ORIGINAL ARTICLE

# Quality Gaps in Documenting Urinary Catheter Use and Infectious Outcomes

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OBJECTIVE. To describe the frequency of use of all types of urinary catheters, including but not limited to indwelling catheters, as well as positive cultures associated with the various types. We also determined the accuracy of catheter-days reporting at our institution.

DESIGN. Prospective, observational trial based on patient-level review of the electronic medical record. Chart review was compared with standard methods of catheter surveillance and reporting by infection control personnel.

SETTING. Ten internal medicine and 5 long-term care wards in 2 tertiary care Veterans Affairs hospitals in Texas from July 2010 through June 2011.

PARTICIPANTS. The study included 7,866 inpatients.

METHODS. Measurements included patient bed-days; days of use of indwelling, external, suprapubic, and intermittent urinary catheters; number of urine cultures obtained and culture results; and infection control reports of indwelling catheter-days.

RESULTS. We observed 7,866 inpatients with 128,267 bed-days on acute medicine and extended care wards during the study. A urinary catheter was used on 36.9% of the total bed-days observed. Acute medicine wards collected more urine cultures per 1,000 bed-days than did the extended care wards (75.9 and 10.4 cultures per 1,000 bed-days, respectively; $P < .0001$). Catheter-days were divided among indwelling-catheter-days (47.8%), external-catheter-days (48.4%), and other (intermittent- and suprapubic-catheter-days, 3.8%). External catheters contributed to 376 (37.3%) of the 1,009 catheter-associated positive urine cultures. Urinary-catheter-days reported to the infection control department missed 20.1% of the actual days of indwelling catheter use, whereas 12.0% of their reported catheter-days were false.

CONCLUSIONS. Urinary catheter use was extremely common. External catheters accounted for a large portion of catheter-associated bacteriuria, and standard practices for tracking urinary-catheter-days were unreliable.

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Catheter-associated urinary tract infection (CAUTI) is one of the most common hospital acquired infections, and its prevention has become a salient topic in health care.[1] However, as CAUTI and its prevention receive greater emphasis, quality gaps in documentation are becoming apparent.[2] These include use of labor-intensive, unreliable approaches to urinary catheter monitoring based on individual recall and paper documentation as well as omission of several catheter types from the surveillance definition of CAUTI. The Joint Commission for Hospital Accreditation has designated implementation of evidence-based practices to prevent CAUTI among the new 2012 National Patient Safety Goals, including monitoring for proper insertion and maintenance of urinary catheters.[3] Furthermore, many other healthcare agencies have recommended new initiatives to prevent CAUTI by reducing urinary catheter use.[1,4-7] Awareness and reliable documentation of urinary catheters are central to CAUTI-prevention goals and accurate reporting. In the current climate of public reporting of hospital-acquired infections, it is particularly important that reported rates be accurate, because they may influence public policy, Medicare reimbursement, and consumer choice. Finally, it is not clear that the existing infrastructure (chiefly infection preventionists) can absorb the new workload created by CAUTI patient-safety goals.[8,9]

Another quality gap in documenting and reporting CAUTI is that only infections resulting from indwelling, transurethral (Foley) catheters meet the National Healthcare Safety Network (NHSN) definition for CAUTI.[10] However, multiple options exist for draining the urinary bladder, including external or condom collection systems (in men), in-and-out cathe-

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terization (also known as intermittent catheterization), and suprapubic catheters. Because these catheters are not included in standard surveillance, little is known about their frequency of use and associated infection rates.[11] Both condom and intermittent catheterization have been recommended as alternatives to indwelling catheterization and as key strategies for preventing CAUTI.[1,12] Because the emphasis on reducing urinary catheter use is likely to increase the use of condom catheters in many settings, documenting rates of use and associated infections is warranted.

We report 1 year of surveillance at 2 tertiary care medical centers for frequency of use of all types of urinary catheters as well as their associated infection rates. We also report on the accuracy of reporting catheter-days by the infection control (IC) department compared with a previously validated (criterion standard) method.

