	<=5 (0.5%)	0.771
Urine test positive culture*****	9 (0.8%)	16 (1.6%)	0.061
* Overall score calculated based on the 31 comorbidity indicators [25]			
** Cases available in the National Surgical Quality Improvement Program (NSQIP) database			
*** Patients who developed a symptomatic urinary tract infection within 30 days after the principal operative procedure in the NSQIP database			
**** Patients with post admit diagnosis of urinary tract infection during inpatient hospital admission			
***** Patients who had a positive urine culture (colony count > 100,000/ml urine) during admission			

Audits

Data were collected on patients who had an indwelling urinary catheter n = 198 (pre n = 99, post n = 99). The audit results can be found in Table 2.

Table 2
Audit results (all 4 units)

Variable	Pre-intervention (June 2017)	Post-intervention (January 2018)	p-value
Patients with assessed indwelling urinary catheter	99	99	
Patients with a documented catheter in last 48 hrs	83 (83.8%)	98 (99.0%)	0.000
Catheter inserted in the ED	8 (8.0%)	6 (6.0%)	0.783
Protocol form completed in chart	n/a	12 (12.1%)	
Patients with culture results available	44 (44.4%)	46 (46.5%)	0.887
Patients with positive culture	32 (32.3%)	32 (32.3%)	1.000
CAUTI prevalence	18 (18.2%)	14 (14.1%)	0.563

Overall, the prevalence of CAUTI rates were 18.2% pre vs 14.1% post, but the difference was not statistically significant (p = .563).

PHASE 2: Theory-based process evaluation

In phase 2, we recruited a total of 18 participants (n = 18), 4 were male (22.2%) and 14 were female (77.8%) to participate in the semi-structured interviews. More than half of the participants were nurses (n = 10, 55.6%). Additional demographic information is available in Table 3.

Table 3
Participant characteristics

Characteristics	Nurse (n = 10)	Physician* (n = 3)	Managers** (n = 5)	Total (n = 18, 100%)
Gender				
Male	3	1	0	4 (22.2%)
Female	7	2	5	14 (77.8%)
Highest educational level				
College	2	0	0	2 (11.1%)
Bachelor degree	8	0	3	11 (61.1%)
Medical school	0	2	0	2 (11.1%)
Master's degree	0	1	2	3 (16.7%)
Years of experience on unit				
< 1	0	0	1	1 (5.6%)
1–5	4	3	1	8 (44.4%)
6–10	4	0	2	6 (33.3%)
11–15	2	0	1	3 (16.7%)
16+	0	0	0	0 (0%)
*includes 1 physician assistant based on role at the hospital				
**includes clinical care leader, educator, and unit manager				

Using the TDF [17–19], the barriers and enablers related to the use of the CAUTI protocol to manage patients with urinary catheters were identified.

Relevance

All 14 TDF domains were relevant to the use of the CAUTI protocol. More beliefs reflected enablers (n = 19) compared to barriers (n = 13).

Shared themes between two people or two provider groups

Shared themes are defined as being barriers or enablers that are shared by at least two people or shared between two different provider groups.

Barriers

There were a total of 13 barriers across 11 TDF domains. The top three (3) barriers to the implementation of the CAUTI protocol were: (1) **competing priorities or time constraints** (n = 11, 61.1%), (2) **patient characteristics, preferences, and previous patient history** (n = 10, 55.6%), (3) **availability of the protocol** (n = 8, 44.4%); **confusion with the protocol overlapping with other orders related to catheters** (n = 8, 44.4%).

Table 4 provides further details of the barriers.

