Chapter 9. Reducing Unnecessary Urinary Catheter Use and Other Strategies To Prevent Catheter-Associated Urinary Tract Infections: Brief Update Review

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Introduction

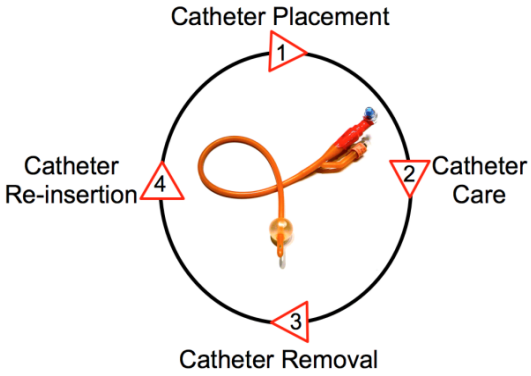
Urinary tract infection has long been considered the most common healthcare-associated infection (HAI), with the vast majority of these infections occurring after placement of the convenient, often unnecessary,[1-3] and easily forgotten urinary catheter.[4] With an estimated one million catheter-associated urinary tract infections[5] (CAUTIs) per year, associated with an additional cost of $676 per admission (or $2836 when complicated by bacteremia),[6] it is not surprising that CAUTIs were among the first hospital-acquired conditions selected for non-payment by Medicare as of October 2008,[7] and have been further targeted for complete elimination[8] as a "never event," with a national goal to reduce CAUTI by 25% and reduce urinary catheter use by 50% by 2014.[9,10] These national initiatives renewed public and research interest in the prevention of CAUTI, prompting updates of several comprehensive guidelines[11-14] and reviews of strategies to prevent CAUTI released since the 2001 "Making Health Care Safer" report.[15]

What Strategies May Prevent Catheter-Associated Urinary Tract Infections?

Similar to other hospital-acquired infections — such as central line-associated blood stream infection (CLABSI) — many CAUTI prevention strategies have been "bundled" into multi-modal sets of interventions known as "bladder bundles,"[16] consisting of educational interventions to improve appropriate use and clinical skill in catheter placement, behavioral interventions such as catheter restriction and removal protocols, and use of specific technologies such as the bladder ultrasound. Despite some early success in implementing a "bladder bundle"[16] to reduce urinary catheterization rates,[17] CAUTI prevention has proven challenging for several important reasons. For example, monitoring urinary catheter use and CAUTI rates to inform and sustain urinary catheter-related interventions is very resource intensive. Perhaps more importantly, improving practice regarding urinary catheter placement and removal also requires interventions to change the expectations and habits of nurses, physicians, and patients about the need for urinary catheters.

To help organize and prioritize the many potential interventions to prevent CAUTI, we use the conceptual model of the "lifecycle of the urinary catheter"[18] to highlight that the highest yield interventions to prevent CAUTI will target at least one of the four "stages" of the catheter's "life." As illustrated in Figure 1, the "lifecycle" of the catheter (1) begins with its initial placement, (2) continues when it remains in place, day after day, (3) ceases when it is removed, and (4) may start over if another catheter is inserted after removal of the first one.

Figure 1, Chapter 9. Lifecycle of the urinary catheter[18]
This conceptual model illustrates four stages of the urinary catheter lifecycle as targets for interventions to decrease catheter use and catheter-associated urinary tract infections.



Meddings J, Saint S. Disrupting the Life Cycle of the Urinary Catheter. *Clin Infect Dis.* 2011; 52(11): 1291-3 by permission of Oxford University Press.

Because avoiding unnecessary urinary catheter use is the most important goal in prevention of CAUTI, this chapter reviews the evidence on two types of interventions that target unnecessary urinary catheter use: (1) protocols and interventions to decrease unnecessary *placement* of urinary catheters (catheter lifecycle stage 1), and (2) interventions that prompt *removal* of unnecessary urinary catheters (catheter lifecycle stage 3).