## METHODS

### Settings

This study was conducted in 10 hospital wards in the Michael E. DeBakey Veterans Affairs (VA) Medical Center in Houston, Texas, and 5 hospital wards at the South Texas Veterans Health Care System in San Antonio, Texas. The Houston wards include 5 acute general medicine (MCL) wards and 5 extended care line (ECL) units, which provide skilled nursing or long-term nursing home care. The 5 San Antonio wards include 3 MCL wards and 2 ECL units. Surveillance occurred from July 2010 to June 2011 in Houston and September 2010 to June 2011 in San Antonio. The study was approved by both institutions' institutional review boards.

### Chart Review Surveillance for Catheter Use and Urine Cultures

We have previously published and validated our method for urinary-catheter surveillance by standardized chart review for both indwelling Foley and condom catheters.[13] Throughout the observation year of this report, study personnel conducted bedside visits periodically to ensure the same level of accuracy of chart review (results not shown).[13]

The chart review of the electronic medical record was performed 5 days per week by a standard protocol. The observed patient bed-days were obtained on the basis of the daily roster of patients and used as the denominator of our catheter surveillance reports. If a urinary catheter was reported in the chart, the type of urinary catheter in place on the day of urine culture was recorded as one of the following types: indwelling Foley (transurethral), external (condom), suprapubic, or intermittent catheterization. We also recorded all urine cultures sent from patients on monitored wards; these were considered catheter associated if the patient had been catheterized for at least 48 hours before urine collection or if the patient's urinary catheter had been removed within 48 hours before urine collection.[5] Our definition of a positive urine culture was one for which the microbiology laboratory reported bacterial or fungal growth. The cutoff point for reporting a positive urine culture result in our institution is $10^3$ colony-forming units/mL of urine or greater; this is also the threshold for CAUTI according to Infectious Diseases Society of America guidelines (IDSA).[5] For simplicity, we define bacteriuria as present in individuals with a positive urine culture result.

### IC Surveillance for Urinary-Catheter-Days

Throughout the study, the infection preventionists (ie, IC nurses not on the research team) at both sites collected data on and reported rates of use of indwelling catheters to the VA Inpatient Evaluation Center (IPEC) quarterly, in accordance with standard practice. Other urinary catheter types are not monitored, in accordance with NHSN guidelines.[10] IPEC analyzes inpatient data and provides feedback to providers and managers to improve patient outcomes. Thus, catheter-days reported to IPEC become the publicly reported data on urinary-catheter use and the denominators for rates of CAUTI at each facility. During the study, ECL wards were reporting individual patient data on catheter use to infection preventionists, whereas acute medicine wards reported the number of catheter-days to IC on a ward level without providing information on which specific patients had catheters. Thus, we have patient-level data for the comparison of our surveillance methods with IC reporting only for the ECL wards. However, the nursing staff on both types of units used the same protocol to report catheter-days to IC. Specifically, catheter use data were collected by the charge nurse or ward clerk by querying nursing staff. Each ward then sent a monthly report on catheter use to the local facility's IC office; these compiled reports were in turn sent to IPEC by infection preventionists. The IC reports reviewed in this study were collected from July through December 2010 in Houston and from September through December 2010 in San Antonio; start dates were determined by when the facility began collecting this information.

### Analyses and Measures of Agreement

*Analyses for catheter surveillance and positive cultures.* Using the Mann-Whitney rank-sum test, we compared the number of catheter-days per 1,000 bed-days between medical and ECL wards for the various catheter types. We tested whether urine cultures collected from catheters were more likely to be positive than cultures from patients without catheters using the $\chi^2$ statistic. The null hypothesis was that bacteriuria rates would be equal in these 2 urine sample groups. Similarly, $\chi^2$ tests were used to assess whether statistically significant differences existed between indwelling and condom-catheter specimens with respect to the percentage of positive cultures. SigmaPlot and SAS, version 9.2, were used for the analysis (SAS Institute).