Table 4
Barriers to CAUTI intervention

Overarching Barriers Across Domains	Frequency Within Theme		Domains	Who Said It?	Example Quote
	(n)	%			
Competing priorities or time constraints*	11	61.1	Environmental Context and Resources; Goals	RN, Managers, Physician	R: You have four patients and one's going to get discharged, so patients going to the OR would take priority, discharges of patients will take priority. Moving patients will take priority. Giving meds will get priority. So, you know, it is a priority but there are a lot of other things to compete with it. (Participant 5, Manager)
Patient characteristics, preferences, and previous patient history (e.g. difficult catheterization, pain, retention issues, immobility, existing UTI/catheter)	10	55.6	Memory, Attention and Decision Processes; Environmental Context and Resources; Social Influences	RN, Physician	R: Patients who dribble, patients who have urinary retention problems, patients who have– but never had have had a clinical long-term catheter in. Doctors will always say, you know, try this, try this technique, just keep working on it. And, at some point you're going, well if you're dealing with skin breakdown, you're dealing with... dignity, nursing time care. So, in order– if I just put a catheter in, all the problems are solved. (Participant 16, RN)

* in the table denotes both a barrier and an enabler

Overarching Barriers Across Domains	Frequency Within Theme		Domains	Who Said It?	Example Quote
	(n)	%			
Availability of the protocol (not available, or cannot get signed by physician)	8	44.4	Social/ Professional Role and Identity; Environmental Context and Resources	RN, Managers	R: Well, I really feel that this stems from the physician side, to be honest, because they're the ones who have to actually make the order or write the order. So, I really feel that it would be beneficial for them to complete it as soon as the surgery's finished, to be honest. Like if the patient's just had surgery, they're not on a clinical pathway, I think they should pull that PPO and sign it off. You know, that's as simple as it gets. And from a nursing perspective, I think don't be beaten down by the fact that it's not being completed. Keep trying. Keep trying. And get the message across, saying look, this is going to save you phone calls from me you know. I didn't... I used this on my patient two weeks ago and I didn't have to call three times because these three steps of the algorithm I was able to follow. (Participant 10, Manager)
Confusion with protocol overlapping with other orders related to catheters*	8	44.4	Environmental Context and Resources	RN, Managers, Physician	R: Honestly, the form in and of itself, I think probably... do you want some feedback from that... I think has a lot of information in it. Can seem intimidating at times but when you really look at it, there's less boxes than there are fingers on like one hand to be able to count. So maybe the visualization of it can sometimes push people off or push people away, but that would be my only thing that I have to say about it. It just looks very busy. (Participant 14, Physician)
More paperwork not seen as beneficial	5	27.8	Beliefs about Consequences; Emotion	RN, Managers, Physician	R: We do it every day we reassess. Do they need the Foley? So, every morning at rounds if the patient has a Foley, it's on our discharge board, and we discuss it. Do they still need it? Why would they need it? If they don't, let's pull it and try to do a trial void. So, I don't think the actual physical thing on orthopedics is beneficial. (Participant 9, Manager)

* in the table denotes both a barrier and an enabler

Overarching Barriers Across Domains	Frequency Within Theme		Domains	Who Said It?	Example Quote
	(n)	%			
High patient turnover and high volume of patients with catheters	5	27.8	Environmental Context and Resources	RN, Managers	R: Is it going to be the same tomorrow? I don't know. This is the surgical floor. We have a fast-pace of patient turnover, so... (Participant 7, RN)
Protocol not always relevant	5	27.8	Environmental Context and Resources; Intentions	RN, Physician	R: I think there's a little bit of a grey area where I think it's a little bit less practical or relevant to our particular population. (Participant 14, Physician)
Not trained	3	16.7	Environmental Context and Resources; Skills	RN, Physician	I: Did you receive any training or information on this protocol? R: No. Well, training yes, but the protocol isn't necessarily anything new, it's just a compilation of what we've been taught. Just like a composition of everything that they taught, right? I: Right. R: So, this specific protocol, no. (Participant 16, RN)
I have not used the protocol*	3	16.7	Social/ Professional Role and Identity	RN, Physician	R: I guess it's a way to standardize things so everybody's on the same page, although I don't really use it... I've never actually went out of my way to take it and initialize it. (Participant 3, Physician)
Do not intend to call for signature or to complete the protocol	2	11.1	Intentions	RN	R: ...but I'm not calling the doctor to sign the protocol. You say like he's just going to do, "Okay, in and out him." (Participant 1, RN)
Need for a reminder*	2	11.1	Memory, Attention and Decision Processes	RN	R: Sometimes when you're busy you don't remember all these things. Plus, if I see this, the truth is if they back this here, it's not going to click my head to say oh, I have one. I'm just going to go with this because it's in my care plan. (Participant 7, RN)

