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Change in staff perspectives on indwelling urinary catheter use after implementation of an intervention bundle: Results of a before/after survey study

Running title: Change in staff perspectives

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Abstract

Objective: To evaluate change in staff perspectives towards indwelling urinary catheter (IUC) use after implementation of a one-year quality improvement project.

Design: Repeated cross-sectional survey at baseline (October 2016) and 12-month follow-up (October 2017).

Setting: Seven acute care hospitals in Switzerland

Participants: The survey was targeted at all nursing and medical staff members working at the participating hospitals at the time of survey distribution. A total of 1,579 (49% response rate) resp. 1,527 (47% response rate) eligible staff members participated in the two survey periods.

Intervention: A multimodal intervention bundle, consisting of an evidence-based indication list, daily re-evaluation of ongoing catheter need and staff training, was implemented over the course of 9 months.

Main Outcome Measures: Staff knowledge (15 items), perception of current practices and culture (scale 1-7), self-reported responsibilities (multiple-response question) and determinants of behavior (scale 1-7) before and after implementation of the intervention bundle.

Results: The mean number of correctly answered knowledge questions increased significantly between the two survey periods (T_0: 10.4, T_1: 11.0, $p<0.001$). Self-reported responsibilities in regard to IUC management by nurses and physicians changed only slightly over time. Perception of current practices and culture in regard to safe urinary catheter use increased significantly (T_0: 5.3, T_1: 5.5, $p<0.001$). Significant changes were also observed for determinants of behavior (T_0: 5.3, T_1: 5.6, $p<0.001$).

Conclusion: Staff members had better knowledge of catheter-associated risks, more positive perceptions of current practices and stronger beliefs regarding restrictive urinary catheter use after the implementation of a multi-modal intervention bundle

ARTICLE SUMMARY

Strengths and limitations of this study

- The repeated survey design allowed us to assess changes in staff perspectives after implementation of a quality improvement intervention. Sustainability of the effects over time however could not be evaluated.
- Using self-generated identification codes to match respondents in the two surveys, it was possible to evaluate if results obtained on the group level quite represent results on the individual participant level.
- No control group was included in the study design. It is possible that other trends or measures within the hospitals may have affected the outcomes.

INTRODUCTION

Although indwelling urinary catheters (IUCs) are commonly used in acute care hospitals, an appropriate medical indication is often missing [1,2]. IUCs are associated with urinary tract infections (UTI) and non-infectious complications such as hematuria and urethral injury. The reduction of IUC use is therefore a key measure to increase patient safety [3–7].

Several quality improvement (QI) studies have shown that avoiding inappropriate IUC use prevents urinary catheter harm [8–11]. Common to these studies is the implementation of a multimodal intervention bundle focusing on the reduction of unnecessary catheter use, proper insertion techniques and safe catheter maintenance. Successful bundles consist of catheter restriction protocols providing appropriate indications for catheter use and suggesting alternative urine collection methods, evaluation strategies such as reminders and/or stop orders to assess ongoing catheter need and prompt removal of unnecessary catheters, as well as educational interventions to increase awareness among healthcare workers and ensure safe catheter handling [12].

In addition to best practices, changes in behavior and culture – the so-called socio-adaptive component – are considered a core element of quality improvement efforts [13,14]- The organizational culture, which may be described as “the way we do things around here” [15] is known to have a favorable influence on patient safety, although the evidence for a direct causative effect on patient outcome is weak [16,17]. Several studies suggest that changes in staff knowledge and attitudes are needed to improve practice in regard to appropriate catheter utilization and prevention of catheter-associated infections [18–23]. However, to our knowledge only few studies [e.g.24–26] have reported the effects of a multi-modal intervention bundle on staff knowledge, perceptions and beliefs.

To promote safe urinary catheter use in Swiss hospitals, a national QI project was developed and conducted by the Swiss Patient Safety Foundation in partnership with Swissnoso, the National Center for Infection Control. The QI project was modeled after other successful QI initiatives in the US [8,9]. The overall project goal was to reduce IUC use and to promote safe catheter insertion and maintenance by implementing an evidence-based intervention bundle in seven Swiss acute care hospitals.

With the present study, we aimed to assess the changes in staff perspectives in the participating hospitals using survey data collected before and after implementation of the intervention bundle. We hypothesized that the intervention bundle may affect staff members differently depending on their tasks, responsibilities and familiarity with catheterization. We therefore stratified results according to professional group, managerial function (a proxy for hierarchical status and clinical

proximity) and frequency of catheter use in order to explore changes within these groups over time. Furthermore, in before/after study designs, data from two (or more) cross-sectional survey waves are commonly analyzed on group level to evaluate short term effects of an intervention [27–29]. However, given the high staff turnover in hospitals and self-selection of participants, it is possible that survey participants are not identical at the different measurement points. Thus, documented changes in staff perspectives between two time points may merely be due to a different composition of participant groups. We therefore used the self-generated identification code technique [30] to anonymously match respondents in the two surveys. This allowed us to compare the effects observed in the overall sample to the effects observed in a sub-sample of matched participants, for whom we can assume that they had been working at the hospitals for the entire duration of the project.

METHODS

Setting

The QI project consisted of two parts, a campaign to raise awareness among health care workers and an intervention that was implemented in seven pilot hospitals. For the campaign, recommendations on safe IUC use in acute care hospitals [31] were developed and disseminated to all acute care hospitals (including pilot hospitals) in Switzerland after collection of baseline data in the pilot hospitals (November 2016). The intervention focused on the implementation of an evidence-based intervention bundle in seven pilot hospitals over the course of nine months (Feb-Oct 2017). The participating hospitals contractually committed to implement the three main components of the bundle: an evidence-based indication list for urinary catheterization (appendix 1), a process to evaluate and document the continued need for catheterization on a daily basis, and staff education on proper catheter insertion and maintenance. For the latter, hospitals were required to provide theoretical trainings on catheter-associated complications to all nursing and medical staff members working on the pilot units. They were encouraged to offer practical trainings for catheter insertion (optional). The hospitals (1 small local hospital, 4 mid-sized regional hospitals and 2 university hospitals) were recruited to represent different organizational types and geographic regions. Each hospital could decide which units participated in the project; however, the participation of the emergency department was mandatory. At each site, interdisciplinary project teams, generally consisting of physicians, nurses and representatives from quality management and the infection prevention unit were responsible for implementing the intervention bundle in the participating organizational units. To encourage knowledge exchange between the local project teams, two full-day workshops were organized at the beginning and the end of the intervention phase. The intervention was accompanied by a before/after surveillance and a

before/after staff survey. This publication will focus on the results from the staff surveys and their changes over time.

Study design

To collect data on staff perspectives regarding IUC use, we conducted a written survey during two time periods. The baseline survey (T_0) took place in October 2016, four months before the participating hospitals started to implement the intervention bundle. The follow-up survey (T_1) took place one year later in October 2017. At that point, all hospitals had implemented the intervention bundle and had been working with the new processes for six to eight months. The target population consisted of surgical positioning specialists, nurses (healthcare assistants, registered nurses and nursing managers) and physicians (residents, senior and chief physicians) working on the participating units at the time of the survey. Staff members not involved in direct patient care, healthcare workers in education and affiliated physicians were excluded.

Questionnaire

The 55-item standardized questionnaire was developed by the authors based on prior survey research conducted during a similar improvement project [32,33], and a review of existing surveys reported in the literature [18–22]. The German version of the questionnaire was pretested among 42 physicians and nurses from three hospitals not participating in the project. Based on their feedback, minor modifications were made to increase validity. The final version was translated into French and Italian by professional translators. Translations were reviewed by four native speakers per language.

The questionnaire consisted of four thematic sections. The first section entailed a 15-item knowledge test on prevalence, risk factors and prevention of catheter-associated complications, as well as appropriate reasons for catheter placement. The second section included 13 items assessing respondents' perception regarding good practices and cultural factors for safe IUC use within the organization. Items were rated on a 7-point Likert scale from "strongly disagree" (1) to "strongly agree" (7). Two items were negatively worded and were reverse coded for data analysis. The content of the first two sections of the questionnaire was in line with the above-mentioned recommendations for safe catheter use [31]. The third section examined self-perceived responsibilities in regard to catheter prescription, placement and care by means of one multiple-response question. The fourth section assessed determinants of personal behavior in regard to the reduction of urinary catheters. Items for this section were developed based on the theory of planned behavior [34]. This theory states that an individual's intention to perform a behavior is largely determined by three factors, namely a favorable or unfavorable evaluation of the behavior

(attitudes), the perceived social expectations to perform or not perform the behavior (subjective norms) and the perceived capability to perform the behavior (perceived behavioral control) [34,35]. In our questionnaire, the three constructs (attitudes, subjective norms and perceived behavioral control) were measured with five items each. All 15 items were rated on a 7-point Likert scale from "strongly disagree" (1) to "strongly agree" (7). Two items were negatively worded and were reverse coded for analysis.

The questionnaire also included a section on demographics and experience with placing urinary catheters. On the first page of the questionnaire, participants were asked to generate an 8-digit code consisting of three elements: the mother's initials (maiden name), father's initials and mother's birth year. We used the same questionnaire at both time points. For the follow-up survey, we included four additional questions that specifically referred to the intervention bundle. All other items remained unaltered.