*Analyses for accuracy of IC reports.* To assess the accuracy of catheter-device-days reported by IC personnel, we compared their documented indwelling-catheter-days with

indwelling-catheter-days captured by chart review, which was our criterion standard. This comparison focused only on indwelling catheters, because IC does not monitor other catheter types. Our measures of agreement between the 2 methods of determining whether a patient had a urinary catheter included the overall simple agreement as well as the diagnostic accuracy (ie, sensitivity, specificity, and predictive values) of IC reports versus our criterion standard, again using the VassarStats web site for statistical computing,[14] which uses the efficient-score method of Newcombe.[15]

## RESULTS

### Bed-Days, Unique Patients, and Frequency of Urinary Catheter Use

During 12 months of observation in Houston and 10 months of observation in San Antonio (using chart review in both locations), we reviewed 7,866 unique inpatients who accounted for 128,267 bed-days, fairly evenly split between acute care medical wards and extended care wards (Table 1). Catheters of any type were in use on 47,393 (36.95%) of 128,267 bed-days observed. Indwelling catheters were in use for 17.7% of these total bed-days, whereas condom catheters were in use for 17.9%. By site, 75.6% of the catheter-days reported were from Houston, whereas 24.4% were from San Antonio. The total number of unique patients reviewed at each site was 4,960 for Houston and 2,906 for San Antonio. Indwelling catheters and external condom catheters each accounted for just under half of total catheter-days (47.8% and 48.4%, respectively). The total number of days in which a urinary catheter of any type was in use was lower on the medicine wards (34.7%) than on the ECL wards (39.2%; $\chi^2 = 330.9$, $P < .0001$). However, indwelling catheter use was significantly more common on acute medical wards, whereas condom catheter use was more common on ECL wards (Table 1).

### Numbers of Urine Cultures from Various Catheter Types and Their Associated Rates of Infection

A total of 5,571 urine cultures were collected from monitored wards (4,912 from acute medicine and 659 from ECL), including 2,173 positive cultures (38.9%). During the period of observation, 43.4 urine cultures were collected per 1,000 bed-days (Table 2). By ward, the medical wards collected more urine cultures per 1,000 bed-days than did the long-term wards (75.9 and 10.4, respectively; $\chi^2 = 38.99$, $P < .0001$). Overall, 1,061 urine cultures were collected from patients with indwelling catheters; 489 were collected from patients with condom catheters. Of 1,611 cultures collected from catheterized patients (28.9% of all urine cultures), 1,009 (62.6%) were positive. Of the 1,242 cultures obtained from catheterized patients in the acute wards, 682 (54.9%) had positive results. This contrasts with the 369 cultures obtained from catheterized patients in the ECL wards, of which 327 (88.6%) had positive results ($\chi 2 = 138.1$, $P < .0001$). Urine cultures collected from catheters were more likely to be positive than were urine cultures that were not associated with catheters (62.6% vs 29.4%; $\chi^2 = 530.9$, $P < .001$; Table 2). Indwelling catheters accounted for most cases of catheter-associated bacteriuria (57.8% of cases) among the 1,009 patients with positive specimens collected from catheters, but condom-catheter-associated bacteriuria contributed a significant proportion of catheter-associated bacteriuria as well (37.4%). Indwelling catheter specimens were less likely to be positive than were condom catheter specimens (Figure 1).

### Accuracy of Catheter-Days Reporting by IC

The overall bed-days included in the reporting accuracy comparison were 21,504 (Table 3), all from ECL wards, because patient-level reporting of urinary catheter use was confined to these wards during the observation period. With chart review as the gold standard, an indwelling catheter was in