The evidence summarized in this chapter was generated using a literature search conducted for a prior systematic review and meta-analysis[19] along with a focused update of the published peer-reviewed literature (from August 2008 to February 2012) through a MEDLINE search for intervention studies to reduce use of unnecessary urinary catheters in the acute care of adults. A CINAHL database search was also performed for interventions developed and implemented by nurses related to urinary catheter use. Studies were included if at least one outcome involving catheter use or CAUTI events (Table 1) was reported as a result of the intervention, and with a comparison group (either pre- vs. post-intervention or a separate control group).

Table 1, Chapter 9. Description of outcomes evaluated (adapted from the prior meta-analysis[19])

Measures of Catheter-Associated Urinary Tract Infection (Cauti) Development	**Number of CAUTI episodes per 1,000 catheter-days** was recorded and a rate ratio was calculated to compare pre- vs. post-intervention. When rates of both asymptomatic and symptomatic CAUTI were reported separately,[20] the rates of symptomatic CAUTI were used for the meta-analysis.[19]
	Cumulative risk of CAUTI during hospitalization (i.e., **the percentage of patients who developed CAUTI**) was also extracted for each study, and a risk ratio was calculated to compare risks before and after the intervention for the meta-analysis.[19]
Measures of Urinary Catheter Use	**Mean number of days of urinary catheter use per patient** was recorded before and after the intervention, and a standardized mean difference (SMD) was calculated to compare the two groups for the meta-analysis.[19]
	Percentage of patient days in which the catheter was in place was calculated before and after the intervention, and a standardized mean difference (SMD) was determined for each study for the meta-analysis.[19]
	Daily catheter prevalence**,** defined as the number of patients with catheters in place during a specific time period, is reported for some of the more recent studies.
Need for Catheter Replacement	***Re-catheterization need*** was extracted as the number and percent of patients who required replacement of a catheter after prior removal of an indwelling catheter.

The table in Appendix D summarizes the intervention studies described in this review, including study designs, patient populations, and the interventions employed to avoid unnecessary catheter placement or to prompt catheter removal.
Meddings J, Rogers MA, Macy M, et al. Systematic review and meta-analysis: reminder systems to reduce catheter-associated urinary tract infections and urinary catheter use in hospitalized patients. Clin Infect Dis. 2010;51(5):550-60 by permission of Oxford University Press.

What Strategies May Reduce Unnecessary Catheter Use?

Strategies To Avoid Unnecessary Placement of Indwelling Urinary Catheters

Simply put, patients without urinary catheters do not develop CAUTI. Yet, multiple studies show that between 21 and 63 percent[1,3,21-24] of urinary catheters are placed in patients who do not have an appropriate indication and therefore may not even need a catheter. Over the past decade, several studies have employed interventions to decrease unnecessary catheter placement (described in Appendix D Table). Although educational interventions are a common and important first step to decrease inappropriate catheter use, more effective and potentially more sustainable interventions go a step further by instituting restrictions on catheter placement. Protocols that restrict catheter placement can serve as a constant reminder for providers about the appropriate use of catheters, can suggest alternatives to indwelling catheter use (such as condom catheters or intermittent straight catheterization), but perhaps most importantly, can generate accountability for placement of each individual urinary catheter. A fairly typical approach for developing a catheter restriction protocol is to begin with a basic list of appropriate catheter uses (such as provided in the Centers for Disease Control and Prevention's Healthcare Infection Control Practices Advisory Committee (HICPAC) guideline[11]); this list (Table 2) can then be tailored to include other indications based on local opinion and specialized patient populations.

Table 2, Chapter 9. Indications for indwelling urethral catheter use (from the 2009 CDC's guideline[11])

A. Examples of *Appropriate* Indications for Indwelling Urethral Catheter Use
Patient has acute urinary retention or bladder outlet obstruction
Need for accurate measurements of urinary output in critically ill patients
Perioperative use for selected surgical procedures: • Patients undergoing urologic or other surgery on contiguous structures of genitourinary tract • Anticipated prolonged surgery duration; catheters inserted for this reason should be removed in post-anesthesia care unit • Patients anticipated to receive large-volume infusions or diuretics during surgery • Need for intraoperative monitoring of urinary output
To assist in healing of open sacral or perineal wounds in incontinent patients
Patient requires prolonged immobilization (e.g., potentially unstable thoracic or lumbar spine, multiple traumatic injuries such as pelvic fractures)
To improve comfort for end of life care if needed
B. Examples of *Inappropriate* Uses of Indwelling Catheters
As a substitute for nursing care of the patient or resident with incontinence
As a means to obtain urine for culture or other diagnostic tests when patient can voluntarily void
For prolonged postoperative duration without appropriate indications (e.g., structural repair of urethra or contiguous structures, prolonged effect of epidural anesthesia, etc.)

