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The effect of a short educational intervention on the use of urinary catheters: a prospective cohort study

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Abstract

Objective: To assess the effectiveness of implementation of evidence-based recommendations to reduce catheter-associated urinary tract infections (CAUTIs).
Design: Prospective cohort study, conducted in 2010–12, with a before and after design.
Setting: A major referral university hospital.
Participants: Data were collected before (n = 244) and 1 year after (n = 255) the intervention for patients who received urinary catheters.
Intervention: The intervention comprised two elements: (i) aligning doctors' and nurses' knowledge of indications for the use of catheters and (ii) an educational effort consisting of three 30- to 45-minute sessions on evidence-based practice regarding catheter usage for nursing personnel on 17 medical and surgical wards.
Main Outcome Measures: The main outcome measures were the proportion of (i) admitted patients receiving urinary catheters during hospitalization, (ii) catheters inserted without indication, (iii) inpatient days with catheter and (iv) the incidence of CAUTIs per 1000 catheter days. Secondary outcome measures were the proportion of (i) catheter days without appropriate indication and (ii) patients discharged with a catheter.
Results: There was a reduction in the proportion of inpatient days with a catheter, from 44% to 41% (P = 0.006). There was also a reduction in the proportion of catheter days without appropriate indication (P < 0.001) and patients discharged with a catheter (P = 0.029). The majority of catheters were inserted outside the study wards.
Conclusions: A short educational intervention was feasible and resulted in significant practice improvements in catheter usage but no reduction of CAUTIs. Other measures than CAUTI may be more sensitive to detecting important practice changes.

Key words: urinary tract infection, catheter-related infections, evidence-based practice

Introduction

Urinary tract infections account for ~40% of all hospital-acquired infections (HAIs) [1, 2] of which ~80% are related to indwelling urinary catheters (hereafter referred to as catheters) [1, 3]. An estimated 2.3% mortality rate has been attributed to catheter-associated urinary tract infections (CAUTIs) [2]. Physical and psychological discomfort, morbidity [4], antimicrobial resistance [5] and increased cost [1] are also well known consequences. The risk for developing a CAUTI is related directly to the time the catheter remains *in situ*. Therefore, limiting catheter use and duration are the most important measures to prevent CAUTIs [1, 6]. Nevertheless, overuse of catheters is widespread, with many hospitalized patients receiving catheters without an appropriate indication and for a prolonged duration [7].

Many health care organizations, such as The Institute for Healthcare Improvement (IHI), are tackling the universal problem of CAUTIs and overuse of catheters [6], as reflected by the number of guidelines on catheter usage [8]. Diverse interventions that focus on limiting catheter use and on their prompt removal may significantly reduce CAUTIs [3, 9–11]. Education of nursing staff, electronic reminders aimed at reducing the duration of invasive devices [6, 12], such as automatic stop orders [13], and the use of nurses specially trained to lead implementation projects (change champions) [12] have proved to be effective in changing practice and reducing CAUTIs [14].

Nurses insert catheters [15] on the instructions of physicians and also because they decide to do so based on the patient's condition. Nurses are therefore in a key position to influence decisions about the insertion, continuing use and removal of catheters [11]. However, as they may base their decisions on personal preference rather than evidence-based guidelines [16] and existing routines within their practice, it is of the utmost importance to engage nurses and raise their awareness about evidence-based recommendations for preventing CAUTIs.

Various process and outcome measures have been proposed to detect practice changes in catheter usage within organizations [3]. Traditionally, the main outcome measure is symptomatic CAUTIs per 1000 catheter days, but due to different definitions and measurements [14], comparison of reported CAUTI rates is problematic. The National Healthcare Safety Network (NHSN) reports a rate of infection from 4.1 to 14.4 per 1000 catheter days for inpatient wards, depending on medical speciality [17]. Other measurements are advised [3], but their applicability to different settings is less clear.