TABLE 1. Urinary Catheter Use, by Ward Type, Facility, and Type of Catheter

| Variable | Overall catheter-days ($n$ = 128,267 bed-days) | | | Medical ward catheter-days ($n$ = 64,699 bed-days) | | | Extended care ward catheter-days ($n$ = 63,568 bed-days) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total | Per 1,000 bed-days | % | Total | Per 1,000 bed-days | % | Total | Per 1,000 bed-days | % | $P$[a] |
| Catheter type | | | | | | | | | | |
| All | 47,393 | 369.5 | ... | 22,466 | 347.2 | ... | 24,927 | 392.1 | ... | <.0001 |
| Indwelling (Foley) | 22,658 | 176.6 | 47.8 | 13,116 | 202.7 | 58.4 | 9,542 | 150.1 | 38.3 | <.001 |
| External (condom) | 22,954 | 179.0 | 48.4 | 8,817 | 136.3 | 39.2 | 14,137 | 222.4 | 56.7 | .001 |
| Suprapubic | 1,403 | 10.9 | 3.0 | 270 | 4.2 | 1.2 | 1,133 | 17.8 | 4.5 | .755 |
| Intermittent | 378 | 2.9 | 0.8 | 263 | 4.1 | 1.2 | 115 | 1.8 | 0.5 | <.001 |
| Facility | | | | | | | | | | |
| Houston | 35,841 | 387.3 | 75.6 | 15,602 | 358.1 | 69.4 | 20,239 | 413.3 | 81.2 | |
| San Antonio | 11,552 | 323.3 | 24.4 | 6,864 | 324.9 | 30.6 | 4,688 | 321.1 | 18.8 | |

NOTE. Data shown in this table were collected using chart review.

[a] $P$ value is for the comparison of catheter-days per 1,000 bed-days between medical wards and extended care wards, based on the Mann-Whitney rank-sum test.

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TABLE 2. Total Urine Cultures Collected, Standardized by Bed-Days, and Standardized by Catheter-Days

| Variable | Total cultures | Cultures per 1,000 bed-days | Cultures per 1,000 catheter-days | Percentage of all urine cultures | Percentage of positive catheter cultures |
|---|---|---|---|---|---|
| All urine cultures collected | | | | | |
| Overall | 5,571 | 43.4 | ... | 100.0 | |
| From noncatheterized patients | 3,960 | 30.9 | ... | 71.1 | ... |
| From catheterized patients | 1,611 | 12.6 | 34.0 | 28.9 | ... |
| From indwelling catheters | 1,061 | 8.3 | 22.4 | 19.0 | ... |
| From condom catheters | 489 | 3.8 | 10.3 | 8.8 | ... |
| From other catheter types | 61 | 0.5 | 1.3 | 1.1 | ... |
| Positive cultures from catheterized patients | | | | | |
| Overall | 1,009 | 7.9 | 21.3 | ... | 62.6 |
| From indwelling catheters | 583 | 4.5 | 12.3 | ... | 57.8 |
| From condom catheters | 377 | 2.9 | 8.0 | ... | 37.4 |
| From other catheter types | 49 | 0.4 | 1.0 | ... | 4.9 |
| Positive cultures from noncatheterized patients | 1,164 | 9.1 | ... | ... | 29.4 |

use for 3,805 days. Overall, IC reports and chart-review data both show an indwelling catheter present on 3,456 (90.8%) of the total number of catheter-days, but this includes both those catheter-days that were detected correctly in IC reports and those that were reported incorrectly, such as days on which the catheter had been removed or on which the patient was no longer on the ward. The number of catheter-days reported correctly to IC personnel was 3,041 (79.9%) of total catheter-days, whereas the number of catheter-days omitted in reports to IC personnel was 764 (20.1%). On the other hand, IC personnel received reports of 415 catheter-days on which a patient was either no longer on the ward or during which the indwelling catheter had been removed; thus, 415 (12.0%) of 3,456 total catheter-days reported to the IC department were incorrect. Overall, reports of catheter-days given to IC personnel were highly specific, but sensitivity was only 80% for detecting a urinary catheter-day (Table 3).

On acute care medicine wards at the Houston VA Medical Center from July through December 2010, IC received reports only on the total number of indwelling catheter-days, without associated patient-level information. When we compared IC reports with our chart review numbers, we assumed that any differences were attributable to missing catheter-days on the reports by the wards to the IC department, because we did not have patient-level data to determine whether some catheter-days were overreported whereas others were underreported. Overall, 4,788 indwelling-catheter-days were reported to IC personnel, which accounted for 88.7% of 5,396 indwelling-catheter-days documented through chart surveillance. This 88.7% detection rate is similar to the overall 90.8% detection rate reported on ECL wards, but we cannot determine whether these reported catheter-days were correct without patient-level information.