The technology required to implement catheter placement restrictions ranges from low technology strategies such as a hospital or unit policy on appropriate catheter placement or pre-printed catheter orders with limited indications to higher technology strategies such as computerized orders[22,23,25] for catheter placement. Catheter restriction protocols have been a common component of successful multi-modal interventions to decrease catheter use and/or CAUTI rates, including hospital-wide[23] interventions and interventions tailored for specific environments such as the emergency department,[21,26] inpatient units[17] (including general medical[25,27,28]-surgical[29] wards and ICU[29-33]), and in the peri-procedural[32] setting. Urinary retention protocols[22,28,29,32-34] are a type of catheter restriction protocols that often incorporate the use of a portable bladder ultrasound[22,28,32,34,35] to verify retention prior to catheterization, and recommend use of intermittent catheterization rather than indwelling catheters to manage a common and often temporary issue.

Strategies To Prompt Removal of Unnecessary Urinary Catheters

Urinary catheters are commonly left in place when no longer needed.[3,24] In most hospitals, four steps are required to remove a urinary catheter:[18] (1) a physician recognizes the catheter is in place, (2) the physician recognizes the catheter is no longer needed, (3) the physician writes the order to remove catheter, and (4) a nurse removes the catheter. Thus, by default, hours and sometimes days may pass before an unnecessary catheter is recognized and removed. Because every additional day of urinary catheter use increases the patient's risk of infectious and non-infectious catheter-related complications, interventions that facilitate prompt removal of unnecessary catheters can have a strong impact. We describe below the evidence regarding strategies that may accelerate or bypass some of these four steps to prompt catheter removal.

Perhaps the most important CAUTI prevention strategy after placement of the catheter is to maintain awareness of the catheter's existence (in lifecycle stage 2 of Figure 1), as health care providers commonly forget the catheter is in place.[4] Thus, a key step in prompting removal of unnecessary catheters is frequently (by day or by shift) reminding nurses and physicians that the catheter remains in place. Catheter reminder interventions include a daily checklist[23,32,33,36,37] or verbal/written reminder[31,38-42] to assess continued catheter need, a sticker reminder on the patient's chart[35,43,44] or catheter bag,[45] or an electronic[23] reminder that a catheter is still in place.

Reminder interventions can be generated by nurses, physicians or electronic order sets, and can be targeted to remind either nurses or physicians about the catheter. Some reminder interventions have employed nurses dedicated to detecting unnecessary catheters.[23,35] Reminder interventions can also serve to remind clinicians of appropriate catheter indications.

Unfortunately, reminder interventions can also be easy to ignore[43] and catheters may remain in place without action. The next type of intervention to prompt removal of unnecessary catheters, which goes a step further, is a "stop order" that requires action. Stop orders prompt the clinician (either nurse or physician) to remove the catheter by default after a certain time period has elapsed or condition has occurred, unless the catheter remains clinically appropriate. For example, catheter stop orders can be configured to "expire" in the same fashion as restraint or antibiotic orders, unless action is taken by a clinician. Stop orders directed at physicians[23,25,28,30,42] require an order to be renewed or discontinued on the basis of review at specific intervals, such as every 24 to 48 hours after admission or post-procedure. Stop orders directed at nurses either require the nurse to obtain a catheter removal order from physicians,[27,32,46] or can empower nurses to remove the catheter without requesting a physician order[20,28,30,34,47-49] on the basis of an appropriate indication list. Admittedly, implementing a nurse-empowered catheter removal protocol may be less effective than anticipated, as early qualitative research of nurse-empowered interventions indicate some nurses are uncomfortable with this autonomy[49] and might not remove catheters as expected.

