# Reduction of urinary catheter use and prescription of antibiotics for asymptomatic bacteriuria in hospitalised patients in internal medicine

## Before-and-after intervention study

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## Summary

PRINCIPLES: Unnecessary treatment of asymptomatic bacteriuria and overuse of urinary catheters in hospitals are of concern regarding antimicrobial resistance and patient safety, respectively. We investigated the effectiveness of a multifaceted intervention in reducing urinary catheter use and unnecessary prescription of antibiotics for asymptomatic bacteriuria in hospitalised patients in a clinic for internal medicine.

METHODS: Data were collected retrospectively from all inpatients during a 3-month period both before and after a multifaceted intervention from the Clinic for Internal Medicine of our secondary care hospital. The intervention consisted of implementation of guidelines, establishment of a standard for urinary catheter management, introduction of restricted orders and a reminder of indwelling catheters, as well as lectures and internet-based learning focusing on asymptomatic bacteriuria.

RESULTS: The incidence rate of urinary catheter days decreased significantly from 27 to 17 catheter days per 100 patient days (incidence rate ratio 0.61, 95% confidence interval 0.57–0.67). The incidence rate of unnecessary antibiotic treatment days for asymptomatic bacteriuria dropped significantly from 22 to 10 treatment days per 1,000 patient days (incidence rate ratio 0.46, 95% confidence interval 0.33–0.63).

CONCLUSIONS: A multifaceted intervention was effective in reducing both urinary catheter days and inappropriate antibiotic use for asymptomatic bacteriuria.

***Key words:*** *urinary tract infection; asymptomatic bacteriuria; antibiotic stewardship; urinary catheter; intervention study*

## Introduction

Urinary tract infections (UTIs) are the most frequent nosocomial infections in acute care hospitals [1, 2]. Though UTIs may be less important than other infections in terms of extra length of stay, costs, morbidity and mortality [2], consequences of antibiotic therapies for UTIs, such as adverse drug reactions, resistance selection and disease associated with *Clostridium difficile*, may be underestimated. Moreover, UTIs may be the most preventable healthcare associated infections [3].

Urinary catheters (UCs) represent the most important risk factor for the development of bacteriuria in hospitalised patients and for symptomatic nosocomial UTIs [4]. They are overused owing to inadvertency and lack of knowledge, and for convenience [5–7]. The rate of acquisition of bacteriuria in a catheterised bladder is approximately 3% to 8% per catheter day [4].

Despite ample evidence for, and broad consensus on, the futility of antibiotic therapy for asymptomatic bacteriuria (ASB), physicians tend to prescribe antibiotics for ASB because of lack of knowledge and misconceptions [5, 8]. In many elderly patients, physicians face difficulty in discriminating symptomatic UTI from the concurrent presence of bacteriuria and chronic urogenital complaints [9]. Given the increasing proportion of elderly patients, this source of overtreatment of bacteriuria may become more important.

Both UCs and antibiotics used for UTIs (quinolones, third-generation cephalosporins, trimethoprim-sulfamethoxazole) are risk factors for infection with, and carriage of, *Enterobacteriaceae* producing extended-spectrum beta-lactamase (ESBL), an increasing concern in European hospitals [10].

These considerations prompted us to undertake a quality improvement initiative aiming to reduce antibiotic treatment days for UTIs and UC days.

## Methods

### Setting

The study was undertaken in the Clinic for Internal Medicine of a teaching hospital, at two separate sites, hereafter

called Centre A and Centre B: Centre A has 50 beds and a 6-bed interdisciplinary intensive care unit, Centre B has 25 usual-care and 4 intermediate-care beds. Overall, 25 physicians in Centre A and 12 physicians in Centre B were in charge of the patients included in the study. The study was conducted within the hospital hygiene and infection prevention framework and had a before-and-after study design. All inpatients discharged from August 1st 2009 to October 31st 2009, inclusive, were included in a baseline assessment. After a multifaceted intervention, all inpatients discharged during the equivalent 3-month period in 2010 were included in the follow-up assessment. As our study was part of the quality improvement process in hospital hygiene and did not directly affect individual patient management, it was deemed exempt from a formal scrutiny by the institutional review board.