## DISCUSSION

### Key Findings

Focusing urinary catheter surveillance exclusively on indwelling catheters significantly underestimates days of urinary catheter use, almost half of which can be attributable to condom catheters in the populations studied. Furthermore, condom catheters contributed almost 40% of all urinary-catheter-associated bacteriuria in this study. IC documentation of indwelling-catheter-days had inaccuracies, probably because IC personnel must rely on ward-level reporting. The challenges facing IC personnel described in this study are unlikely to be confined geographically or restricted only to the VA

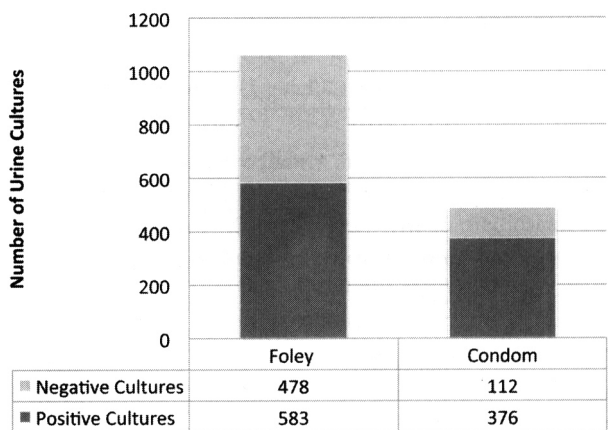


FIGURE 1. Proportion of Foley and condom catheter cultures with positive results. A total of 77.1% of all urine cultures collected from patients with condom catheters had positive results in comparison with 55.0% of urine cultures collected from patients with Foley (indwelling) catheters ($\chi^2 = 69.2$, $P < .001$).

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TABLE 3. Comparison of Infection Control (IC) to Chart Review Capture of Indwelling-Catheter-Days on Extended Care Wards

| | Chart surveillance | | |
|---|---|---|---|
| IC report | Patient had catheter according to chart | Patient did not have catheter according to chart | Total |
| Catheter present | 3,041 | 415 | 3,456 |
| Catheter absent | 764 | 17,284 | 18,048 |
| Total | 3,805 | 17,699 | 21,504 |

NOTE. Overall, catheter-days reports given to IC had a sensitivity of 80% (95% confidence interval [CI], 79%–81%), specificity of 98% (95% CI, 97%–98%), positive predictive value of 88% (95% CI, 87%–89%), and negative predictive value of 96% (95% CI, 95%–96%) for accurately detecting an indwelling-catheter-day.

healthcare system. Therefore, the quality gaps that we observed have important implications for CAUTI prevention strategies and public policy beyond the VA.

### Quality Gaps Concerning Condom-Catheter-Associated Bacteriuria

Condom catheters contribute substantially to catheter-associated bacteriuria and should not be neglected in surveillance for CAUTI. Although the NHSN specifies a standardized approach to collecting a urine specimen for culture from an indwelling catheter, no such standardized recommendation exists for condom catheter cultures. Ideally, urine cultures from patients with condom catheters would be collected only after removing the old catheter, cleaning the penis, and applying a fresh catheter. Previous work has established that bacteriuria detected using this method reflects true bladder colonization in 85% of cases, whereas nonstandardized collection methods result in contaminated specimens.[16] Much of the condom-catheter-associated bacteriuria that we observed may represent contamination from skin flora, colonization of tubing, or inappropriate collection of urine from the drainage bag rather than from a freshly applied condom catheter. Regardless of the clinical significance, these condom-catheter-associated positive cultures represent a substantial workload and costs for the microbiology laboratory and are undoubtedly driving inappropriate use of antibiotics for treatment of asymptomatic bacteriuria.

The association of condom catheters with an increased risk of bacteriuria and urinary tract infection has been noted previously in observational studies.[17-19] However, a current CAUTI-prevention recommendation is to consider condom catheters as an alternative to indwelling catheters.[4] This is based in part on a randomized trial of condom versus indwelling catheters involving 75 adult male inpatients who underwent daily urine cultures while catheterized.[11] Our recommendation is that condom catheter application, management, and sample collection need standardization before we can determine whether these devices are safer than indwelling urinary catheters. However, until additional research is conducted, condom catheters provide a good alternative to indwelling catheters in the hospital setting.