Data collection

Each local project team was required to identify all staff members from the target population, inform and invite them to participate in the survey and distribute the print version of the questionnaire. In some sites, questionnaires were handed out during shift reports or other staff events; in others they were distributed to internal mail boxes. In one hospital, questionnaires were sent to private home addresses. Participation in the survey was voluntary and anonymous. The returning of the questionnaire was considered informed consent.

Ethics

Approval for the quality improvement project and all data collection was obtained from the Lead Ethics Committee of the Canton of Bern, Switzerland (no. 2016-00682).

Data analysis

Descriptive statistics were calculated for each item. Missing values were excluded from analysis (pairwise exclusion). Chi-squared tests were used to determine differences in sample composition. A "knowledge score" was generated consisting of the number of correctly answered questions out of 15. Cronbach's alpha was calculated to determine internal consistency of the 13-item perception scale and the 15-item behavior scale. For both scales a mean scale score and 95% confidence interval was computed. Knowledge score and mean scale scores were computed for the overall sample and stratified by professional group (nurses/physicians), managerial function (with/without) and frequency of catheter placement (frequent/infrequent user). Frequent users were defined as healthcare workers placing a catheter a few times a month or more often; infrequent users as

placing a catheter a few times a year or less often. Changes between time points were determined for the overall sample and each subgroup by means of *t*-tests for independent samples.

To analyze the sub-sample of matched participants, self-generated IDs were matched based on the 8-digit code and hospital affiliation. Cases with identical codes or missing data were excluded. For matched participants, knowledge score and mean scale scores were computed. Change between time points was determined by means of *t*-test for paired samples. Mixed analysis of variance was conducted to determine if participation in theoretical and practical training had an effect on knowledge scores over time.

All tests were two-sided and a p-value <0.05 was considered statistically significant. Cohen's *d* was calculated as a measure of effect size. For paired samples, the formula t_c as described in Dunlap et al [36] was used to calculate *d*. As an orientation for interpreting the importance of the effect, we used the following classification: 0.2=small effect, 0.5=medium effect and 0.8=large effect. [37] All analyses were performed with Stata version 14.1 (StataCorp, College Station, Texas).

Patient and public involvement

Patients or public were not involved in any stages of this study.

RESULTS

Response rate and study sample

1,579 out of 3,245 eligible staff members participated in the baseline survey (48.7% response rate) and 1,527 out of 3,235 eligible staff members participated in the follow-up survey (47.2% response rate). The proportion of questionnaires received from each hospital in the total sample was similar in both waves (p=0.39). The characteristics of the study samples at T_0 and T_1 are provided in table 1. Sample composition differed slightly in regard to age (p=0.03), profession (p=0.04) and work unit between the two time points (p=0.02).

Almost all of the 3,106 participants in both survey periods generated an 8-digit ID. At baseline, 35 respondents (2.2%) had missing values on each of the three code elements and the sample contained 3 sets of identical IDs. At follow-up, 51 respondents (3.3%) did not provide an 8-digit ID and 2 sets of identical IDs were found. For 420 respondents, we were able to successfully match the 8-digit identification code and hospital affiliation. This represents 27.5% of the 1,527 potential matches. 1,118 IDs were only present at T_0 and 1,052 IDs were only present at T_1.

Table 1. Study sample characteristics

	T_0 n = 1,579	T_1 n = 1,527
Participants per hospital, n (%) *		
Hospital A (approx. 900 beds)	221 (14.0)	223 (14.6)
Hospital B (approx. 800 beds)	154 (9.8)	170 (11.1)
Hospital C (approx. 500 beds)	138 (8.7)	127 (8.3)
Hospital D (approx. 500 beds)	362 (22.9)	325 (21.3)
Hospital E (approx. 400 beds)	347 (22.0)	342 (22.4)
Hospital F (approx. 300 beds)	284 (18.0)	250 (16.4)
Hospital G (approx. 100 beds)	73 (4.6)	90 (5.9)
Females, n (%)	1,187 (77.6)	1,191 (79.7)
Age in years (mean, SD) +	36.8 (10.5)	35.9 (10.5)
Profession, n (%) +		
Nurse	1,050 (69.1)	1,084 (72.8)
Physician	350 (23.0)	288 (19.3)
Other	120 (7.9)	117 (7.9)
With managerial function, n (%)	232 (16.4)	193 (13.9)
Years working in this hospital, n (%)		
< 2 years	376 (24.5)	380 (25.4)
2 to < 5 years	385 (25.0)	357 (23.9)
5 to < 10 years	264 (17.2)	271 (18.1)
10 to < 20 years	307 (20.0)	297 (19.9)
≥ 20 years	206 (13.4)	190 (12.7)
Work unit in the past three months, n (%) +		
Ward	906 (58.5)	963 (63.9)
Emergency department	248 (16.0)	190 (12.6)
Intensive care unit	144 (9.3)	129 (8.6)
Operating room	146 (9.4)	141 (9.4)
Other	104 (6.7)	85 (5.6)
Overall experience with catheter placement throughout career, n (%)		
Never	26 (1.7)	30 (2.0)
1-5 times	169 (11.0)	171 (11.4)
6-20 times	341 (22.2)	370 (24.6)
> 20 times	1,002 (65.2)	931 (62.0)
Frequency of catheter placement in current position, n (%)		
Frequent user	690 (44.2)	618 (41.1)
Infrequent user	871 (55.8)	885 (58.9)

Note: Due to rounding percentages may not always add up to 100%.

* In the larger hospitals, not all of the departments participated in the project

+ Characteristics differ significantly between the two time periods ($p<0.05$)

T_0=baseline survey, T_1=follow-up survey

Frequent user=places a catheter a few times a month or more often
Infrequent user=places a catheter a few times a year or less often

Knowledge

For the overall study sample, the mean number of correctly answered knowledge items increased significantly between T_0 and T_1 (p<0.001) (table 2). Subgroup analysis indicates that knowledge scores increased in particular for nurses, staff members without managerial function and staff members frequently placing catheters. However, their knowledge scores at follow-up still remained lower compared to the scores of physicians, staff members with managerial function and infrequent users. Knowledge scores increased more for participants with a matched ID compared to unmatched participants. Effect sizes for the changes between the time points were small to moderate. Percentages of correct answers for each of the 15 items are provided in appendix 2.

Table 2. Mean number of correct answers provided for 15 knowledge items

	Mean $_{T0}$ (95% CI)	n_{T0}	Mean $_{T1}$ (95% CI)	n_{T1}	p-value	Effect size
Overall sample	10.4 (10.3;10.5)	1,579	11.0 (10.9;11.1)	1,527	<0.001	0.29
Professional group						
Nurses	10.2 (10.1;10.4)	1,050	10.9 (10.8;11.0)	1,084	<0.001	0.35
Physicians	11.1 (11.0;11.3)	350	11.4 (11.2;11.6)	288	0.047	0.16
Managerial function						
With	11.3 (11.1;11.5)	232	11.6 (11.4;11.9)	193	0.058	0.19
Without	10.3 (10.1;10.4)	1,187	10.9 (10.8;11.0)	1,199	<0.001	0.33
Frequency of catheter placement						
Frequent user	10.0 (9.8;10.1)	690	10.7 (10.6;10.9)	618	<0.001	0.40
Infrequent user	10.8 (10.7;10.9)	871	11.2 (11.1;11.3)	885	<0.001	0.22
Matched ID	10.4 (10.3;10.6)	420	11.3 (11.1;11.5)	420	<0.001	0.49
Unmatched ID	10.5 (10.3;10.6)	1,118	11.0 (10.9;11.1)	1,052	<0.001	0.31

T_0=baseline survey, T_1=follow-up survey
Frequent user=places a catheter a few times a month or more often,
Infrequent user=places a catheter a few times a year or less often

We used the sub-sample of matched participants to examine the effect of training on the change in knowledge score over time. Among all matched respondents, 102 (25.3%) indicated having participated in *both* theoretical and practical training; 130 (32.2%) respondents had participated in *either* theoretical or practical training and 172 (42.6%) respondents had participated in *no* training. Results from the mixed analysis of variance showed that there was no significant interaction effect between time and training ($F_{2,401}$ =1.05, p=0.35). In other words, knowledge scores between participants with practical and/or theoretical training did not change differently over time as compared to participants without training.

Perception of practices and culture

The mean scale score for perception of current practices and culture increased significantly within the overall sample and within all subgroups between the two time points (p<0.001). Mean scale sores also increased for both matched and unmatched participants to a similar extent (table 3). Generally, agreement to the statements was moderate at baseline and strengthened over time. Yet, agreement remained moderately strong, with no group reaching a mean scale score above 6 even after implementation of the intervention bundle. Mean scores for each item are provided in appendix 3.