What Is the Impact of Strategies To Avoid Unnecessary Urinary Catheter Use?

Impact of Interventions To Avoid Unnecessary Catheter Placement

Multiple before-and-after studies of interventions to decrease inappropriate catheter placement (such as catheter placement restrictions and urinary retention protocols) have resulted in a decrease in the use of urinary catheters,[21-23,28,29,31,33] a lower proportion of catheters in place without a physician order[21,23,25,26] and a reduction in the proportion of catheters in place without an appropriate indication.[21,23,26,28]

Impact of Reminder and Stop Order Interventions on Catheter Use and CAUTIs

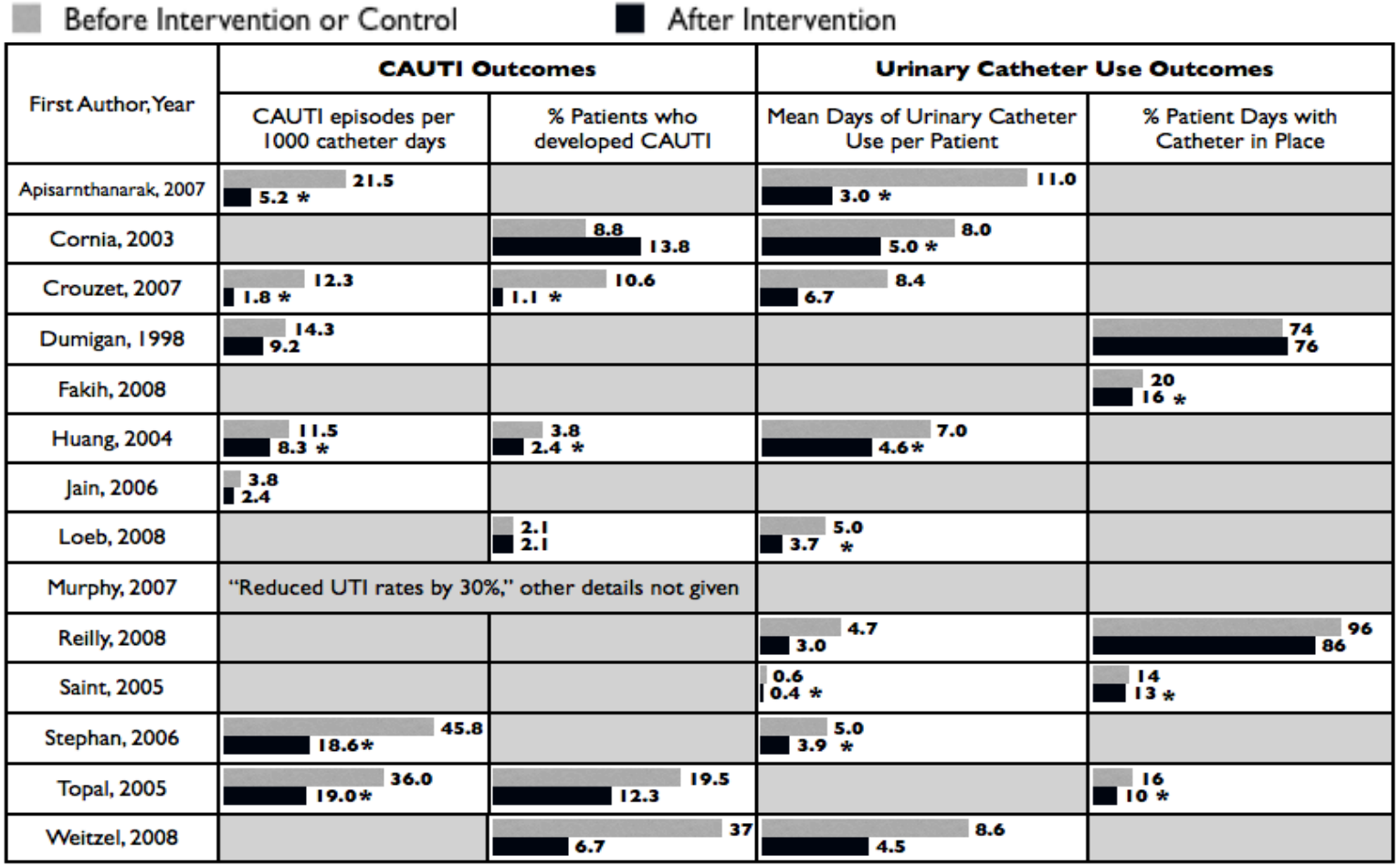
A systematic review and meta-analysis of 14 studies[19] published prior to August 2008 (including nine reminder interventions and five stop order interventions) demonstrated that the rate of CAUTI (episodes per 1,000 catheter-days) was reduced by 52 percent ($p<0.001$) with the use of either a reminder or stop order. Based on this meta-analysis, reminders and stop orders could result in large numbers of avoided CAUTI episodes per 1,000 catheter-days, particularly when baseline rates of CAUTI are high (Table 3, adapted from a previous meta-analysis[19]).