* in the table denotes both a barrier and an enabler

Overarching Barriers Across Domains	Frequency Within Theme		Domains	Who Said It?	Example Quote
	(n)	%			
Not aware of protocol*	2	11.1	Knowledge	RN, Physician	R: I don't know exactly what's on the protocol, to be honest. I just... in terms of length, like is that what you mean? (Participant 3, Physician)
Previous experience (e.g. with finding protocol, patients with catheters without UTIs)	2	11.1	Reinforcement	RN	R: I have had– I've never had a patient with ins and outs, personally, that's had a UTI. I think I've had one. You know, dealing with medicine patients, nursing home patients. Surgery patients are our bread and butter so most of them will not have catheters, but there are the some. But I find it in my experience, not research based; UTIs from a catheter are fairly rare in our practice of surgery. I don't deal with medicine patients so much, and often I find doctors will go with the research to say avoid it because it causes a UTI. In my experience goes, you save a lot of clinical time, dignity, and potential other risks beyond just a UTI by just putting the catheter in. (Participant 16, RN)
* in the table denotes both a barrier and an enabler					

Enablers

There was a total of 19 enablers across 12 TDF domains. The three most common enablers were: (1) **knowing the benefits of using the protocol** (n = 16, 88.9%), (2) **the importance of education and training** (n = 13, 72.2%); **the protocol being all-inclusive, easy and ready for use** (n = 13, 72.2%); **easy access to the protocol** (n = 13, 72.2%), and (3) **the awareness and agreement with the evidence** (n = 12, 66.7%). Table 5 provides further details of the enablers.

Table 5
Enablers to CAUTI intervention

Overarching Facilitators Across Domains	Frequency Within Theme		Domains	Who Said It?	Example Quote
	(n)	%			
Knowing the benefits of using the protocol (e.g. decreased UTIs, decreased costs, improved knowledge, improved nursing autonomy, improved patient flow - not chasing doctors, standardized care, justification for catheter)	16	88.9	Beliefs about Consequences; Social/ Professional Role and Identity; Goals; Optimism; Reinforcement	RN, Managers, Physician	<p>R: Because sometimes if you look back through orders and charts people will just write DC Foley, or reinsert Foley, and they don't have any sort of note as to why there's a catheter in there... it's just keeping people on track with whether or not they're following the protocol with respect to should we be trialling void on this patient, or continuing bladder scan to make sure that we can get the Foley out as soon as possible. (Participant 18, Physician Assistant)</p> <p>R: The doctors are aware that instead of doing in and out six, every six hours, the first... like in the pathways, it's just per protocol and the protocol signed. We do first, we make sure the patient retained, because by bladder scan them how much it is. Then after that we just do the, the protocol. Put it in... put it in the care plan and use it. When it's not needed, then we see, without calling the doctor, because once they sign it, they are giving us the authority to do what we think best for the patient. (Participant 1, RN)</p>