Table 3. Perception: mean scale score

	Mean $_{T0}$ (95% CI)	n_{T0}	Mean $_{T1}$ (95% CI)	n_{T1}	p-value	Effect size
Overall sample	5.3 (5.3; 5.3)	1,568	5.5 (5.5; 5.6)	1,521	<0.001	0.31
Professional group						
Nurses	5.4 (5.3; 5.4)	1,044	5.6 (5.6; 5.7)	1,082	<0.001	0.33
Physicians	5.1 (5.0; 5.1)	347	5.3 (5.2; 5.4)	286	<0.001	0.29
Managerial function						
With	5.2 (5.1; 5.3)	230	5.6 (5.5; 5.7)	191	<0.001	0.52
Without	5.3 (5.3; 5.4)	1,180	5.6 (5.5, 5.6)	1,197	<0.001	0.29
Frequency of catheter placement						
Frequent user	5.2 (5.1; 5.3)	690	5.4 (5.3, 5.5)	618	<0.001	0.22
Infrequent user	5.4 (5.3; 5.4)	861	5.7 (5.6, 5.7)	880	<0.001	0.37
Matched ID	5.4 (5.3; 5.4)	416	5.6 (5.5; 5.7)	416	<0.001	0.32
Unmatched ID	5.3 (5.2; 5.3)	1,108	5.5 (5.5; 5.6)	1,049	<0.001	0.31

Note: Scale consisted of 13 items.
Items were answered on a scale from 1 (strongly disagree) to 7 (strongly agree).
Cronbach's alpha for the scale: T_0 α=0.79 and T_1 α=0.80
T_0=baseline survey, T_1=follow-up survey
Frequent user=places a catheter a few times a month or more often,
Infrequent user=places a catheter a few times a year or less often

Responsibilities

Self-reported responsibilities concerning IUC management by nurses and physicians changed only slightly over time (figure 1). At baseline and at follow-up, nurses felt mainly responsible for placing, maintaining and removing an IUC. However, at T_1, fewer nurses felt responsible for prescribing catheter placement (p<0.001) as compared to T_0 and a higher percentage felt responsible for assessing the need for continued catheterization (p=0.002). Physicians perceived themselves to be mainly responsible for prescribing catheter placement and removal at both time points. At T_1, fewer of them felt responsible for placing or assisting with placing an IUC as compared to T_0, but differences were not statistically significant.

Determinants of behavior

The mean score for the scale assessing the determinants of behavior increased significantly between baseline and follow-up (p<0.001). Positive changes in mean scores were observed for all three constructs (attitudes, subjective norms and perceived behavioral control). They were particularly strong for items assessing perceived social expectations to use catheters restrictively. The positive trends could be observed for professional group, managerial function and frequency of catheter placement. There was no notable difference between the results for matched and unmatched participants. Medium effect sizes indicate practical relevance of these changes. Table 4 shows results for all groups. Mean scores for each item are provided in appendix 4.

Table 4. Determinants of behavior: mean scale score

	Mean $_{T0}$ (95% CI)	n_{T0}	Mean $_{T1}$ (95% CI)	n_{T1}	p-value	Effect size
Overall sample	5.3 (5.3; 5.3)	1,539	5.6 (5.6; 5.6)	1,502	<0.001	0.43
Professional group						
Nurses	5.3 (5.2; 5.3)	1,046	5.6 (5.6; 5.7)	1,083	<0.001	0.56
Physicians	5.4 (5.3; 5.5)	349	5.6 (5.5; 5.6)	287	0.005	0.23
Managerial function						
With	5.6 (5.5; 5.7)	230	5.8 (5.7; 5.9)	192	<0.001	0.38
Without	5.2 (5.2; 5.3)	1,184	5.6 (5.5; 5.6)	1,198	<0.001	0.50
Frequency of catheter placement						
Frequent user	5.2 (5.2; 5.3)	675	5.6 (5.5; 5.6)	615	<0.001	0.46
Infrequent user	5.3 (5.3; 5.4)	847	5.6 (5.6; 5.7)	884	<0.001	0.41
Matched ID	5.3 (5.3; 5.4)	405	5.7 (5.6; 5.8)	405	<0.001	0.58
Unmatched ID	5.3 (5.3; 5.3)	1,090	5.6 (5.5; 5.6)	1,038	<0.001	0.37

Note: Scale consisted of 15 items.
Items were answered on a scale from 1 (strongly disagree) to 7 (strongly agree).
Cronbach's alpha for scale: T_0 α=0.72 and T_1 α=0.74
T_0=baseline survey, T_1=follow-up survey
Frequent user=places a catheter a few times a month or more often,
Infrequent user=places a catheter a few times a year or less often

DISCUSSION

With this before and after survey study, we analyzed how staff knowledge, perceptions and attitudes regarding IUC use changed following the implementation of a multimodal intervention bundle in seven hospitals.

Knowledge scores increased significantly between baseline and follow-up, indicating that staff members in our pilot hospitals had more factual knowledge about the use and potential harm of urinary catheters after the intervention. We saw the most substantial changes over time in nursing

staff and in staff without managerial function and staff frequently placing catheters. It is conceivable that trainings offered were specifically targeted at staff members frequently in charge of catheterization in daily practice. However, their knowledge scores at follow-up remained lower than those of physicians, staff with managerial function and staff rarely placing catheters. Pilot hospitals were required to provide theoretical trainings to all staff members working on the pilot units and offer practical training on a voluntary basis. Local project teams received templates for training materials from the program team, but they were free to design and organize the trainings according to their local structure and processes. Our survey results show that by no means all staff members from the target population attended a training session. Informal feedback received from local project leaders suggests that substantial effort was required to organize trainings. Interestingly, we could not verify that participating in education and training sessions contributed to knowledge increases in our sub-sample of matched participants. Although staff training is usually included as a core component in QI projects,[38] it is difficult to determine its influence on the overall effect when implemented as part of a multi-modal bundle. Our results show that resource-intensive education sessions need not be the only way to convey knowledge and awareness about safety issues and good practices. Other measures such as implementing new policies, using unit-level champions to model safety behaviors, or promoting bedside teaching may be alternative avenues. Training sessions do, however, offer a platform for hospitals to disseminate norms and expectations, especially if they are used by leaders to demonstrate their commitment to the cause.

Urinary catheter management is a strongly interprofessional topic and it is therefore essential that roles and responsibilities are clear for all of the involved health care workers. In a previous study with data from the baseline survey, we analyzed how nurses and physicians perceived their respective responsibilities for IUC management [39]. We found that physicians felt mainly responsible for prescribing catheter placement and removal, while nurses generally considered themselves responsible for placing, managing and removing them. However, both nurses and physicians felt equally responsible for assessing the need for continued catheterization. The results from the present study show that at the end of the intervention, the perceived division of tasks between the two groups remained largely the same. However, this does not necessarily indicate that tasks especially in regard to the re-evaluation of the need for a catheter were not clarified over the course of the project. Rather, it is conceivable that because of the intervention bundle, both groups were encouraged to assume responsibility in this area.

Examining respondents' perception of current practices and cultural factors within their organization, we found a small, but significant effect at the end of the intervention. The moderate effect size suggests that staff members indeed perceived positive changes in IUC management and safety climate within their organization. We also found that factors determining intentions to

perform a certain behavior, namely personal attitudes, perceived behavioral control and subjective norms changed over the course of the project. At follow-up, staff members generally expressed higher willingness to contribute to a safe and restrictive use of IUCs. In particular, participants felt higher expectations from their social environment to reduce catheters, suggesting that a change in culture could indeed be initiated. Wakefield and colleagues found that perceptions about the behavior of professional peers, and the personal belief that engaging in a certain behavior will lead to better safety outcomes, are the strongest factors influencing safety behavior. The authors conclude that interventions too often rely on educational measures in order to change behavior and argue that using behavioral models to design interventions may be more effective [15]. Our results seem to confirm this.

Even though there was a clear positive trend, average agreement for both scales remained moderately strong at follow-up. Recommended practices and socio-adaptive components were thus, from the perspective of participants, not fully established in the institutions even after the intervention. This highlights the importance of continued efforts to incorporate recommended practices into routine care even after completion of the actual project phase. With high staff turnover rates in the hospitals, it seems particularly important to ensure that new staff members learn about and understand the policies, practices and expectations regarding IUC use in the hospitals.

Almost all of the respondents generated an 8-digit code. Interestingly, however, only 28% of the IDs provided could be matched between the two surveys. Participants at follow-up were thus, for the most part, not the same individuals than at baseline. This may be due to high staff turnover rates during the intervention period and could mean that many new employees, who had not been working at the hospital at the time of the baseline survey, participated in the follow-up survey. However, it is also conceivable that unmatched participants had been working at the hospital throughout the intervention, but had been unwilling or unable to participate in the same survey twice. We found that in all of the thematic sections, the scores for unmatched participants increased to the same extent than for matched participants. This suggests results obtained on the group level quite closely represent results on the individual participant level.

Limitations

This study has several limitations. A control group was not included in the study design for practical purposes. The single-group design does therefore not allow any causal inferences about the contribution of the intervention bundle on the observed effects. It is possible that other trends or measures within the hospitals may have affected the outcomes. Furthermore, the study design does not allow us to evaluate sustainability of the intervention over time. Another follow-up survey

could shed more light on the long-term effects in the hospitals. Since data collection was organized by local project teams, we have no information on non-participants. It is possible that only highly motivated staff members participated in the survey, which may result in more positive responses. The two survey samples were comparable with respect to participants per hospital. For some of the socio-demographic characteristics, notably profession and work unit, we found significant differences between the two time periods. However, since the results for the matched participants were comparable to the overall sample, it can be assumed that sample composition did not influence the overall results.