Table 3, Chapter 9. Number of avoided CAUTI episodes per 1,000 catheter-days

Baseline rate of CAUTI episodes per 1,000 catheter-days	Number of avoided CAUTI episodes per 1,000 catheter-days anticipated by the type of intervention to prompt catheter removal		
	Reminder	Stop order	Overall
5	2.8	2.0	2.6 (95%CI, 1.6–3.6)
10	5.6	4.1	5.2 (95%CI, 3.2-7.2)
20	11.2	8.2	10.4 (95%CI, 6.4-14.4)

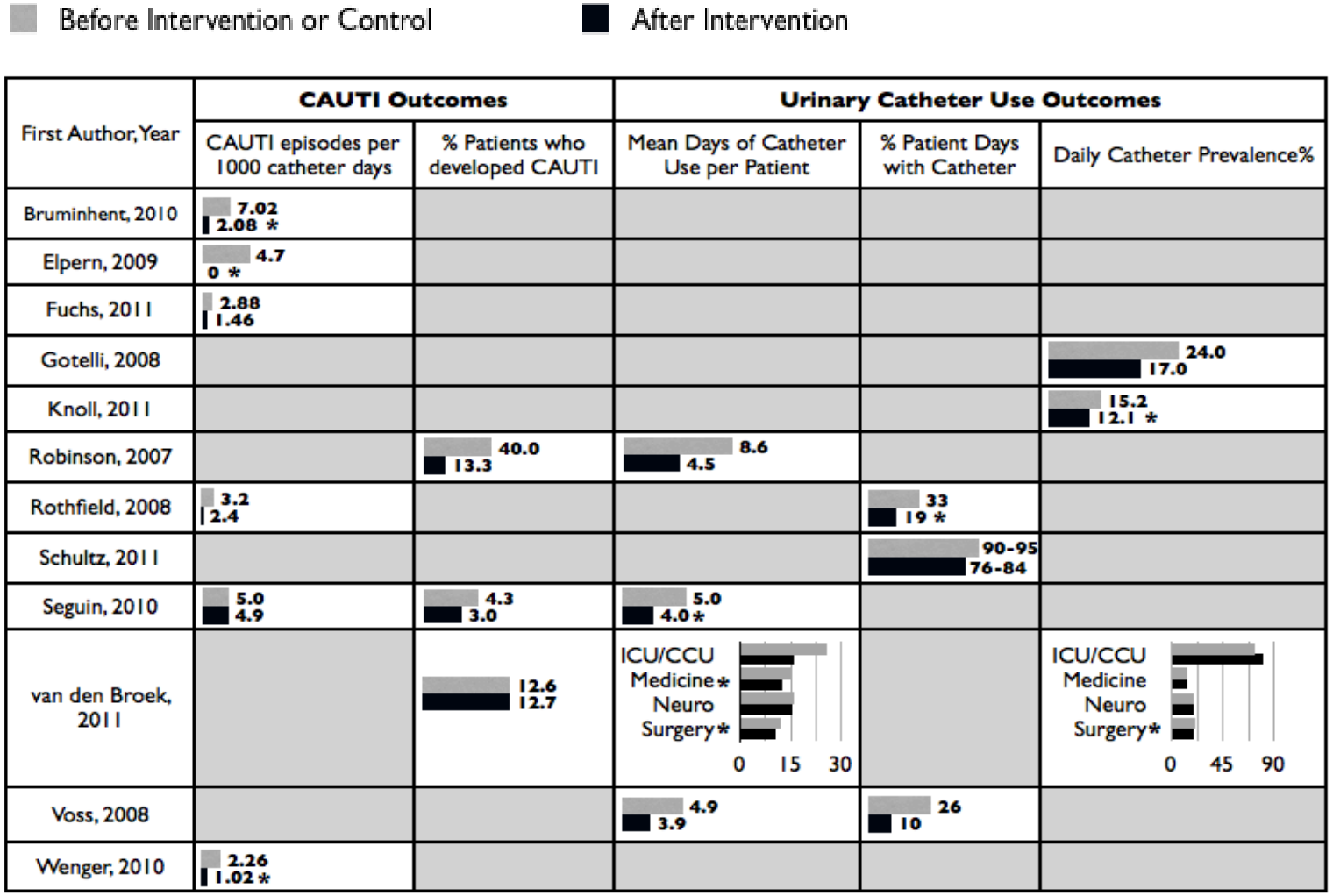
This meta-analysis[19] also suggested that the mean duration of urinary catheterization decreased by 37 percent, with 2.61 fewer days of catheterization per patient in the intervention vs. control groups. The pooled standardized mean difference (SMD) in the duration of catheterization was -1.11 overall (p=0.070); a statistically significant decrease in duration was observed in studies that used a stop order (SMD -0.30; p=0.001) but not in those that used only a reminder intervention (SMD -1.54; p=0.071).[19] An update of the literature review since this meta-analysis yielded 12 additional studies with reminder and/or stop order interventions. Figure 2 illustrates the major findings of the 14 studies for catheter use and CAUTI events as reported in the prior meta-analysis;[19] Figure 3 illustrates the major findings for the 12 subsequent studies, including eight that reported measures of catheter use, and eight that reported CAUTI events.