The IHI initiative and campaign for preventing CAUTIs raised our awareness of the importance of evidence-based practice in catheter use and motivated us to implement the IHI guidelines about prevention of CAUTIs. The implementation was directed at surgical and medical wards at our hospital.

The hypothesis was that urinary tract infections (primary outcome), number of patients receiving a urinary catheter and the time with a catheter *in situ* could be reduced by the following interventions: (i) nurses' and doctors' indications for catheter usage were aligned and (ii) three 30- to 45-minute group educational sessions were held on the wards.

The aim of the study was to assess the effectiveness of implementation of evidence-based recommendations to reduce CAUTIs.

Methods

Study design and setting

We conducted a prospective cohort study with a before and after design. The setting was the country's main hospital, a referral and university hospital, with 660 beds and around 27 000 patient admissions annually [18]. It has a leading role in health care in the country and accounted for almost 70% of its general hospital expenses in 2009 [19]. The hospital serves patients from all health care districts and is the largest employer of health care professionals in the country. Although patient safety and reduction of HAIs has been highlighted in the hospital's scorecard since 2010 [18], no structured program on catheter usage or the prevention of CAUTIs has been implemented, and only limited criteria for catheter use pertaining to specific procedures existed. HAI's prevalence studies are completed four times a year, but CAUTI rates are not recorded separately. According to these studies, urinary infections accounted for 36% of all HAIs at the hospital in 2009 [20].

Clinical Nurse Specialists (CNSs) from the hospital departments of Surgical and Medical Services initiated and supervised this intervention and research project with support from the hospital management at all levels. Initially, two CNSs from the departments of Surgical Services formed a research team with nurses from the Department of Quality Improvement, Infection Control, and Urology. Four months later, the project was expanded to include wards within the Medical Services, and three CNSs joined the team. All team members were experienced nurses with comprehensive knowledge of treatment processes and the hospital.

Participants

Data collection took place between 2010 and 2012 in 17 inpatient surgical and medical wards. Data were collected on each ward during two time periods, with a 12-month interval, first (T1) before the intervention and then 12 months later (T2). All consecutive inpatients who received a catheter during the data collection period were included in the sample.

Intervention

The intervention consisted of two main elements. The first concerned aligning doctors' and nurses' knowledge of approved indications for the use of catheters. The second was the implementation of the four components of care recommended by the IHI [3] to prevent CAUTIs, on the participating wards (Table 1).

The first step in the intervention was to gain a consensus among the stakeholders, including urologists and anaesthesiologists, on the appropriate indications for catheter insertion within the hospital. The agreed indications were adjusted from IHI [3] as follows: (i) urinary tract obstruction, (ii) neurogenic bladder and urinary retention, (iii) urologic or other surgery with adjoining structures, (iv) close monitoring of urinary output required, (v) Stage III or IV sacral pressure ulcers in the incontinent patient, (vi) palliative care (patient's preference), (vii) epidural catheter in place (first 24 hours) and (viii) patient could not be moved because of injuries/ unstable fracture. The last two were added to conform to other protocols within the hospital. Existing guidelines

Table 1 Main actions taken when preparing the intervention, relationship with the four IHI components of care for prevention of CAUTIs [3] and the responsible person for each action[a]

The four components of care		
1. Avoid unnecessary use of urinary catheters		
2. Insert urinary catheters using aseptic technique		
3. Maintain urinary catheters based on recommended guidelines		
4. Review urinary catheter necessity daily and remove promptly		
Main actions (in chronological order)	**Component**	**Responsible**
1. New identification and publication of indications for catheter insertion	1, 4	CU/CNS/ICN/UT
2. Revised protocol for management of postoperative urinary retention	1, 4	CNS/ICN/UT/CU/ anaesthesiologist
3. New design and printing of handouts, posters and pamphlets	1, 4	CNS/UT
4. Purchase of new types of bedpans	1, 4	UT
5. Preparation of toolkit (condoms, diapers, catheters for intermittent catheterization for demonstration)	1, 4	UT
6. Revision and publication of existing procedure documents for catheter utilization	2, 3	CNS/ICN/UT/CU
7. Purchase of a mannequin for demonstrations and hands-on training	2, 3	CNS
8. Design and purchase of pens, and Post-it memos with slogans for distribution within wards	1, 4	Implementation group
9. Three educational sessions within each ward at which the educational material was introduced, and use of portable bladder scan demonstrated	1,2, 3, 4	CNS/UT