Conclusion

Changing staff attitudes, knowledge and behavior are important prerequisites for an effective reduction of catheter use and catheter-associated complications. We found that staff members had better knowledge of catheter-associated risks, a more positive perception of current practices and cultural factors within their organization and stronger beliefs and attitudes towards restrictive urinary catheter use after the implementation of a multi-modal intervention bundle. The positive trends were present in all subgroups, indicating that regardless of responsibilities and practice of catheter placement, perspectives on urinary catheter use changed over time. Efforts now need to be targeted at sustaining these changes, so that restrictive use of IUCs becomes an integral part of the hospital culture.

Author contributions: AN, SZ, JM, AS and DS contributed to the design of the study and the survey instrument, SK und GF contributed to the data collection. AN and DS analyzed the data. AN and SZ drafted the manuscript, JM, AS, SK, GJ and DS critically revised the manuscript for important intellectual content. All authors approved the manuscript.

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Figure legends

Figure 1. Self-reported responsibilities in regard to urinary catheters by profession

* Change between time periods significant on $p<0.05$.

Appendices

Appendix 1. List of indications for indwelling urinary catheters

Appendix 2. Knowledge: % correct answers provided per item at T0 and T1

Appendix 3. Perception: mean and standard deviation per item at T0 and T1

Appendix 4. Behavior: mean and standard deviation per item at T0 and T1

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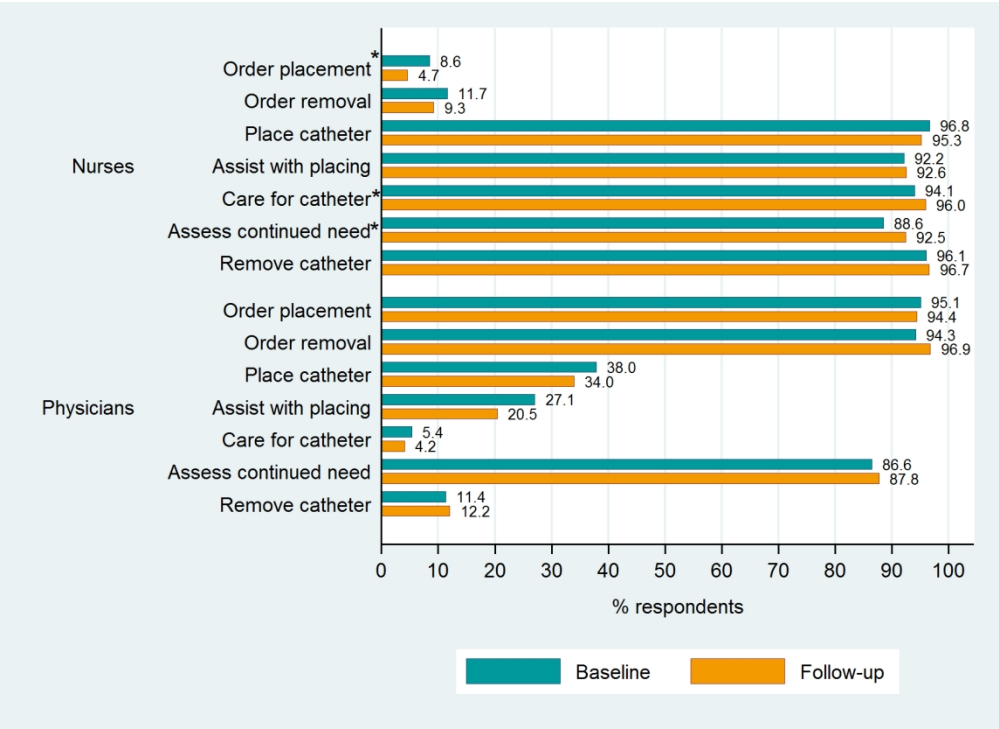

Figure 1. Self-reported responsibilities in regard to urinary catheters by profession

152x110mm (300 x 300 DPI)

Appendix 1. List of indications for indwelling urinary catheters

Note: This list does not cover urological emergencies. Treatment for these cases is decided by the urologist.

No indications for a urinary catheter are:

- Asymptomatic chronic urinary retention
- Urine output monitoring / fluid monitoring for stable patients, if daily weight control is possible
- Need for intensive care
- Urinary incontinence
- Immobilization, as long as alternative methods[1] for controlled bladder drainage have not been exhausted
- Comfort from the perspective of the patient (or their trusted representative) OR from the perspective of staff

Indication	Specification
Urinary retention	Acute urinary retention of any origin Symptomatic chronic outflow obstruction PLUS >300 ml residual urine
Urine output monitoring	In regular, short intervals (hourly or as defined by hospital) PLUS direct therapeutic consequences from monitoring, if body weight of patient cannot be measured
Surgery	Long surgery (>4h) Perioperative: for surgical reasons, if bladder has to be empty. Catheter is to be removed at the end of the surgery Urogenital surgery and/or pelvic floor surgery Epidural / peridural anesthesia/analgesia
Pressure ulcers PLUS incontinence	Pressure ulcers stage III or IV, or sacral/perineal skin transplants PLUS incontinence, if alternative methods[1] for controlled bladder drainage failed
Prolonged immobilization	Immobilization for medical reasons, especially for pain reduction, if alternative methods[1] for controlled bladder drainage failed
Palliation PLUS Comfort	Terminal-palliative situation PLUS dysfunction of bladder PLUS/OR difficulties with normal voiding, if alternative methods[1] for controlled bladder drainage failed Severe psychological strain PLUS at the request of the informed patient (or their trusted representative)

[1] Alternative methods are: condom catheter, urinal, bedpan, bedside commode, incontinence pads, pants

List was translated for this publication by the authors.

Appendix 2. Knowledge – % correct answers provided per item

	% T_0 n = 1,579	% T_1 n = 1,527
Please estimate:		
How many patients in Switzerland receive a catheter during their hospital stay? (10-25%)	37.6	39.1
Please indicate if the following statements are correct:		
After 30 catheter-days, nearly all patients show bacteriuria. (correct)	81.6	86.9
The duration of catheterization is an important risk factor for the development of a urinary tract infection. (correct)	98.0	98.9
Most hospital-acquired urinary tract infections are associated with a urinary catheter. (correct)	82.2	86.3
Single-use urinary catheters carry a higher risk for infections as compared to indwelling catheters. (false)	89.9	91.9
A closed drainage system is essential for the prevention of catheter-associated urinary tract infections. (correct)	77.4	82.0
Compared to catheters, non-invasive methods for bladder draining (e.g., condom catheters, incontinence pads) have the advantage that they do not carry a risk for injuries. (correct)	62.4	69.0
Non-infectious complications (e.g., injuries or allergic reactions) only occur in absolutely rare instances during catheterization. (false)	61.2	68.8
The choice of an antiseptic for disinfecting the urethral meatus does not affect the correct asepsis when inserting a catheter. (false)	80.6	82.6
Up to 50 percent of catheters placed in an emergency department are not medically justified. (correct)	61.4	73.8
One effective measure to prevent catheter-associated urinary tract infections is to change catheters or drainage bags in regular intervals. (false)	30.4	36.2
In which of these situations is the placement of a urinary catheter indicated?		
To monitor urine output in stable patients who can be weighed. (not indicated)	97.5	98.1
In case of distress at the request of a terminally ill patient. (indicated)	93.3	93.2
For patients requiring intensive care. (not indicated)	21.2	32.3
For patients with restricted mobility. (not indicated)	79.9	81.4

Correct answers for knowledge items are provided in parentheses. Items were translated for this publication by the authors. Sample size differs slightly for each item due to a varying number of missing values.

Appendix 3. Perception of practices and culture – Mean and standard deviation per item

	Mean T_0 (SD) n = 1,579	Mean T_1 (SD) n = 1,527
On my unit, IUCs are placed only as clearly indicated medical measure.	5.5 (1.4)	5.7 (1.3)
Nursing workload plays an important role when a decision for placing an IUC is made.	2.8 (1.8)	2.5 (1.6)
Whenever possible, staff on my unit tries to use alternatives to an IUC (e.g., condom catheters, incontinence pads).	4.7 (1.8)	5.1 (1.7)
The daily assessment to evaluate if an IUC is still needed is a given for us.	5.3 (1.6)	5.6 (1.5)
People in charge on my unit make sure that everyone placing IUCs is sufficiently trained for this task.	5.4 (1.7)	5.6 (1.5)
Basic infection prevention measures are well complied with during placement and care of IUCs.	6.0 (1.1)	6.1 (1.0)
If someone needs help when placing an IUC, it is clear on my unit who can be contacted.	5.8 (1.5)	5.9 (1.4)
It is common on my unit that, whenever possible, two healthcare workers work together to place a catheter.	5.0 (1.9)	5.2 (1.7)
For medical leadership on my unit, restrictive use of IUCs is very important.	5.1 (1.6)	5.4 (1.4)
For nursing leadership on my unit, restrictive use of IUCs is very important.	5.1 (1.5)	5.7 (1.3)
Medical and nursing staff on my unit have a similar attitude concerning the use of IUCs.	5.1 (1.4)	5.3 (1.4)
For staff members on my unit, it is a matter of course to openly question the placement of an IUC.	5.5 (1.4)	5.7 (1.2)
It is difficult on my unit to speak up when rules of hygiene are broken during placement and care of an IUC.	2.9 (1.7)	2.8 (1.6)

Items were translated for this publication by the authors. Sample size differs slightly for each item due to a varying number of missing values.