Figure 2, Chapter 9. Summary of CAUTI and urinary catheter outcomes from 14 studies



Note: Summary comes from the 14 studies[20,25,28-30,33,36-41,43,45] included in the 2010 meta-analysis.[19]
*Difference of $p<0.05$ reported between intervention and comparison group.

Figure 3, Chapter 9. Summary of CAUTI and urinary catheter outcomes from 12 additional studies



Note: Summary comes from 12 additional studies[23,27,31,32,34,35,42,44,46-49] since the prior meta-analysis.[19]
*Difference of $p<0.05$ reported between intervention and comparison group.

Potential for Unintended Harm by Catheter Removal Interventions

Interventions that facilitate removal of urinary catheters do pose the risk of premature urinary catheter removal, with patients then requiring unnecessary recatheterization; any catheterization event is associated with procedure-related discomfort and other potential complications. Thus, monitoring the need for re-catheterization is important to avoid unintended patient harm. In the meta-analysis of reminder and stop order studies, only four of the 14 studies reported rates of re-catheterization[20,25,39,43] with low re-catheterization rates noted in both intervention and control groups. None of the 12 more recent studies involving reminders or stop orders to prompt catheter removal reported data on potential patient harm, such as premature removal.

Summary of Other Strategies To Prevent CAUTI

Several recent evidence-based guidelines[11-14] have focused on preventing CAUTI and have assessed the evidence and provided recommendations for implementing prevention strategies. Key recommendations in the CDC guideline,[11] in addition to appropriate catheter use (Table 2), include (1) aseptic insertion of urinary catheters by properly trained personnel, using aseptic technique and sterile equipment (with an exception being that clean technique is appropriate for chronic intermittent catheterization), and (2) proper urinary catheter maintenance with a sterile, closed drainage system permitting unobstructed urine flow. Aseptic insertion is primarily recommended as a standard of care for which limited evidence exists. Stronger evidence (epidemiological and clinical) supports the importance of a sterile, closed, unobstructed urinary drainage system.