[a]CNS, Clinical Nurse specialist; CU, Chief of Urology; UT, Urotherapist; ICN, Infection Control Nurse.

on postoperative urinary retention were also revised. The implementation of the four components of care [3] were introduced on the study wards with educational sessions for registered and practical nurses. The intervention was further informed by guidelines from the Healthcare Infection Control Practices Advisory Committee [14]. The educational sessions consisted of three visits to each ward, at intervals of 4–8 weeks, by the same two members of the improvement team, a CNS and an urotherapist (specialist in bladder dysfunction and continence care). Each visit was scheduled at a predefined time, chosen in collaboration with the ward manager, and lasted 30–60 minutes. The majority of the nursing personnel on duty attended the sessions, 6–18 persons each time. A checklist was used to ensure all wards received the same education, and discussions about specific problems were also offered. The intervention was pilot-tested within one surgical ward, resulting in minor content changes. Table 1 demonstrates, in chronological order, the main actions taken, their relation to IHI's four components of care [3] and who assumed responsibility for each action.

Assessment methods

A data collection form was developed, and the team collected data daily from patients' records. Figure 1 illustrates the study design and data collection process. If the patient had a new catheter inserted within 24 hours of the removal of a previous one, it was counted as the same catheter. If the time from removal was more than 24 hours, the second catheter was counted separately. When information about catheter use was inadequately documented, the researchers read nurses' and doctors' notes and used their clinical expertise to evaluate the indication. The researchers also met regularly to ensure consistency in the data collection. At catheter removal, the data collection for each patient was completed and the date and reason for removal were documented. The discharge date was also noted. For patients discharged with the catheter, information about catheter use was completed at discharge. Information on the number of patients admitted to the study wards during the data collection period was retrieved from the hospital's Office of Finance and Information Services.

Outcome measures

Four measurements recommended by IHI, Centers for Disease Control and Prevention (CDC)/NHSN and the Society for Healthcare Epidemiology of America were initially selected to assess the outcome of the study (Table 2, measures 1–4) [3,14, 22]. After initial analysis of data from T1, two more measures were added. As our focus was on reducing unnecessary use of catheters, measure 5, the proportion of catheter days without appropriate indication [3], was included to complement measure 2 [23]. Measure 5 indicates unnecessary prolonged use of an inserted catheter, whereas measure 2 indicates whether a catheter was inserted unnecessarily. Finally, we did not anticipate the large number of patients discharged with a catheter. As patients discharged with a catheter are more prone to suffering adverse events after discharge [24], we were interested in exploring practice changes in this respect, and added measure 6, the proportion of patients discharged with a catheter. Table 2 lists the six measures, along with their definition and how they address the aforementioned IHI components of care. The average number of catheter days was also calculated.

Statistical analysis

A power analysis performed for the initial research at the surgical wards assumed that 25% of hospitalized patients received a catheter during hospitalization [7]. For a power of 0.8 ($\alpha = 0.05$) and to detect a 10 percentage point decrease in the proportion of patients receiving a catheter (measure 1), a total of 430 admitted patients were needed during each data collection period. This analysis also formed the basis for the number of patients needed during each data collection period for the medical wards. Patient recruitment was completed when more than 500 patients in total had been admitted to each speciality, surgical and medical, resulting in roughly 1100 admissions for each data collection period: T1 and T2. Data were entered into Microsoft Excel and transferred into Stata 11.0 for statistical analysis. An independent-samples t-test was applied to test for differences in point estimates of the average of continuous variables between the study periods T1 and T2. A two-sided test was applied for the average age and the average length of stay, and a one-sided test for the average number of catheter days. To test for differences in the point estimates of proportions between the study periods, a two-sample test of proportions was applied. A two-sided test was applied for the proportion of females and a one-sided test for outcome measures 1, 2, 4, 5 and 6. The difference in the point estimate