Appendix 4. Determinants of personal behavior – Mean and standard deviation per item

	Mean T_0 (SD) n = 1,579	Mean T_1 (SD) n = 1,527
Perceived behavioral control		
I can properly estimate in which situations the use of an IUC is appropriate.	6.1 (1.0)	6.1 (1.0)
I can influence the use of IUCs in my daily work.	5.5 (1.4)	5.7 (1.4)
I am convinced that I am proficient in caring for an indwelling catheter.	5.5 (1.6)	5.6 (1.6)
I am convinced that I am proficient in inserting a urinary catheter.	5.7 (1.5)	5.7 (1.4)
I am confident that I can reduce the use of IUCs in everyday work.	5.0 (1.5)	5.5 (1.4)
Subjective Norms		
My colleagues appreciate my commitment to reduce the use of IUCs.	5.1 (1.5)	5.4 (1.4)
In my hospital I am expected to contribute to the reduction of IUCs.	4.6 (1.8)	5.7 (1.5)
Our patients appreciate it when IUCs are avoided.	5.5 (1.4)	5.6 (1.4)
My supervisors expect that everyone follows the internal protocols for inserting catheters.	6.0 (1.2)	6.1 (1.2)
My supervisors expect me to reduce the use of IUCs.	4.5 (1.7)	5.5 (1.5)
Attitudes		
The risk from IUCs for patients is underestimated.	5.1 (1.6)	5.0 (1.8)
I find it difficult in my daily work to reduce the use of IUCs.	3.7 (1.7)	3.3 (1.6)
I am convinced that by reducing the use of IUCs, adverse events to patients can be avoided.	5.8 (1.3)	6.1 (1.1)
A reduced use of IUCs makes patient care more stressful for me.	3.0 (1.8)	2.9 (1.7)
I think that it's important to reduce the use of IUCs in the hospital.	5.7 (1.3)	6.0 (1.2)

Items were translated for this publication by the authors. Items are presented according to their construct (perceived behavioral control, subjective norm and attitudes). In the questionnaire, order of the items was randomized. Sample size differs slightly for each item due to a varying number of missing values.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	title page
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	p.2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	p.3-4
Objectives	3	State specific objectives, including any prespecified hypotheses	p.3-4
Methods			
Study design	4	Present key elements of study design early in the paper	p.5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	p.4 & p.5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	p.5 & p.6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	p.5-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	N/A
Bias	9	Describe any efforts to address potential sources of bias	N/A
Study size	10	Explain how the study size was arrived at	p.6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	p.6-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	p.6-7
		(*b*) Describe any methods used to examine subgroups and interactions	p.6-7
		(*c*) Explain how missing data were addressed	p.6-7
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	N/A

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	p.7
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	p.8 (table 1)
		(b) Indicate number of participants with missing data for each variable of interest	p.8 (table 1)
Outcome data	15*	Report numbers of outcome events or summary measures	p.9-11
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	N/A
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	p.9
Discussion			
Key results	18	Summarise key results with reference to study objectives	p.11-13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	p.13-14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	p.14
Generalisability	21	Discuss the generalisability (external validity) of the study results	p.13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	p14

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Change in staff perspectives on indwelling urinary catheter use after implementation of an intervention bundle in seven Swiss acute care hospitals: Results of a before/after survey study

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Change in staff perspectives on indwelling urinary catheter use after implementation of an intervention bundle in seven Swiss acute care hospitals: Results of a before/after survey study

Running title: Change in staff perspectives

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Abstract

Objective: To evaluate changes in staff perspectives towards indwelling urinary catheter (IUC) use after implementation of a one-year quality improvement project.

Design: Repeated cross-sectional survey at baseline (October 2016) and 12-month follow-up (October 2017).

Setting: Seven acute care hospitals in Switzerland

Participants: The survey was targeted at all nursing and medical staff members working at the participating hospitals at the time of survey distribution. A total of 1,579 staff members participated in the baseline survey (49% response rate) and 1,527 participated in the follow-up survey (47% response rate).

Intervention: A multimodal intervention bundle, consisting of an evidence-based indication list, daily re-evaluation of ongoing catheter need and staff training, was implemented over the course of 9 months.

Main Outcome Measures: Staff knowledge (15 items), perception of current practices and culture (scale 1-7), self-reported responsibilities (multiple-response question) and determinants of behavior (scale 1-7) before and after implementation of the intervention bundle.

Results: The mean number of correctly answered knowledge questions increased significantly between the two survey periods (T_0: 10.4, T_1: 11.0, $p<0.001$). Self-reported responsibilities with regard to IUC management by nurses and physicians changed only slightly over time. Perception of current practices and culture in regard to safe urinary catheter use increased significantly (T_0: 5.3, T_1: 5.5, $p<0.001$). Significant changes were also observed for determinants of behavior (T_0: 5.3, T_1: 5.6, $p<0.001$).

Conclusion: We found small, but significant changes in staff perceptions after implementation of an evidence-based intervention bundle. Efforts now need to be targeted at sustaining and reinforcing these changes, so that restrictive use of IUCs becomes an integral part of the hospital culture.

ARTICLE SUMMARY

Strengths and limitations of this study

- The repeated survey design allowed us to assess changes in staff perspectives after implementation of a quality improvement intervention. Sustainability of the effects over time, however, could not be evaluated.
- By using self-generated identification codes to match respondents in the two surveys, it was possible to evaluate if results obtained on the group level (two cross-sections) represent results on the individual participant level (longitudinal).
- No control group was included in the study design. It is possible that other trends or measures within the hospitals may have affected the outcomes.

INTRODUCTION

Although indwelling urinary catheters (IUCs) are commonly used in acute care hospitals, an appropriate medical indication is often missing [1,2]. IUCs are associated with urinary tract infections (UTI) and non-infectious complications such as hematuria and urethral injury. The reduction of IUC use is therefore a key measure to increase patient safety [3–7].

Several quality improvement (QI) studies have shown that avoiding inappropriate IUC use prevents urinary catheter harm [8–11]. Common to these studies is the implementation of a multimodal intervention bundle focusing on the reduction of unnecessary catheter use, proper insertion techniques and safe catheter maintenance. Successful bundles consist of catheter restriction protocols providing appropriate indications for catheter use and suggesting alternative urine collection methods, evaluation strategies such as reminders and/or stop orders to assess ongoing catheter need and prompt removal of unnecessary catheters, as well as educational interventions to increase awareness among healthcare workers and ensure safe catheter handling [12].

In addition to best practices, changes in behavior and culture – the so-called socio-adaptive component – are considered a core element of quality improvement efforts [13,14]. The organizational culture, which may be described as “the way we do things around here” [15] is known to have a favorable influence on patient safety, although the evidence for a direct causative effect on patient outcome is weak [16,17]. Several studies suggest that changes in staff knowledge and attitudes are needed to improve practice in regard to appropriate catheter utilization and prevention of catheter-associated infections [18–23]. However, to our knowledge only few studies [24–26] have reported the effects of a multi-modal intervention bundle on staff knowledge and socio-adaptive components, such as perceptions and beliefs, but none of them addressed all these factors together.

To promote safe urinary catheter use in Swiss hospitals, a national QI project was developed and conducted by the Swiss Patient Safety Foundation in partnership with Swissnoso, the National Center for Infection Control. The QI project was modeled after other successful QI initiatives in the US [8,9]. The overall project goal was to reduce IUC use and to promote safe catheter insertion and maintenance by implementing an evidence-based intervention bundle in seven Swiss acute care hospitals.

With the present study, we aimed to assess the changes in staff perspectives in the participating hospitals using survey data collected before and after implementation of the intervention bundle. We hypothesized that the intervention bundle may affect staff members differently depending on their tasks, responsibilities and familiarity with catheterization. We therefore stratified results

according to professional group, managerial function (a proxy for hierarchical status and clinical proximity) and frequency of catheter use in order to explore changes within these groups over time. In before/after study designs, data from two (or more) cross-sectional survey waves are commonly analyzed on group level to evaluate short term effects of an intervention [27–29]. However, given the high staff turnover in hospitals and self-selection of participants, it is possible that survey participants are not identical at the different measurement points. Thus, documented changes in staff perspectives between two time points may merely be due to a different composition of participant groups. We therefore used the self-generated identification code technique [30] to anonymously match respondents in the two surveys. This allowed us to compare the effects observed in the overall sample to the effects observed in a sub-sample of matched participants, for whom we can assume that they had been working at the hospitals for the entire duration of the project.