* in the table denotes both a barrier and an enabler

Overarching Facilitators Across Domains	Frequency Within Theme		Domains	Who Said It?	Example Quote
	(n)	%			
Importance of education and training	13	72.2	Behavioural Regulation; Environmental Context and Resources; Skills	RN, Managers, Physician	R: I think just educating the people that need it the most; mostly the doctors, residents. And just making them aware that the protocol is there so that it makes everything so much easier. Because you're going to be calling for a catheter insertion anyways, so instead of writing it out you can just tick the box and sign it that away. (Participant 17, RN)
Protocol all-inclusive, easy and ready for use*	13	72.2	Beliefs about Capabilities; Environmental Context and Resources; Skills	RN, Managers, Physician	I: And how easy or difficult would you say it is? R: It's easy because we already know it. It's not new information. (Participant 11, RN) I: Do you think that the protocol is all inclusive and applies to all patients? R: Probably, I mean it doesn't specify anything about orthopedic procedures... Otherwise I think it pretty much covers everything of reasons why you'd have a catheter. (Participant 18, Physician Assistant)
Easy access to the protocol (improving flow, simplifying, automating e.g. pre-signed in chart, placed with other orders/ pathways)	13	72.2	Behavioural Regulation	RN, Managers, Physician	R: It is signed already. When you need it, you just take it out and you just co-sign it and you just show why you need it and then assess it. I think that's a good idea, like in emerge or in the OR... if you are having it, like assess, the protocol is always there. (Participant 1, RN)
Awareness and agreement with the evidence	12	66.7	Beliefs about Consequences; Knowledge	RN, Managers, Physician	R: In theory I agree with it... they'll avoid catheters to a certain degree to avoid a UTI. (Participant 16, RN)

* in the table denotes both a barrier and an enabler

Overarching Facilitators Across Domains	Frequency Within Theme		Domains	Who Said It?	Example Quote
	(n)	%			
Influence by other team members to use the protocol (e.g. through role modeling)	10	55.6	Social/ Professional Role and Identity; Environmental Context and Resources; Social Influences	RN, Managers, Physician	R: Allied health could be useful for sure because they're mobilizing the patients. They're moving them around in rooms, especially in thinking of the physiotherapy in particular on our unit. If we could get them on board to say, 'Okay, I want to mobilize this patient. Do they really need that catheter?' 'Can we get that out of there?' (Participant 10, Manager)
Intention to use the protocol, or already use the protocol *	8	44.4	Intentions; Memory, Attention and Decision Processes; Social/ Professional Role and Identity	RN, Physician	I: So, do you think following the protocol is automatic or do you need to remember, to be reminded to use it? R: If I do it, I'll remember. If it's in the care plan, I'll remember to do it. That's just the truth. If I have an order here, I'm going to go back to this. If I have an order here, I'm not going to think about it. (Participant 7, RN)
Triggers (e.g. order in chart, seeing nurse educator, patient has a catheter) and reminders help me remember	8	44.4	Behavioural Regulation; Memory, Attention and Decision Processes	RN, Managers, Physician	R: Sometimes people just need a reminder and I think that's probably the case, and just to reiterate the importance of why we're trying to use the protocol. (Participant 18, Physician Assistant)
Confidence about using protocol	7	38.9	Beliefs about Capabilities	RN, Physician	I: How confident do you feel using the protocol? R: I know it inside and out and I like it. So, I use it. (Participant 17, RN)

* in the table denotes both a barrier and an enabler

Overarching Facilitators Across Domains	Frequency Within Theme		Domains	Who Said It?	Example Quote
	(n)	%			
Some of my colleagues agree	6	33.3	Social/ Professional Role and Identity	RN, Physician	<p>I: And, do you think your colleagues agree with the use of the protocol?</p> <p>R: It's variable. So, some of the resident physicians I work with use it all the time and some of the resident physicians I don't think know that it exists. So, it's quite variable on depending which team working with. (Participant 18, Physician Assistant)</p>
Increase buy-in and awareness (e.g. discuss at rounds)	5	27.8	Behavioural Regulation	Managers, Physician	<p>R: I'd say probably kind of what I was saying before, just having the whole team kind of being on board with it and making sure that the nurses are aware about the protocol. Having the physicians educated on the use of the protocol. And, just kind of the team, whole team supporting it, I think that's the way to get it to be promoted. (Participant 18, Physician Assistant)</p>
Emotions influence its use (e.g. worry if do not use)	4	22.2	Emotion	RN, Physician	<p>I: Does not using the protocol ever evoke any worry or concern?</p> <p>R: Yes. You wonder if the protocol isn't used, at what point would be triggering what thought process. Right? Because I'm not always here, you're here 40 hours, let's say, actively on the unit a week. But you have many more hours during the day so yeah, the protocol does give some sort of like sense of security that the stuff will get done for sure. (Participant 14, Physician)</p>