### Definitions

Symptomatic UTI was defined as newly developed and not otherwise explained fever ($\geq$38 °C) and/or dysuria, frequency, urgency or suprapubic tenderness in the presence of significant bacteriuria. ASB was defined as significant bacteriuria in the absence of symptoms or in association with symptoms that were pre-existing and/or explained by another condition. In contrast to published guidelines, we accepted a single urine specimen with significant bacteriuria instead of two consecutive specimens for the diagnosis of ASB in women [8]. Significant bacteriuria was defined as growth of at least one bacterial species at $10^2$ colony-forming units (cfu) per ml in a urine specimen taken from a single catheterisation, at $10^3$ cfu/ml in midstream urine or urine from an indwelling catheter in a symptomatic patient, at $10^5$ cfu/ml in midstream urine or urine from an indwelling catheter in an asymptomatic patient [4, 8], and at $10^6$ cfu/ml from spontaneously voided urine if no more appropriate urine specimen was available. Treatment of ASB was deemed appropriate exclusively in pregnant women or immediately before an invasive intervention affecting the urinary tract [8]. UTIs were classified as nosocomial if documented more than 48 hours after admission with no evidence of their presence on admission. Definite symptomatic nosocomial UTI was diagnosed in accordance with the above-mentioned criteria. Probable symptomatic nosocomial UTI included in addition cases with typical clinical symptoms and leucocyturia, but with missing urine culture or urine culture negative due to antibiotic therapy, as well as cases with the same uropathogenic microorganism in urine and blood cultures, in the absence of other diagnostic criteria. Antibiotic treatment was attributed to UTI only when clearly stated in the patient's documentation.

### Intervention

The intervention consisted of a bundle of measures. For all activities, endorsement was obtained from the head of the Clinic for Internal Medicine and from the Head of Nursing. A news text informed the entire staff of the project. Guidelines on indications for UCs and their management were newly established by an interprofessional working group. The guidelines comprised a list of appropriate and inappropriate indications for UCs. A sticker for the patient documentation was introduced, reminding health-

care workers of the presence of a urinary catheter and the need to consider removal. The guideline obliged nurses to ask for a new order every 3 days if an indwelling catheter was still thought to be indicated. Guidelines for the diagnosis and treatment of UTIs were revised in Centre A and newly introduced in Centre B. Guidelines on appropriate techniques for the collection and handling of urine specimens for culture were implemented in both clinics. All the guidelines, as well as teaching materials, were published on the intranet, where it is accessible by the entire staff of the hospital. Teaching included a web-based learning and assessment tool on UTIs and urinary catheters, developed by ME (contents) and FB (technical part) and named "uricheck". The tool consists of clinical case descriptions, followed by multiple-choice questions, immediate feedback and key messages. It also includes important articles from the medical literature on UTIs and urinary catheters. The physicians were asked to complete the web-based teaching, using a personal login. Nonresponders were reminded first by e-mail, then by a phone call. A series of newsletters on various aspects of UTI and urinary catheter management was published on the intranet and sent to all physicians, and lectures for physicians and nurses on management of UTIs and urinary catheters were held. Weekly clinical rounds for discussion of antibiotic treatment and UC indications with the first author were offered at the two centres. Simple intranet-based reporting forms for catheter insertion (indicating the reason for catheterisation) and catheter withdrawal were introduced. The clinical rounds and the reporting forms were implemented in Centre A, but the head of Centre B declined both for workload reasons.