METHODS

Setting

The QI project consisted of two parts, a campaign to raise awareness among health care workers and an intervention that was implemented in seven pilot hospitals. For the campaign, recommendations on safe IUC use in acute care hospitals [31] were developed and disseminated to all acute care hospitals (including pilot hospitals) in Switzerland after collection of baseline data in the pilot hospitals (November 2016). The intervention focused on the implementation of an evidence-based intervention bundle in seven pilot hospitals over the course of nine months (Feb-Oct 2017). The participating hospitals contractually committed to implement the three main components of the bundle: an evidence-based indication list for urinary catheterization (appendix 1), a process to evaluate and document the continued need for catheterization on a daily basis, and staff education on proper catheter insertion and maintenance. For the latter, hospitals were required to provide theoretical trainings on safe urinary catheter utilization and catheter-associated complications to all nursing and medical staff members working on the pilot units. They were also encouraged to offer practical training sessions for catheter insertion. Local project teams received templates for training materials from the program team, but they were free to design and organize the trainings according to their local structure and processes. In theoretical trainings, information on risk factors for, and prevention of catheter-associated complications, correct indications for urinary catheters and proper catheter insertion techniques was conveyed either by means of presentations at staff events and/or through completion of an e-learning tool. In most hospitals, theoretical trainings were mandatory for nursing and medical staff. In two hospitals, theoretical inputs were immediately followed by practical training sessions for catheter insertion; in four

hospitals, practical trainings were offered on separate occasions and attendance was voluntary. One hospital did not offer practical training sessions. No exact data could be elicited in regard to the percentage of staff members from the pilot units that actually completed theoretical and/or practical trainings. Strategies to implement the intervention bundle in pilot hospitals included designated champions, internal newsletters, posters and screen savers with key project messages.

The hospitals (1 small local hospital, 4 mid-sized regional hospitals and 2 university hospitals) were recruited to represent different organizational types and geographic regions. Each hospital could decide which wards participated in the project; however, the participation of the emergency department was mandatory. Participating wards included internal medicine, general surgery and neurosurgery and gynecology/obstetrics. At each site, interdisciplinary project teams, generally consisting of physicians, nurses and representatives from quality management and the infection prevention unit were responsible for implementing the intervention bundle in the participating organizational units. To encourage knowledge exchange between the local project teams, two full-day workshops were organized at the beginning and the end of the intervention phase. The intervention was accompanied by a before/after surveillance and a before/after staff survey. The results of the before/after surveillance, which measured urinary catheter utilization ratio and catheter-associated complications, will be reported in another publication [32]. Our publication will focus on the results from the staff surveys and their changes over time.

Study design

To collect data on staff perspectives regarding IUC use, we conducted a written survey during two time periods. The baseline survey (T_0) took place in October 2016, four months before the participating hospitals started to implement the intervention bundle. The follow-up survey (T_1) took place one year later in October 2017. At that point, all hospitals had implemented the intervention bundle and had been working with the new processes for six to eight months. The target population consisted of surgical positioning specialists, nurses (healthcare assistants, registered nurses and nursing managers) and physicians (residents, senior and chief physicians) working on the participating units in one of the seven pilot hospitals at the time of the survey. Staff members not involved in direct patient care, healthcare workers in education and affiliated physicians were excluded.

Questionnaire

The 55-item standardized questionnaire was developed specifically for this study by the authors based on prior survey research conducted during a similar improvement project [33,34], and a review of existing surveys reported in the literature [18–22] (appendix 2). The German version of

the questionnaire was pretested among 42 physicians and nurses from three hospitals not participating in the project. Based on their feedback, minor modifications were made to increase validity. The final version was translated into French and Italian by professional translators. Translations were reviewed by four native speakers per language.

The questionnaire consisted of four thematic sections. The first section entailed a 15-item knowledge test on prevalence, risk factors and prevention of catheter-associated complications, as well as appropriate reasons for catheter placement. The second section included 13 items assessing respondents' perception regarding good practices and cultural factors for safe IUC use within the organization. Items were rated on a 7-point Likert scale from "strongly disagree" (1) to "strongly agree" (7). Two items were negatively worded and were reverse coded for data analysis. The content of the first two sections of the questionnaire was in line with the above-mentioned recommendations for safe catheter use [31]. The third section examined self-perceived responsibilities in regard to catheter prescription, placement and care by means of one multiple-response question. The fourth section assessed determinants of personal behavior in regard to the reduction of urinary catheters. Items for this section were developed based on the theory of planned behavior [35]. This theory states that an individual's intention to perform a behavior is largely determined by three factors, namely a favorable or unfavorable evaluation of the behavior (attitudes), the perceived social expectations to perform or not perform the behavior (subjective norms) and the perceived capability to perform the behavior (perceived behavioral control) [35,36]. In our questionnaire, the three constructs (attitudes, subjective norms and perceived behavioral control) were measured with five items each. All 15 items were rated on a 7-point Likert scale from "strongly disagree" (1) to "strongly agree" (7). Two items were negatively worded and were reverse coded for analysis.

The questionnaire also included a section on demographics and experience with placing urinary catheters. On the first page of the questionnaire, participants were asked to generate an 8-digit code consisting of three elements. To do this, respondents were asked to link the following three elements into a string of letters and numbers: the mother's initials (maiden name), father's initials and mother's birth year (for an example see appendix 2). These three elements were selected because they do not change over time and refer to personal information usually known by the respondent [30]. With this technique, it is possible to clearly identify data from the same subject and, at the same time, ensure anonymity. We used the same questionnaire at both time points. For the follow-up survey, we included four additional questions that specifically referred to the intervention bundle. All other items remained unaltered.

Data collection

Each local project team was required to identify all eligible staff members from the target population, inform and invite them to participate in the survey and distribute and collect the print version of the questionnaire. In some sites, questionnaires were handed out during shift reports or other staff events; in others they were distributed to internal mail boxes. In one hospital, questionnaires were sent to private home addresses. Participation in the survey was voluntary and anonymous. The returning of the questionnaire was considered informed consent.

Ethics

Approval for the study was obtained from the Lead Ethics Committee of the Canton of Bern, Switzerland (no. 2016-00682).

Data analysis

Descriptive statistics were calculated for each item. Missing values were excluded from analysis (pairwise exclusion). A large proportion of subjects participating in the baseline survey did not participate in the follow-up survey. Thus, responses to both surveys cannot be assumed to stem from the same sample. Therefore, tests for unpaired samples were used for the main analyses comparing results between time points (see below for analyses of matched individuals). Chi-squared tests were used to determine differences in sample composition. A “knowledge score” was generated consisting of the number of correctly answered questions out of 15. Cronbach’s alpha was calculated to determine internal consistency of the 13-item perception scale and the 15-item behavior scale. For both scales a mean scale score and 95% confidence interval was computed. Knowledge score and mean scale scores were computed for the overall sample and stratified by professional group (nurses/physicians), managerial function (with/without) and frequency of catheter placement (frequent/infrequent user). Frequent users were defined as healthcare workers placing a catheter a few times a month or more often; infrequent users as placing a catheter a few times a year or less often. Frequency was determined based on the self-reported frequency of placing a catheter in the current work position. Changes between time points were determined for the overall sample and each subgroup by means of *t*-tests for independent samples.

To analyze the sub-sample of matched participants, self-generated IDs were matched based on the 8-digit code and hospital affiliation. For these sub-analyses, cases with identical codes or missing data were dropped. For matched participants, knowledge score and mean scale scores were computed. To determine changes between time points in this sub-sample of matched participants, we used paired analysis. Changes between time points were determined by means of *t*-test for paired samples. Mixed analysis of variance was conducted to determine if participation in theoretical and practical training had an effect on knowledge scores over time. In addition, we

performed difference-in-difference analyses to compare results for group-level data (cross-sectional data of two unmatched groups) and individual-level data (longitudinal data of matched participants). For each of the main outcomes, we compare average change over time among matched participants to the average change over time among unmatched participants.

All tests were two-sided and a p-value <0.05 was considered statistically significant. Cohen's *d* was calculated as a measure of effect size. For paired samples, the formula t_c as described in Dunlap et al [37] was used to calculate *d*. As an orientation for interpreting the importance of the effect, we used the following classification: 0.2=small effect, 0.5=medium effect and 0.8=large effect [38]. All analyses were performed with Stata version 14.1 (StataCorp, College Station, Texas).

Patient and public involvement

Patients or public were not involved in any stages of this study.

RESULTS

Response rate and study sample

1,579 out of 3,245 invited staff members participated in the baseline survey (48.7% response rate) and 1,527 out of 3,235 invited staff members participated in the follow-up survey (47.2% response rate). The proportion of questionnaires received from each hospital in the total sample was similar in both waves (p=0.39). The characteristics of the study samples at T_0 and T_1 are provided in table 1. Sample composition differed slightly in regard to age (p=0.03), profession (p=0.04) and work unit between the two time points (p=0.02).

Almost all of the 3,106 participants in both survey periods generated an 8-digit ID. At baseline, 35 respondents (2.2%) had missing values on each of the three code elements and the sample contained 3 sets of identical IDs. At follow-up, 51 respondents (3.3%) did not provide an 8-digit ID and 2 sets of identical IDs were found. For 420 respondents, we were able to successfully match the 8-digit identification code and hospital affiliation. This represents 27.5% of the 1,527 potential matches. 1,118 IDs were only present at T_0 and 1,052 IDs were only present at T_1.