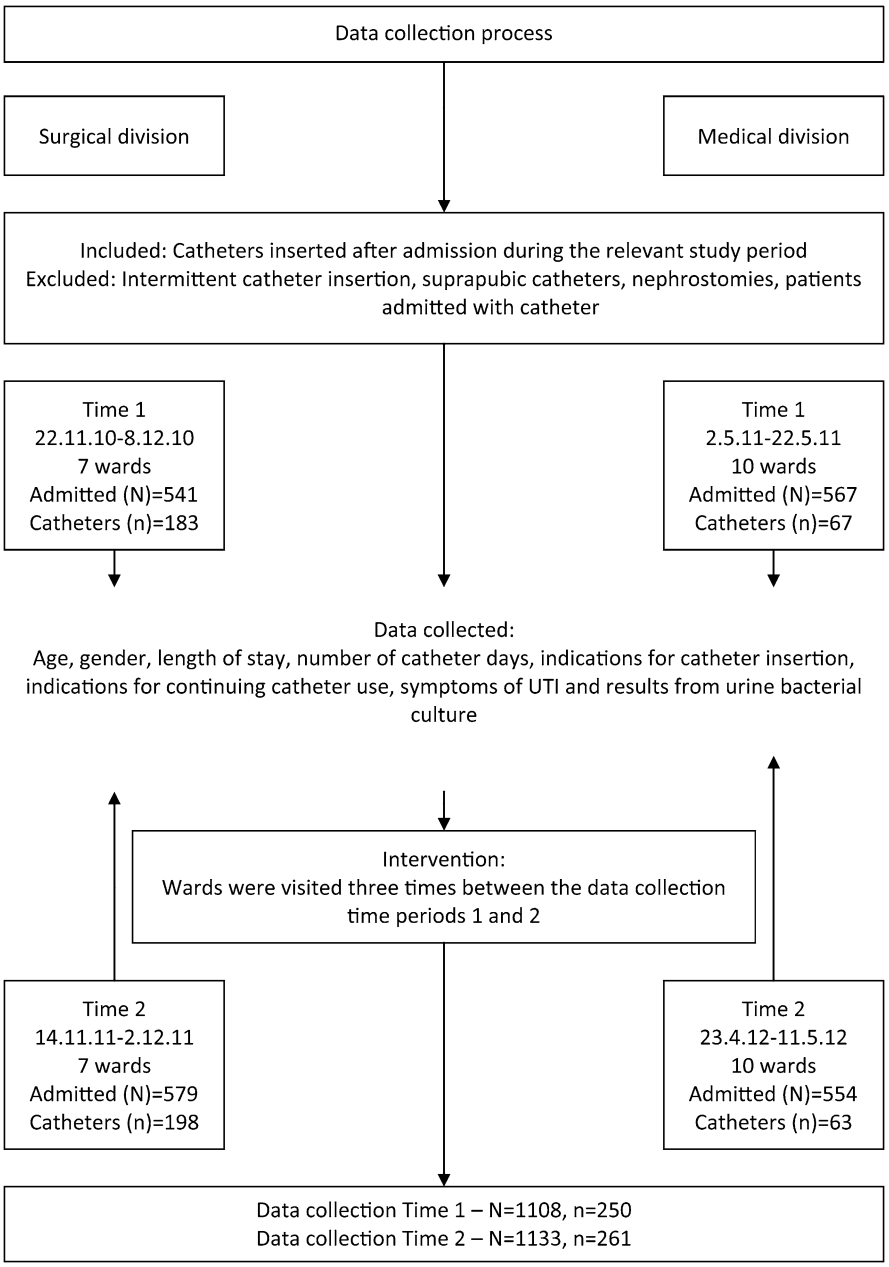

Figure 1 Study design and data collection process.

of the incidence of CAUTIs per 1000 catheter days (measure 3) between the study periods was assessed by binomial probability mid-p- exact test (one-sided). The level of significance was set at $P \leq 0.05$ for all statistical tests.