### Data collection

Data for the periods before and after the intervention were extracted retrospectively from the entire patient documentation of all patients by the first author, using predefined criteria. Data collection included demographic characteristics, underlying diseases and information on urinary catheterisation episodes including type, indication and duration of catheterisation. Further data were collected on symptoms of UTI, urine collection technique and culture results, and on antibiotic treatment for ASB, symptomatic UTIs and other indications. EpiData Entry™ software was used for data entry. For the periods of interest a list of all medical inpatients from the hospital information system and a similar list of all patients having been coded for reimbursement using the AP-DRG system were extracted in order to crosscheck the completeness of the patient populations.

### Statistical analysis

Categorical variables are presented as numbers and percentages, and were compared with Pearson's chi-squared or Fisher's exact test, as appropriate. Continuous variables are given as medians with interquartile ranges or means with standard deviations. Normally distributed variables were compared with Student's t-test, whereas the Wilcoxon rank sum test was used for skewed distributions. Incidence rates (IRs) were compared by calculating incidence rate ratios (IRRs) and confidence intervals (CIs). Multivariate Poisson regression was used for the comparison of incidence rates of UC days while adjusting for potential imbalances

in risk factors in the patient populations before and after the intervention. Stata[TM] version 11.0 software (StataCorp) was used for analysis. All tests were two-tailed, and a p-value of less than 0.05 was considered to indicate a significant difference.

## Results

### Patients and patient characteristics

Centre A contributed 955 patients (450 before and 505 after the intervention) and Centre B 550 patients (284 before and 266 after the intervention), giving a total of 1505 patients. Patient-days amounted to 5803 before and 5620 after the intervention. Cross-checking from coding data confirmed 100% completeness of patient ascertainment.

Mean patient age was 68 years (range 16–97) and 779 (52%) of the patients were male. The characteristics of the populations before and after the intervention are summarised in table 1. Although there was no significant difference, length of stay tended to be shorter in the period after the intervention, which is a common trend in an era of increasing financial restraints. The proportions of patients admitted for or with symptomatic UTI did not differ between the periods.

### Uptake of the intervention

Thirty-two of the 37 physicians (86%) involved in patient care during the postintervention period completed the web-based teaching tool during the intervention period. The sticker reminding healthcare workers of urinary catheters was found on 77 of 106 patient charts (73%) when indicated in the postintervention period. Fifty-eight percent of the UC insertions after the intervention were in accordance with the list of appropriate indications.

### Urinary catheters

A similar proportion of patients was admitted with an indwelling UC before (6.3%) and after (6.9%) the intervention (p = 0.635, table 2). However, the proportion of patients having at least one episode of catheterisation during hospital stay decreased significantly from 26.6% before to 18.0% after the intervention (p <0.001). Before the intervention, 9.8% of the patients were discharged with an indwelling UC, and after the intervention, 6.2% (p = 0.01). Although the mean duration of catheterisation decreased from 8.1 days (range 1–78) before to 6.8 days (range 1–27) after the intervention, the difference did not reach statistical significance (p = 0.809). However the marked decrease of catheter episodes and the trend towards shorter duration of catheterisations resulted in a highly significant reduction in urinary catheter days of almost 40%, from 27 to 17 per 100 patient days (IRR = 0.61, 95% CI 0.57–0.67, p <0.001). Although the IRs differed between the two centres (reduction from 25 to 15 catheter days per 100 patient days in Centre A, reduction from 32 to 21 catheter days per 100 patient days in Centre B), there was no major difference in effect size between the two centres (IRR = 0.60, 95% CI 0.54–0.66 in Centre A; IRR = 0.66, 95% CI 0.58–0.75 in Centre B). Multivariate Poisson regression adjusting for age, sex, centre, diabetes, McCabe score [11], cost weight and intensive care days, which were all independently associated with the IR of UC days, still showed a highly significant 35% reduction of UC days from before to after the intervention (IRR = 0.65, 95% CI 0.59–0.70, p <0.001).