Table 1. Study sample characteristics

	T_0 n = 1,579	T_1 n = 1,527	p-value+
Participants per hospital, n (%) *			0.385
Hospital A (approx. 900 beds)	221 (14.0)	223 (14.6)	
Hospital B (approx. 800 beds)	154 (9.8)	170 (11.1)	
Hospital C (approx. 500 beds)	138 (8.7)	127 (8.3)	
Hospital D (approx. 500 beds)	362 (22.9)	325 (21.3)	
Hospital E (approx. 400 beds)	347 (22.0)	342 (22.4)	
Hospital F (approx. 300 beds)	284 (18.0)	250 (16.4)	
Hospital G (approx. 100 beds)	73 (4.6)	90 (5.9)	
Females, n (%)	1,187 (77.6)	1,191 (79.7)	0.173
Age in years (mean, SD)	36.8 (10.5)	35.9 (10.5)	0.0255
Profession, n (%)			0.043
Nurse	1,050 (69.1)	1,084 (72.8)	
Physician	350 (23.0)	288 (19.3)	
Other	120 (7.9)	117 (7.9)	
With managerial function, n (%)	232 (16.4)	193 (13.9)	0.066
Years working in this hospital, n (%)			0.849
< 2 years	376 (24.5)	380 (25.4)	
2 to < 5 years	385 (25.0)	357 (23.9)	
5 to < 10 years	264 (17.2)	271 (18.1)	
10 to < 20 years	307 (20.0)	297 (19.9)	
≥ 20 years	206 (13.4)	190 (12.7)	
Work unit in the past three months, n (%)			0.020
Ward	906 (58.5)	963 (63.9)	
Emergency department	248 (16.0)	190 (12.6)	
Intensive care unit	144 (9.3)	129 (8.6)	
Operating room	146 (9.4)	141 (9.4)	
Other	104 (6.7)	85 (5.6)	
Overall experience with catheter placement throughout career, n (%)			0.300
Never	26 (1.7)	30 (2.0)	
1-5 times	169 (11.0)	171 (11.4)	
6-20 times	341 (22.2)	370 (24.6)	
> 20 times	1,002 (65.2)	931 (62.0)	
Frequency of catheter placement in current position, n (%)			0.084
Frequent user	690 (44.2)	618 (41.1)	
Infrequent user	871 (55.8)	885 (58.9)	

Note: Due to rounding percentages may not always add up to 100%.

* In the larger hospitals, not all of the departments participated in the project

+ p-values for changes between the two time periods

T_0=baseline survey, T_1=follow-up survey

Frequent user=places a catheter a few times a month or more often
Infrequent user=places a catheter a few times a year or less often

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Knowledge

For the overall study sample, the mean number of correctly answered knowledge items increased significantly between T_0 and T_1 (p<0.001) (table 2). Subgroup analysis indicates that knowledge scores increased in particular for nurses, staff members without managerial function and staff members frequently placing catheters. Effect sizes for the changes between the time points were small to moderate. Percentages of correct answers for each of the 15 items are provided in appendix 3.

Table 2. Mean number of correct answers provided for 15 knowledge items

	Mean $_{T0}$ (95% CI)	n_{T0}	Mean $_{T1}$ (95% CI)	n_{T1}	p-value	Effect size
Overall sample	10.4 (10.3;10.5)	1,579	11.0 (10.9;11.1)	1,527	<0.001	0.29
Professional group						
Nurses	10.2 (10.1;10.4)	1,050	10.9 (10.8;11.0)	1,084	<0.001	0.35
Physicians	11.1 (11.0;11.3)	350	11.4 (11.2;11.6)	288	0.047	0.16
Managerial function						
With	11.3 (11.1;11.5)	232	11.6 (11.4;11.9)	193	0.058	0.19
Without	10.3 (10.1;10.4)	1,187	10.9 (10.8;11.0)	1,199	<0.001	0.33
Frequency of catheter placement						
Frequent user	10.0 (9.8;10.1)	690	10.7 (10.6;10.9)	618	<0.001	0.40
Infrequent user	10.8 (10.7;10.9)	871	11.2 (11.1;11.3)	885	<0.001	0.22
Matched ID	10.4 (10.3;10.6)	420	11.3 (11.1;11.5)	420	<0.001	0.49
Unmatched ID	10.5 (10.3;10.6)	1,118	11.0 (10.9;11.1)	1,052	<0.001	0.31

T_0=baseline survey, T_1=follow-up survey
Frequent user=places a catheter a few times a month or more often
Infrequent user=places a catheter a few times a year or less often

We used the sub-sample of matched participants to examine the effect of training on the change in knowledge score over time. Among all matched respondents, 102 (25.3%) indicated having participated in *both* theoretical and practical training; 130 (32.2%) respondents had participated in *either* theoretical or practical training and 172 (42.6%) respondents did not participated in *any* training (missing values n=16). Results from the mixed analysis of variance showed that there was no significant interaction effect between time and training ($F_{2,401}$ =1.05, p=0.35). In other words, knowledge scores between participants with practical and/or theoretical training did not change differently over time as compared to participants without training.

Perception of practices and culture

The mean scale score for perception of current practices and culture increased significantly within the overall sample and within all subgroups between the two time points (p<0.001) (table 3).

Generally, agreement to the statements was moderate at baseline and strengthened over time. Yet, agreement remained moderately strong, with no group reaching a mean scale score above 6 even after implementation of the intervention bundle. Mean scores for each item are provided in appendix 4.

Table 3. Perception: mean scale score

	Mean $_{T0}$ (95% CI)	n_{T0}	Mean $_{T1}$ (95% CI)	n_{T1}	p-value	Effect size
Overall sample	5.3 (5.3; 5.3)	1,568	5.5 (5.5; 5.6)	1,521	<0.001	0.31
Professional group						
Nurses	5.4 (5.3; 5.4)	1,044	5.6 (5.6; 5.7)	1,082	<0.001	0.33
Physicians	5.1 (5.0; 5.1)	347	5.3 (5.2; 5.4)	286	<0.001	0.29
Managerial function						
With	5.2 (5.1; 5.3)	230	5.6 (5.5; 5.7)	191	<0.001	0.52
Without	5.3 (5.3; 5.4)	1,180	5.6 (5.5, 5.6)	1,197	<0.001	0.29
Frequency of catheter placement						
Frequent user	5.2 (5.1; 5.3)	690	5.4 (5.3, 5.5)	618	<0.001	0.22
Infrequent user	5.4 (5.3; 5.4)	861	5.7 (5.6, 5.7)	880	<0.001	0.37
Matched ID	5.4 (5.3; 5.4)	416	5.6 (5.5; 5.7)	416	<0.001	0.32
Unmatched ID	5.3 (5.2; 5.3)	1,108	5.5 (5.5; 5.6)	1,049	<0.001	0.31

Note: Scale consisted of 13 items.
Items were answered on a scale from 1 (strongly disagree) to 7 (strongly agree).
Cronbach's alpha for the scale: T_0 α=0.79 and T_1 α=0.80
T_0=baseline survey, T_1=follow-up survey
Frequent user=places a catheter a few times a month or more often
Infrequent user=places a catheter a few times a year or less often

Responsibilities

Self-reported responsibilities concerning IUC management by nurses and physicians changed only slightly over time (figure 1). At baseline and at follow-up, nurses mainly felt responsible for placing, maintaining and removing an IUC. However, at T_1, fewer nurses felt responsible for prescribing catheter placement (p<0.001) as compared to T_0 and a higher percentage felt responsible for assessing the need for continued catheterization (p=0.002). Physicians perceived themselves to be mainly responsible for ordering catheter placement and removal at both time points. At T_1, fewer of them felt responsible for placing or assisting with placing an IUC as compared to T_0, but differences were not statistically significant.

Determinants of behavior

The mean score for the scale assessing the determinants of behavior increased significantly between baseline and follow-up (p<0.001). Positive changes in mean scores were observed for all

three constructs (attitudes, subjective norms and perceived behavioral control). They were particularly strong for items assessing perceived social expectations to use catheters restrictively (see appendix 5). The positive trends could also be observed for professional group, managerial function and frequency of catheter placement (table 4). Medium effect sizes indicate practical relevance of these changes.

Table 4. Determinants of behavior: mean scale score

	Mean $_{T0}$ (95% CI)	n_{T0}	Mean $_{T1}$ (95% CI)	n_{T1}	p-value	Effect size
Overall sample	5.3 (5.3; 5.3)	1,539	5.6 (5.6; 5.6)	1,502	<0.001	0.43
Professional group						
Nurses	5.3 (5.2; 5.3)	1,046	5.6 (5.6; 5.7)	1,083	<0.001	0.56
Physicians	5.4 (5.3; 5.5)	349	5.6 (5.5; 5.6)	287	0.005	0.23
Managerial function						
With	5.6 (5.5; 5.7)	230	5.8 (5.7; 5.9)	192	<0.001	0.38
Without	5.2 (5.2; 5.3)	1,184	5.6 (5.5; 5.6)	1,198	<0.001	0.50
Frequency of catheter placement						
Frequent user	5.2 (5.2; 5.3)	675	5.6 (5.5; 5.6)	615	<0.001	0.46
Infrequent user	5.3 (5.3; 5.4)	847	5.6 (5.6; 5.7)	884	<0.001	0.41
Matched ID	5.3 (5.3; 5.4)	405	5.7 (5.6; 5.8)	405	<0.001	0.58
Unmatched ID	5.3 (5.3; 5.3)	1,090	5.6 (5.5; 5.6)	1,038	<0.001	0.37

Note: Scale consisted of 15 items.
Items were answered on a scale from 1 (strongly disagree) to 7 (strongly agree).
Cronbach's alpha for scale: T_0 α=0.72 and T_1 α=0.74
T_0=baseline survey, T_1=follow-up survey
Frequent user=places a catheter a few times a month or more often
Infrequent user=places a catheter a few times a year or less often

Difference-in-difference analyses of group and individual level data

Knowledge scores increased slightly more among participants with a matched ID compared to unmatched participants (p=0.047). Mean scale sores for perception of current practices and culture increased for both matched and unmatched participants to a similar extent (p=0.894). Mean scale scores for determinants of behavior increased slightly more for participants with a matched ID compared to unmatched participants (p=0.033).