* in the table denotes both a barrier and an enabler

Overarching Facilitators Across Domains	Frequency Within Theme		Domains	Who Said It?	Example Quote
	(n)	%			
No negative aspects	4	22.2	Beliefs about Consequences	RN, Managers	<p>I: Do you think there's any other negative aspects to using the protocol?</p> <p>R: Hmm, I can't think of anything that's negative about it. (Participant 17, RN)</p>
Automatically use it*	4	22.2	Memory, Attention and Decision Processes	RN, Physician	<p>I: Do you have any triggers to remembering to use it?</p> <p>R: I think it's been drilled into my head for the last 10 months that I know. (Participant 11, RN)</p>
No influence from family/patient	3	16.7	Social Influences	RN, Physician	<p>I: Do you think patients and families influence the use of this protocol?</p> <p>R: No, I don't think so, no. They wouldn't know about it, they would just know that my fathers supposed to have a catheter or not, and that's about it. (Participant 16, RN)</p>
Nurses typically initiate the protocol and discussions about removing catheters (seen as nursing role)	2	11.1	Social/ Professional Role and Identity	RN	<p>I: Do you think any other team members influence the use of the protocol? So like allied health for an example.</p> <p>R: Not really that I've seen. Mostly just nurses initiating and, yeah, I can't say I've ever an MD initiate. It's just, just nursing really. (Participant 13, RN)</p>

* in the table denotes both a barrier and an enabler

Overarching Facilitators Across Domains	Frequency Within Theme		Domains	Who Said It?	Example Quote
	(n)	%			
Awareness and role clarity (who should be initiating, using)	2	11.1	Environmental Context and Resources	RN, Managers	R: All I know is that the doctors didn't know how to use that sheet and no one knew how long we should keep it in and then the nurse ended up wanting to take it out because the doctor ordered it out and it was very confusing for everyone. So, on that sheet, it's hard to tell who's supposed to be assessing what, whether it's all the nurse or whether it's the physician. (Participant 2, RN)
There are no competing tasks/priorities*	2	11.1	Environmental Context and Resources	RN, Managers	I: Are there any competing tasks or time constraints that you find influence the use of it? R: No. Not the actual task of like doing our in and out catheters or removing Foleys, but I mean the paper if it's there, no. (Participant 11, RN)
Aware of protocol*	2	11.1	Knowledge	RN, Physician	I: So, are you aware of the protocol? R: Yes. (Participant 1, RN)

* in the table denotes both a barrier and an enabler

Conflicting themes

In certain instances, themes were identified as both a barrier and an enabler depending on the participants' responses. A total of 5 themes were conflicting including: (1) **competing priorities**: participants (n = 10, 55.6%) identified competing priorities or time constraints as a barrier, whereas other participants (n = 2, 11.1%) felt that there were no competing tasks or priorities (an enabler); (2) **protocol use**: Participants (n = 3, 16.7%) did not use the protocol (a barrier) however, others (n = 8, 44.4%) intended to use or had already used the protocol (an enabler); (3) **awareness of protocol**: Participants (n = 2, 11.1%) stated that they were aware of the protocol (an enabler), and (n = 2, 11.1%) were not (a barrier); (4) **protocol clarity**: Participants (n = 8, 44.4%) felt that the protocol was confusing and overlapping with other orders (a barrier) whereas (n = 13, 72.2%) stated that the protocol was all-inclusive, easy and ready for use (an enabler); and (5) **remembering to use the protocol**: Participants (n = 2, 11.1%) needed a reminder (a barrier) whereas (n = 4, 22.2%) were automatically using it.