A more controversial topic is the use of antimicrobial catheters. Based on the current evidence, the CDC guideline recommends[11] that antimicrobial catheters should not be used routinely to prevent CAUTI. It also suggests that further research is needed both on the effect of silver-alloy coated catheters in reducing the risk of clinically significant CAUTI outcomes and on the benefit of silver-alloy coated catheters in selected patients at high risk of infection.

Bundles of interventions are also an important strategy, as part of a multi-modal approach that focuses efforts on high-yield interventions. For example, one strategy that includes several of the components from the "Bladder Bundle" implemented by the Michigan Health and Hospital Association (MHA) Keystone Center for Patient Safety & Quality is the "ABCDE" approach:[16]

- **A**dherence to general infection control principles is important (e.g., hand hygiene, surveillance and feedback, aseptic insertion, proper maintenance, education).
- **B**ladder ultrasound may avoid indwelling catheterization.
- **C**ondom catheters or other alternatives to an indwelling catheter such as intermittent catheterization should be considered in appropriate patients.
- **D**o not use the indwelling catheter unless you must!
- **E**arly removal of the catheter using a reminder or nurse-initiated removal protocol appears warranted.

What Is the Cost of Implementing a CAUTI Prevention Program?

The cost of implementing a CAUTI prevention program will vary based on the level of technology used (e.g., computerized vs. pre-printed catheter orders, and whether portable bladder ultrasounds are purchased) and the time invested in implementing and evaluating the interventions. Saint and colleagues, in their study of a written urinary catheter reminder

generated by a research nurse to remind physicians which of their inpatients had urinary catheters,[43] found that the intervention was either cost-neutral or modestly cost-saving depending on the assumptions made. More recently, a study[35] of five hospitals in the Netherlands employed a multi-modal intervention including reminders in four hospitals, and a stop order in the fifth hospital. The program was found to be cost-saving, with the mean amount saved being € 537 (or ~$700) per 100 hospitalized patients.

What Methods Have Been Used To Improve the Implementation of Interventions To Prevent Catheter-Associated Urinary Tract Infections?

Because reducing unnecessary catheter use often requires changing well-established habits and beliefs of nurses and physicians, the challenge of implementation should not be under-estimated. To facilitate implementation of practices to prevent CAUTI, the Michigan Keystone Bladder Bundle Initiative[16] used the Johns Hopkins University collaborative model for transformational change. This model is based in part on the "four E's": Engage, Educate, Execute, and Evaluate.[50] During the "Engage" and "Educate" steps, hospitals were provided information in multiple formats and a toolkit describing the intervention steps and outcomes measures. In the "Execute" step, the hospital was strongly encouraged to choose one nurse champion[51] (for example, a case manager, nurse coordinator, or clinical nurse specialist) to lead the initiative and organize a bladder bundle team, including at least one physician, and to participate in workshops and conference calls with other participating hospitals to provide additional expert content and practical coaching. Also during the "Execute" step, daily patient rounds (which in some hospitals were called a "catheter patrol") were recommended to assess catheter presence and necessity, and provide feedback to specific units and re-evaluate strategies in progress. Hospitals were also encouraged to implement more active strategies for prevention, such as a catheter reminder system or promoting the use of catheter alternatives by developing protocols or making sure the necessary supplies were readily available. In the "Evaluate" phase, hospitals were asked to conduct a baseline assessment of catheter use (point prevalence) and appropriate use according to specified indications and to conduct periodic reassessments to assess progress and sustainability.

Implementation challenges within CAUTI prevention should be expected[52] and managed accordingly. Qualitative assessment focusing on HAI prevention has identified two important potential barriers to healthcare-associated infection preventive efforts: "active resisters" and "organizational constipators."[53] Active resisters are hospital personnel who vigorously and openly oppose changes in practice, as a matter of habit or culture (e.g., "just not how they were trained"). Management of active resisters often requires those in authority to mandate compliance, collect data, and provide feedback.[53] A "champion" who is influential or a peer of the resisting staff may also help to overcome active resistance.[51,52] "Organizational constipators" are usually mid- or high-level executives who act as barriers to change by preventing or delaying certain actions needed to implement new practices.[53] Strategies to address an organizational constipator are to include this person in early discussions to improve buy-in and motivation, working around the person, or replacing the constipator.