### Quality Gaps Concerning Accuracy and Workload of Urinary Catheter Documentation

We have documented significant issues with the accuracy of the current method of urinary catheter monitoring and reporting. Overall, IC reports and our chart surveillance agreed on 91% of the total days of indwelling catheter use, but IC reports captured catheter use by the correct patient on only 80% of these catheter-days. Reliance on IC reports by most surveyed hospitals, both public and private, is structurally biased, because the process is time consuming and dependent on manual catheter-day reporting. However, because rates of CAUTI are reported as number of urinary tract infections per 1,000 catheter-days, inaccurate denominators lead to inaccurate public reporting of CAUTI.[20,21] In our study, errors by IC personnel most often resulted in false-positive reporting of catheter use. Because catheter-days are the denominator for reporting CAUTI, false-positive catheter detection will erroneously lower the facility CAUTI rate. A recent study of 96 hospitals in Michigan bears this out, with much lower CAUTI rates captured through claims data than was expected. The authors of this study recommend the use of surveillance data obtained by IC personnel,[22] but our study highlights limitations to even this approach.

### Limitations

The main limitation of our study is that it was performed in 2 VA hospitals and primarily involved male patients. Condom catheters would be used less frequently in hospitals with more female patients. However, widespread use of condom catheters has been reported in prevalence studies from other countries.[19] The approach to urinary-catheter-day monitoring and reporting that we observed is not confined to the VA system, because this strategy is recommended by the NHSN for VA and non-VA hospitals.[23] Another limitation is that we lack patient-level data about urinary symptoms, so we cannot

determine the appropriateness of catheter use or urine culture collection. Finally, we cannot determine how many of the positive cultures represented CAUTI according to NHSN surveillance criteria, because we lack the symptom data associated with each culture and also used a more sensitive threshold for urine culture positivity. Our perspective for this study was that of the individual healthcare provider at our institution, who sees positive urine culture results and then must determine which represent CAUTI and which represent asymptomatic bacteriuria.

### A Potential Solution: Streamlining through Electronic Surveillance

In the bigger picture of patient safety, time devoted to catheter monitoring by infection preventionists cuts into the worthwhile activities of education and training in infection prevention.[8,9] This concern is backed by 2 recent surveys of IC practices in long-term care facilities in Utah and Canada.[8,9] Both studies found that opportunities for streamlining easily automatable tasks, such as generating lists of positive microbiology culture results, were not supported by information technology, so that a substantial proportion of recommended surveillance activities were not performed.

New mandates for IC programs require either additional funding or effective streamlining. One example of a successful IC initiative backed by adequate funding for additional personnel, educational efforts, and laboratory testing was the VA initiative to prevent methicillin-resistant *Staphylococcus aureus* infections.[24] In the current economic climate, it seems unlikely that a similar investment will be made in CAUTI prevention, so streamlining surveillance activities through automation may be a more feasible approach. One promising approach is natural language processing, in which a computerized surveillance system learns to recognize and extract information from free text.[25] Two non-VA studies have also proposed electronic surveillance for urinary catheters and CAUTI that would use progress note templates to ensure entry of necessary catheter data.[21,26] However, additional nursing education would be required to implement these templates.

We have identified quality gaps in monitoring and reporting CAUTI, both in the failure to document condom catheters and in their important contribution to catheter-associated bacteriuria and in the laborious and hence unreliable reporting of urinary-catheter-days. These quality gaps have clinical relevance to many stakeholders in healthcare, not least of all to the patient, who expects a reasonable report of the risks of various hospital-acquired infections. We propose that automation of urinary catheter surveillance would both reduce the workload on IC personnel and permit capture of condom-catheter-days in addition to indwelling-catheter-days. Once we have accurate metrics on the use of urinary catheters, we can effectively address unnecessary catheter use and the prevention of urinary-catheter-associated infections.

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