### Symptomatic nosocomial UTI

Symptomatic nosocomial UTI was infrequent and tended to diminish further from before (5 of 734 patients) to after (1 of 771 patients) the intervention (IRR 0.21, 95% CI 0.00–1.85, p = 0.067). Probable cases of symptomatic nosocomial UTIs decreased from 9 of 734 patients before to 3 of 771 patients after the intervention (IRR = 0.34, 95% CI 0.06–1.38), a reduction that almost reached statistical significance (p = 0.052), despite the low numbers.

| Table 1: Characteristics of the patient populations before and after the intervention. | | | |
|---|---|---|---|
| Characteristic | Before intervention n = 734 | After intervention n = 771 | p-value |
| Patient days | 5803 | 5620 | |
| Age in years – mean (SD) | 68.0 (18.4) | 68.5 (17.8) | p = 0.550 |
| Male sex – n (%) | 369 (50.3) | 410 (53.2) | p = 0.260 |
| Admission from community – n (%) long term care – n (%) other clinic/hospital – n (%) | 597 (81.3) 46 (6.3) 91 (12.4) | 623 (80.8) 66 (8.6) 82 (10.6) | p = 0.158 |
| McCabe score* none or nonfatal – n (%) ultimately fatal – n (%) rapidly fatal – n (%) | 521 (71.0) 195 (26.6) 18 (2.5) | 550 (71.3) 188 (24.4) 33 (4.3) | p = 0.110 |
| Diabetes mellitus – n (%) | 147 (20.0) | 177 (23.0) | p = 0.167 |
| Intensive care days per 1,000 patient days | 60 | 68 | p = 0.091 |
| Length of stay – days median (IQR) mean (SD) | 6 (3–10) 7.9 (7.0) | 6 (3–9) 7.3 (6.6) | p = 0.058 |
| Cost weight** – Mean (SD) | 1.025 (1.229) | 0.969 (0.850) | p = 0.599 |
| Symptomatic UTI on admission – n (%) | 30 (4.1) | 28 (3.6) | p = 0.646 |
| IQR = interquartile range; SD = standard deviation; UTI = urinary tract infection *According to McCabe and Jackson [11] ** Cost weight attributed to a case using coding based on the AP-DRG coding system | | | |

### Antibiotic prescriptions

Antibiotic treatment days for ASB decreased significantly after the intervention to less than half the IR before the intervention (IRR = 0.46, 95%-CI 0.33–0.63; table 3). Together with the above mentioned nonsignificant reduction of the already rare symptomatic nosocomial UTIs, this resulted in a significant net decrease of antibiotic use for UTIs overall, from 75 to 59 treatment days per 1,000 patient days (IRR = 0.79, 95% CI 0.69–0.92). Despite a marked difference between the two centres of the clinic in the proportion of patients being treated for ASB, there was no major difference in effect size (table 3).

## Discussion

Our findings confirm that a multifaceted intervention aiming at a reduction of UC days and unnecessary antibiotic therapy for ASB can be successful in medical acute-care patients.

UC use in our clinic was in the upper range of published rates [12–14] before the intervention, but dropped significantly by more than a third. However, the decrease of the mean dwelling time of UCs was only moderate and nonsignificant, indicating that increased knowledge on catheter use, a change in attitude and a more appropriate application of the UC indication list may have been the most important effects of the intervention. In contrast to the findings of other authors, who used various alert mechanisms [15–18], but in concurrence with the observations of Crouzet et al. [19], our sticker reminding healthcare workers of the indwelling catheter and the temporal restriction of catheter orders seem to have had less of an impact. Though not formally evaluated, the temporal restriction of catheter orders appears to have been ignored by some physicians and nurses. This leaves an opportunity for further improvement by using an electronic ordering process [14, 18, 20], which

allows checks and restraints, as soon as a clinical information system will be fully introduced in our hospital.

Information on incidence rates of antibiotic treatment days for ASB in hospitalised medical patients is scarce in the medical literature. We are, actually, among the first to report this precise measure for the undesired habit of treating ASB. The most informative publications in this respect provide treatment episodes, rather than treatment days per 1,000 patient days, and refer to long-term care [21, 22]. The study of Stéphan et al. was performed in postoperative surgical patients [23]. Thus, the probable incidence rate of antibiotic treatment days for ASB was largely unknown and turned out to be lower before the intervention than anticipated. Despite this fact, the intervention resulted in a highly significant reduction of antibiotic use for this condition, to less than half the incidence rate before the intervention.