A unique challenge to expect when implementing urinary catheter removal strategies is reluctance by some nurses to remove the catheter,[52] even when the nurse is "empowered" to do so. In some cases, nurses may be active resisters due to disagreement with the catheter policy

and/or a desire to avoid the inconveniences and increased frequency of patient contact required for the care of incontinence and catheter alternatives. Other nurses report they simply do not feel comfortable[49] removing the catheter without explicit orders from the physician, which is ironic considering that many nurses place catheters without orders. Nursing comfort with catheter removal can be increased[49] with peer support and education, and may be facilitated by directly addressing the workload concerns associated with the removal of indwelling catheters. Indeed, a survey of nurses[27] during implementation of a nurse-empowered catheter removal protocol indicated increased nursing and patient satisfaction, despite the expected increase in workload.

Even though CAUTI is a very common healthcare-associated infection, Krein and colleagues reported that CAUTI preventive practice use is lagging behind efforts to prevent central line-associated bloodstream infection and ventilator-associated pneumonia,[54] with room for improvement in adopting catheter removal and CAUTI preventive strategies demonstrated again in two recent large surveys of hospitals[55] and ICUs.[56] Fortunately, many resources exist (www.Catheterout.org) to help hospitals develop and implement programs to decrease catheter use and prevent CAUTI, including a range of tools and educational materials to address implementation challenges. Hospital and unit-level leadership also play a key role in preventing infection.[57]

Monitoring and Providing Feedback on Catheter Use and CAUTI Rates

Inappropriate urinary catheter use is an easy habit to start and a difficult one to break.[18] Consequently, many studies[17,30] have emphasized the importance of on-going surveillance and feedback as an intervention to reduce healthcare-associated infections such as CAUTI and sustain prevention efforts. New national efforts to reduce CAUTI (www.onthecuspstophai.org/stop-cauti/) incorporate periodic feedback to participating units on urinary catheter use and CAUTI rates. The CAUTI rates evaluated include the National Healthcare Safety Network (NHSN) and the newly described population-based rates.[58] The population-based CAUTI rate incorporates both the NHSN rate and the device utilization ratio, to account for interventions focused on reduction in catheter use and improvements in placement and maintenance.

Important next steps to address CAUTI involve developing strategies to decrease the effort and resources required to monitor catheter use and CAUTI rates. Advanced informatics tools have recently been shown to increase the impact of this feedback loop to the extent that rates of CAUTI were lower in facilities that deployed these tools compared with those that did not.[59] Careful selection or development of datasets used for implementing hospital payment changes and public reporting for CAUTI events is also recommended. Unfortunately, the current administrative data used to implement non-payment[7] for hospital-acquired CAUTIs and to publicly report hospital performance likely captures few CAUTI events, given documentation and coding challenges[60] to translate a urinary tract infection event from a medical record into hospital-acquired CAUTI in the administrative datasets.

Conclusions and Comment

In summary, hospitals should strongly consider employing interventions to avoid unnecessary catheter placement and to prompt removal of unnecessary catheters. These interventions appear to be low cost, low risk and effective strategies to address a common

hospital-acquired infection in the United States, with some unique but not impossible challenges for implementation. Furthermore, reducing indwelling catheter use addresses the noninfectious complications of urinary catheter use such as catheter-related patient discomfort and immobility (Table 4).

Table 4, Chapter 9. Summary table

Scope of the Problem Targeted by the PSP (Frequency/Severity)	Strength of Evidence for Effectiveness of the PSPs	Evidence or Potential for Harmful Unintended Consequences	Estimate of Cost	Implementation Issues: How Much do We Know?/How Hard Is it?
Common/Moderate	Moderate-to-high	Low	Low	Moderate/Moderate

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