Ethics

This study was approved by the National Bioethics Committee (VSNb2011020005/03.15), the hospital management and the Data Protection Authority (2010100905ÞJP).

Results

The total number of admitted patients was 1108 at T1 and 1133 at T2. The number of patients receiving a catheter at T1 and T2 were 244 and 255, respectively. The samples were not significantly different ($P > 0.05$) with respect to average age, average length of stay and the proportion of females (see Table 3).

The majority of catheters (70% at T1 and 79% at T2) were not inserted at the study wards but in theatres, intensive care wards, or recovery and emergency department.

Key figures are presented in Table 3 and results for outcome measures 1–6 are reported in Table 4.

Catheter-associated urinary tract infection

The incidence of CAUTIs per 1000 catheter days (measure 3) was relatively low at both time points, and the reduction of 1.5 infections per 1000 catheter days was not statistically significant.

Table 2 Outcome measures of the study and relevant components of the intervention

Measures		Component Number
1	Proportion of patients receiving urinary catheter during hospitalization (No. of admitted patients receiving catheter during the study period/No. of admitted patients during the study period)	1
2	Proportion of catheters inserted without appropriate indication (No. of catheters inserted without appropriate indication at insertion/No. of catheters inserted) [3, 14]	1
3	Urinary tract infection rate (No. of symptomatic CAUTIs[a] for patients receiving catheter during the study period/No. of catheter days for patients receiving catheter during the study period) × 1000 [3, 14, 21]	1, 2, 3, 4
4	Proportion of inpatient days with catheter (utilization ratio) (No. of catheter days for patients receiving catheter during the study period/No. of patient days for patients receiving catheter during the study period) [14, 21, 22]	1, 4
5	Proportion of catheter days without appropriate indication (No. of catheter days without appropriate indication/No. ofcatheter days) [3]	1, 4
6	Proportion of patients receiving catheter who were discharged with catheter (No. of patients discharged with catheter/ No. of patients receiving catheter) [24]	4

[a]The hospital's definition for symptomatic CAUTIs applied in this study is according to CDC/NHSN (2009) except for the threshold which is $\geq 10^3$ microorganism/ml of urine instead of $\geq 10^3$ and $<10^5$ microorganism CFU/ml.

Table 3 Descriptive statistics and key results

	T1	T2	*P*-value
Females (%)	52.4	58.2	0.185[a]
Average age (in years) (SD)	67.6 (15.3)	67.4 (15.5)	0.833[b]
Average length of stay (in days) (SD)	9.9 (13.0)	9.4 (11.5)	0.656[b]
Number of catheters without appropriate indication for insertion	11	6	
Number of infections	6	4	
Total number of inpatient catheter days	1046	973	
Number of inpatient catheter days without appropriate indication	421	290	
Total number of inpatient days	2365	2395	
Number of patients discharged with catheter	40	27	

[a]Two-sided two-sample test of proportions.
[b]Two-sided t-test of independent samples.

Table 4 Outcome measures

Outcome measure	T1	T2	*P*-value
1. Proportion of patients receiving catheter	22.0 %	22.5 %	0.609[a]
2. Proportion of catheters inserted without appropriate indication	4.4 %	2.3 %	0.093[a]
3. Number of infections per 1000 catheter days	5.7	4.1	0.313[b]
4. Proportion of inpatient days with catheter (utilization ratio)	44.2 %	40.6 %	0.006[a]
5. Proportion of catheter days without appropriate indication	40.2 %	29.8 %	<0.001[a]
6. Proportion of patients receiving catheter who were discharged with catheter	16.4 %	10.6 %	0.029[a]

[a]One-sided two-sample test of proportions.
[b]Mid-p-exact value.