Nurse-specific themes

Registered nurses were the only key informant group to describe discipline specific beliefs. There were three nurse-specific barriers (n = 3) and one enabler (n = 1). The barriers included: (1) **do not intend to call for signature or to complete the protocol** (n = 2, 11.1%), (2) **need for a reminder** (n = 2, 11.1%), (3) **previous experience** (i.e, with finding protocol, patients with catheters without UTIs) (n = 2, 11.1%). The nurse-specific enabler was that **nurses typically initiate the protocol and initiate the discussions about catheter removal** (seen as nursing role) (n = 2, 11.1%).

Discussion

Summary of the findings

Overall, our findings showed the difficulties in implementing a CAUTI protocol across a large academic health science centre. In phase 1, our findings demonstrated that the implementation intervention did not work across the four audit units. Phase 2 was put in place as a theory-based process evaluation to help us improve the implementation process, whether it was successful or not. The benefit of performing a process evaluation is that in cases such as this where despite the evidence that this protocol worked in another setting [26, 27], and did not work at our hospital we can gain insight into why this was the case.

Meddings and colleagues [28] evaluated interventions to reduce catheter use and CAUTIs. They found that interventions to reduce unnecessary catheter use were successful, and they also identified the importance of addressing socioadaptive factors [28]. These socioadaptive strategies, which focused primarily on enhancing attitudes and behaviors related to CAUTI, included leadership, staff, and patient engagement, and enhanced communication [29]. Another systematic review of interventions to reduce catheter-related infections found that all interventions had some form of education as a key component [30].

In our study, although education was a key component, other components were lacking to address the main barriers determined during the process evaluation. Strategies targeting the identified barriers need to be implemented [31]. This could include better integration of the protocol with current processes. For example, a possible method to mitigate competing priorities and time constraints of the CAUTI protocol could be to model the practice by a peer expert and conduct audit and feedback at the individual level. In order to reduce the confusion with protocol overlapping with other orders related to catheters, a redesign of the process specifically in light of the recent changes to an electronic health record system at the hospital. The CAUTI protocol could be incorporated into the electronic documentation. This may also reduce the number of steps for physicians to manually obtain and fill out the order sheet. We also identified the need for tailoring the protocol to the needs of local units. For example, on the surgical and orthopedic units, the CAUTI protocol needed to be embedded into the existing clinical pathways. We also needed to ensure that the protocol was always available. Development of tools for providers to educate patients on catheter use as well as information resources for patients. According to a systematic review

[32], no single intervention can be recommended to effectively reduce CAUTI. Therefore, the identification of barriers and enablers will not only help improve the intervention in a local context, but will also help other institutions looking to implement similar protocols.

Strengths and limitations

This study included a broad range of providers to better gain insight on the implementation issues. A clear limitation was the low uptake of the intervention, which was further explained by the process evaluation. The audits were done only on four units, which may not represent the uptake of the intervention across all the other units. Only four themes were discipline specific and therefore could be a reflection of the sample size. This study also highlights the challenges in scaling up quality improvement work. Even though something worked in a different service line in a hospital it does not necessarily translate to a different service line implying the need for true local efforts as being part of the “secret sauce” for quality improvement.

Conclusion

This study used multiple methods to evaluate the implementation of the CAUTI protocol across a large academic health science centre. No statistically significant differences in CAUTI prevalence rates were noted pre- and post-intervention. The theory-based process evaluation provided insights into barriers and enablers to the implementation which may help reformulate the intervention in the future. This study also emphasized the need for everyone in the interdisciplinary team to work together to increase patient safety.

Declarations

Ethics approval and consent to participate: Approval was obtained from the Ottawa Hospital Research Ethics Board.

Consent for publication: Not required

Availability of data and material: No additional data are available.

Competing interests: None declared.

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Authors' contributions: CB was a major contributor in writing the manuscript. All co-authors were involved in the design of the project and critically appraised and edited the manuscript. All authors read and approved the final manuscript.

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