The marked reduction of UC use led to a nonsignificant decrease of symptomatic nosocomial UTIs to an unexpectedly low level [24], largely obviating antibiotic treatment for this condition and adding to the decrease of antibiotic use for UTIs overall.

Our study has some limitations. Data were extracted by the first author alone. This might be a source of bias, although strict definitions and special software for data entry were used to minimise arbitrariness and errors, respectively. We are not able to identify clearly the single most important element of our multifaceted intervention leading to reduced UC use and antibiotic treatment. However a bundle of measures may actually be essential to achieve the change of attitude necessary for the observed improvements. We had no control clinic or ward without the intervention; this would have been impossible to establish because of the limited size of our hospital, and choosing another hospital as a control would have resulted in other unpredictable differences. We cannot exclude temporal trends or other unexpected imbalances between the populations, which might confound our results, because they are inherent in

| **Table 2:** Urinary catheter use. | | | |
|---|---|---|---|
| | **Before intervention** | **After intervention** | **p-value** |
| Patients - n | 734 | 771 | |
| Admission with indwelling urinary catheter – n (%) | 46 (6.3) | 53 (6.9) | p = 0.635 |
| Patients with catheters – n (%) | 195 (26.6) | 139 (18.0) | p <0.001 |
| Discharge with urinary catheter – n (%) | 72 (9.8) | 48 (6.2) | p = 0.010 |
| Catheter episodes – n | 227 | 161 | |
| Catheter type<br>  Foley catheter – n (%)<br>  suprapubic catheter – n (%) | 210 (92.5)<br>17 (7.5) | 145 (90.1)<br>16 (9.9) | p = 0.394 |
| Duration of catheter episodes in days – mean (SD)<br>range | 8.1 (9.0)<br>1–78 | 6.8 (4.9)<br>1–27 | p = 0.809* |
| *Wilcoxon rank sum test | | | |

| **Table 3:** Antibiotic use for urinary tract infections in treatment days per 1,000 patient days. | | | |
|---|---|---|---|
| | **IR of antibiotic treatment days per 1,000 patient days** | | |
| **Condition prompting antibiotic therapy** | **Before intervention** | **After intervention** | **IRR (95% CI)** |
| Asymptomatic bacteriuria | | | |
|   Centre A | 15.8 | 6.9 | 0.44 (0.27–0.70) |
|   Centre B | 34.6 | 17.6 | 0.51 (0.32–0.79) |
|   Both centres | 22.2 | 10.1 | 0.46 (0.33–0.63) |
| Symptomatic nosocomial UTI | 9.7 | 8.2 | 0.85 (0.56–1.28) |
| Symptomatic non-nosocomial UTI | 42.7 | 40.9 | 0.96 (0.80–1.15) |
| Any UTI | 74.6 | 59.3 | 0.79 (0.69–0.92) |
| CI = confidence interval; IR = incidence rate; IRR = incidence rate ratio; UTI = urinary tract infection | | | |

the before-and-after design. However, among the differences in patient characteristics, the trend towards more admissions from long-term care and the higher incidence rate of intensive care days in the postintervention period tend to reduce the true effects of our intervention on both UC days and unnecessary treatment of ASB.

On the other hand, the relatively large number of patient days resulting in solid estimates of effect is a strength of our study. Together with the internal congruence of the findings, this gives credibility to the relationship between the intervention and observed effects.

In conclusion, our study shows that even in a population of increasingly comorbid and elderly patients, a multifaceted intervention improving knowledge about UCs and management of UTIs, as well as heightening the awareness for overuse of catheters and overtreatment of ASB, can effectively reduce both UC days and inappropriate antibiotic use for ASB.

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