Appropriate use of catheters

The proportion of catheter days without appropriate indication (measure 5) decreased significantly between T1 and T2. The proportion of catheters placed without appropriate indication (measure 2) was low during both study periods, and the observed reduction was not statistically significant. There was no significant reduction in the proportion of patients receiving catheters between study periods (measure 1).

Prolonged use of catheters

The proportion of inpatient days with catheter (measure 4) decreased significantly between the study periods, as did the proportion of patients discharged with a catheter (measure 6). The average number of catheter days decreased from 4.2 (SD 5.8) days at T1 to 3.7 (SD 5.1) days at T2, but the reduction was not statistically significant ($P = 0.171$).

One patient had missing data on length of stay and was therefore excluded in calculations requiring patient length of stay such as average length of stay and the utilization ratio, and three patients had missing data regarding the ward where they had received their catheters.

Discussion

This study indicates that a brief educational intervention can improve an important aspect of practice, that is, the use of indwelling urinary catheters. After the implementation, there was a significant decrease in the proportion of inpatient days with a catheter, catheter days without appropriate indication and patients discharged with a catheter. With respect to our primary outcome of reducing the CAUTI rate, the changes were not statistically significant. Furthermore, the number of patients receiving a catheter did not decrease.

These results indicate that the intervention affected the decision to review the necessity for continuing use of a catheter once it had been placed and that nurses were more vigilant about the prompt removal of catheters, as this was highlighted in the educational sessions.

Educational sessions were deemed an appropriate way to deliver the education at the wards, since they fit the purpose of influencing attitudes and facilitating transfer of knowledge, and also could be incorporated into the staff's busy working schedule. Traditional educational meetings outside the ward might seem more feasible but have their drawbacks. For many, educational meetings outside the ward meant disruption to their work and placed extra demands on them. In-service training and education could therefore be difficult

in practice if they required nursing staff to leave their wards. Teaching within small groups facilitates active participation and allows for discussions of special cases and patient groups. This form of education therefore provides opportunities for answering questions and correcting misconceptions [25] and is in line with the adult learning approach that enables reflective learning and active participation [26]. Nevertheless, in our study, it is also possible that this method might have resulted in impaired knowledge transfer if the attention of nursing staff was more on their patients and their needs. However, some attendants came voluntarily, outside their working hours, and in the case of a staff shortage or excessive workload, the sessions were postponed. The lively discussions, comments and questions also suggest that the nurses' attention was caught. The lack of qualified change champions within the wards to assist managers to implement changes also affected our choice of method. Using electronic alerts, which can assist in reducing CAUTIs [6, 12, 13] and allow easily accessible audits, was not an option because the hospital's electronic documentation system did not offer such features.

Despite the decrease in the proportion of inpatient days with a catheter, the ratio was still quite high (41%) at T2 compared to some other studies [27], where it has been reported to be as low as 10% [28]. Failure to reduce the use of catheters can be explained by two factors. First of all, it was unknown to us initially, and was only revealed in the course of the study, that the majority of catheters were inserted on wards outside the scope of the intervention. Second, the proportion of catheter insertions without appropriate indications was low at both data collection points when compared to some other studies [29]. Applying a strict criterion of documented indications for catheter placement is a recommended process indicator [3]. However, we were aware that documentation on catheters was rather poor in the hospital and therefore, when documentation was lacking, we decided to determine the indication as appropriate or not with reference to the hospital's guidance. This may have led to the observed result of a low proportion of catheters being placed without an appropriate indication.

The CAUTI rate is the most widely recommended outcome measure to assess appropriate catheter use within organizations. However, similar to other studies [23, 30], we found its use in the context of this study of limited value, as it failed to reflect important practice changes. Comparable intervention studies show similar results with respect to catheter use and CAUTI rate [6, 11]; despite fewer catheter days [31] or reduced duration of inappropriate urinary catheterization [10], the CAUTI rate is not always reduced. This may be explained by how the CAUTI rate is calculated [3], i.e. as the number of infections per 1000 catheter days [23, 31]. The CAUTI rate may actually increase when there is a proportionally larger decline in catheter days than in the number of infections, as other authors have demonstrated [23, 31]. The shortcomings of this measurement may give rise to misleading results, even when valuable improvements have been made [23, 31].

The CAUTI rate should therefore be interpreted with caution and in relation to other changes in catheter use within the hospital. We also propose that the proportion of catheter days without appropriate indication [23] and the utilization ratio should be applied as outcome measures when the aim is to reduce the number of unnecessary catheters and prolonged catheter use. Improvement in this area should eventually lead to fewer urinary tract infections. Other measures should also be given more consideration, such as the number of patients discharged with a catheter. To our knowledge, this measure has not been among the recommended ones, although it is of clinical importance. For example, older surgical patients with indwelling catheters who are discharged from hospital to a skilled nursing facility are at greater risk of rehospitalisation for urinary tract infection and mortality within 30 days from admission, compared to those without catheters [24].

The main strength of this study is the method of data collection, which ensured close monitoring of all patients receiving catheters. All acute medical and surgical wards in the hospital were included, and as they constituted over 60% of the total hospital inpatient wards, this study provided representative information on catheter usage practices within the organization. This information will serve as a baseline reference for future studies and interventions to improve clinical practice. The main weakness is inadequate documentation in patient records, both concerning indications for catheter use and symptoms of urinary tract infections, and this may have affected the study's results. We tried to compensate for this limitation by using our clinical expertise to make subjective judgments on appropriate catheter use based on the patient's condition. As this may have created another source of bias, regular meetings were held to discuss uncertainties and ensure consistency in the assessment. Another limitation to acknowledge is the fact that attendance of nursing staff to the educational sessions was not mandatory and the education may therefore not have been received by all staff caring for the patients. However, the Nurse Managers, who are considered influential persons in implementing changes, were always present. Guidelines for catheter usage are currently documented in the hospital's quality manual, which should add to the sustainability of this project, but it is unknown to what extent doctors and registered and practical nurses adhere to these instructions.

The observed changes may be influenced by the method used. Therefore, more studies using other methodological approaches are needed. To explore whether the intervention has targeted the knowledge of doctors and nursing staff, exploring their knowledge on catheter usage by questionnaires before and after the implementation seems imperative. Clinical audits could also provide a good view of the sustainability of the intervention [32]. To study the appropriateness of the implementation, obtaining the views of health professionals, for instance by using focus groups, could provide valuable information about hindrances in transferring knowledge to practice in our settings. More studies about appropriate insertion of catheters outside patients' wards, for instance in operating rooms, are also needed. It could then be interesting to conduct a randomized controlled trial to study further whether an educational method like this leads to practice changes.

Future interventions within the hospital should focus on decreasing further the number of catheter days without appropriate indication. As most catheters are inserted in emergency departments and theatres, these settings must be targeted with more involvement of physicians [3, 7]. Electronic reminders and stop orders should be added in future development of the hospital's electronic patient record system [6, 13] as they allow easily accessible audits, but a prerequisite for this to be effective is sufficient documentation on catheter utilization.

Conclusions

This short educational intervention resulted in an important practice change related to the continuing use of a catheter once it has been placed, but did not affect the decision on placing a catheter or result in a reduction of the CAUTI rate. Other outcome measures than the traditional measurement of CAUTIs, such as patients discharged with a catheter, and the utilization ratio, were found to be more

sensitive to practice changes. Further improvements in catheter usage within the hospital are still needed and other settings must be targeted. More studies are required on the sustainability of the results and the effects of the intervention on knowledge transfer.

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