DISCUSSION

We observed positive changes in staff knowledge, perceptions and attitudes regarding IUC use following the implementation of a multimodal intervention bundle in seven hospitals. Observed effects were small to moderate, requiring a closer look at the challenges of implementing and evaluating a multi-faceted intervention bundle in a large scale, national program. We found that in

two of the thematic sections – knowledge and determinants of behavior - the scores for matched participants increased slightly more than for unmatched participants. This seems plausible as the unmatched group includes participants of various levels of program exposition. It suggests that data analyzed on group level (two unmatched cross-sections) to evaluate short term effects of an intervention can to some extent, but not fully represent longitudinal effects on the individual participant level.

Knowledge scores increased significantly between baseline and follow-up, indicating that staff members in our pilot hospitals had more factual knowledge about the use and potential harm of urinary catheters after the intervention. Interestingly, however, we could not verify that participation in education and training sessions contributed to knowledge increases. When analyzing the results in our sub-sample of matched participants (i.e. individuals for whom we know that they worked in the hospital throughout the entire program), we found that changes in knowledge scores did not differ between staff members with and without training. The findings indicate that other factors, such as the dissemination of the indication list or the presence of champions may have contributed to the observed effects in knowledge. Regarding respondents' perception of current practices and cultural factors within their organization, we also found a small, but significant effect at the end of the intervention. The moderate effect size suggests that staff members indeed perceived positive changes in IUC management and safety climate within their organization. Factors determining intentions to perform a certain behavior, namely personal attitudes, perceived behavioral control and subjective norms changed over the course of the project too. At follow-up, staff members generally expressed higher willingness to contribute to a safe and restrictive use of IUCs. In particular, participants felt higher expectations from their social environment to reduce catheters, suggesting that a change in culture could indeed be initiated.

Even though there was a clear positive trend, the differences between survey periods on all three sections of the questionnaire (knowledge, perception of practices and culture, and determinants of behavior) where only small to moderate. Recommended practices and socio-adaptive components were thus, from the perspective of participants, not fully established even after the intervention. These results are not surprising, because change in organizational culture is a slow process, requiring endurance and continuous effort that could not be provided within the short time frame of the QI program. Studies that have collected long-term data on surgical checklist implementation state suggest that it takes time for cultural change to develop and for positive effects to fully become evident [39,40]. For example, an Australian study that has examined compliance with surgical safety checklist use reports that reduction in mortality rates reached significance only in the 2-3 year period after implementation [39]. In addition, we did not strictly define implementation strategies in order to allow pilot hospitals to adapt the intervention bundle to their local context.

Therefore, implementation fidelity could not systematically be assessed. Informal feedback from local project coordinators suggests that it was not always possible to deliver the intervention bundle as intended. For example, even though training sessions were mandatory, not all staff from the target population could eventually be reached.

Another explanation could be high staff turnover rates. Almost all of the respondents generated an 8-digit code. Interestingly, however, only 28% of the IDs provided could be matched between the two surveys. Participants at follow-up were thus, for the most part, not the same individuals as at baseline. This could be a sign for high staff turnover rates during the intervention period. However, it is also possible that unmatched participants had been working at the hospital throughout the intervention, but had been unwilling or unable to participate in the same survey twice. Nevertheless, this finding points to the importance of ensuring that hospitals continuously offer training, education and policy reinforcement. Continued efforts to incorporate recommended practices into routine care even after completion of the actual project phase are needed to move the intervention from a time-limited "project" to a continuous commitment and ensure that motivation to reduce urinary catheters is kept at a high level [41,42].

In our QI program, a before/after surveillance for catheterization and catheter-associated complications was conducted in the same time periods as the staff survey. Results show a significant decrease in catheter utilization rates in all pilot hospitals [32]. Secondary data analysis would be needed to examine the relationship between catheter utilization rates and staff perspectives. Some hypotheses can be put forward to explain the observation that while changes in staff perspectives were rather small, we did see a decrease in catheter utilization. It is possible that even small changes in staff knowledge and perception can have a substantial practical relevance. However, it is also possible that the items in our questionnaire do not adequately measure knowledge and perceptions required to reduce IUC use (content validity). To our knowledge, no other study has assessed the effects of an intervention bundle on staff behavior with similar measures; therefore it is not possible to relate our findings to existing research. Wakefield and colleagues found that perceptions about the behavior of professional peers, and the personal belief that engaging in a certain behavior will lead to better safety outcomes, are the strongest factors influencing safety behavior [15]. The authors conclude that interventions too often rely on educational measures in order to change behavior and argue that using behavioral models to design interventions may be more effective. Our results provide additional support for this argument. We saw the strongest effects in perceived norms to reduce catheter use, suggesting that efforts aimed at changing organizational culture may be particularly effective. We would however argue that staff education and training can offer an important platform to disseminate and

reinforce new norms and expectations, especially if they are used by clinical leaders to demonstrate their commitment to the cause and to foster interprofessional collaboration.

Promoting collaboration among nurses and physicians is especially important because urinary catheter management is a strongly interprofessional topic and roles and responsibilities need to be clear for all of the involved health care workers. In a previous study with data from the baseline survey, we analyzed how nurses and physicians perceived their respective responsibilities for IUC management [43]. We found that physicians mainly felt responsible for prescribing catheter placement and removal, while nurses generally considered themselves responsible for placing, managing and removing them. However, both nurses and physicians felt equally responsible for assessing the need for continued catheterization. The results from the present study show that at the end of the intervention, the perceived division of tasks between the two groups remained largely the same. This could either indicate that because of the intervention bundle, both groups were encouraged to assume responsibility in this area and interprofessional commitment was strengthened. However, it could also mean that tasks especially in regard to the re-evaluation of the need for a catheter were not clarified over the course of the project.

Limitations

This study has several limitations. We used the theory of planned behavior to model intention to reduce urinary catheter use. However, it is not possible to know if changes observed in staff perceptions led to a true change in practice. In a future study, staff survey data should be linked with surveillance data on hospital-level to examine if specific changes in staff perceptions are associated with changes in specific clinical outcomes. Direct observations of catheter placements may be considered as another method to gain insight into compliance with protocols for safe catheterization and changes in clinical practice [44]. This method was originally proposed to participating hospitals in our project, but was rejected due to the additional resources required. For practical purposes, we did not include a control group in the study design. The single-group design does therefore not allow any causal inferences about the contribution of the intervention bundle on the observed effects. It is possible that other secular trends or measures within the hospitals may have affected the outcomes. A stepped wedge design could present an alternative to this design. This design randomizes participating sites into sequential cohorts. All cohorts eventually implement the intervention, each providing their own control data in the meantime and offering researchers the chance to investigate implementation challenges and make adjustments along the way [45]. In addition, conducting focus groups or interviews with staff from each site could have provided a more in-depth understanding of staff perceptions after the intervention and the contextual factors that shape the implementation of a complex intervention in a new setting. The before/after study

design does not allow us to evaluate sustainability of the intervention over time. A further follow-up survey or a time-series approach could have shed more light on the long-term effects in the hospitals. We chose to administer paper instead of electronic versions of the survey to minimize coverage error because not all staff members in participating hospitals had access to individual e-mail addresses. Furthermore, paper surveys have been shown to generate higher response rates than surveys administered online [46]. With this method, we were able to attain reasonable response rates at both survey periods. Since data collection was organized by local project teams, however, we have no information on non-participants. It is possible that only highly motivated staff members participated in the survey, which may result in more positive responses. The two survey samples were comparable with respect to participants per hospital. For some of the socio-demographic characteristics, notably profession and work unit, we found significant differences between the two time periods. We cannot differentiate if this is due to selective non-responses or staff fluctuation. Lastly, it is possible that only high performing units open to change have been chosen to participate in the intervention project. This may limit generalizability of our findings to other units and hospitals.

Conclusion

Changing staff attitudes, knowledge and behavior are important prerequisites for an effective reduction of catheter use and catheter-associated complications. We found small, but significant changes in staff perceptions after implementation of an evidence-based intervention bundle. The positive trends were present in all subgroups, indicating that regardless of responsibilities and practice of catheter placement, perspectives on urinary catheter use changed over time. Efforts now need to be targeted at reinforcing and sustaining these changes, so that restrictive use of IUCs becomes an integral part of the hospital culture.

Author contributions: AN, SZ, JM, AS and DS contributed to the design of the study and the survey instrument, SK und GJ contributed to the data collection. AN and DS analyzed the data. AN and SZ drafted the manuscript, JM, AS, SK, GJ and DS critically revised the manuscript for important intellectual content. All authors approved the manuscript.

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Figure legends

Figure 1. Self-reported responsibilities in regard to urinary catheters by profession

* Change between time periods significant on p<0.05.

Appendices

Appendix 1. List of indications for indwelling urinary catheters

Appendix 2. Questionnaire

Appendix 3. Knowledge: % correct answers provided per item at T0 and T1

Appendix 4. Perception: mean and standard deviation per item at T0 and T1

Appendix 5. Behavior: mean and standard deviation per item at T0 and T1

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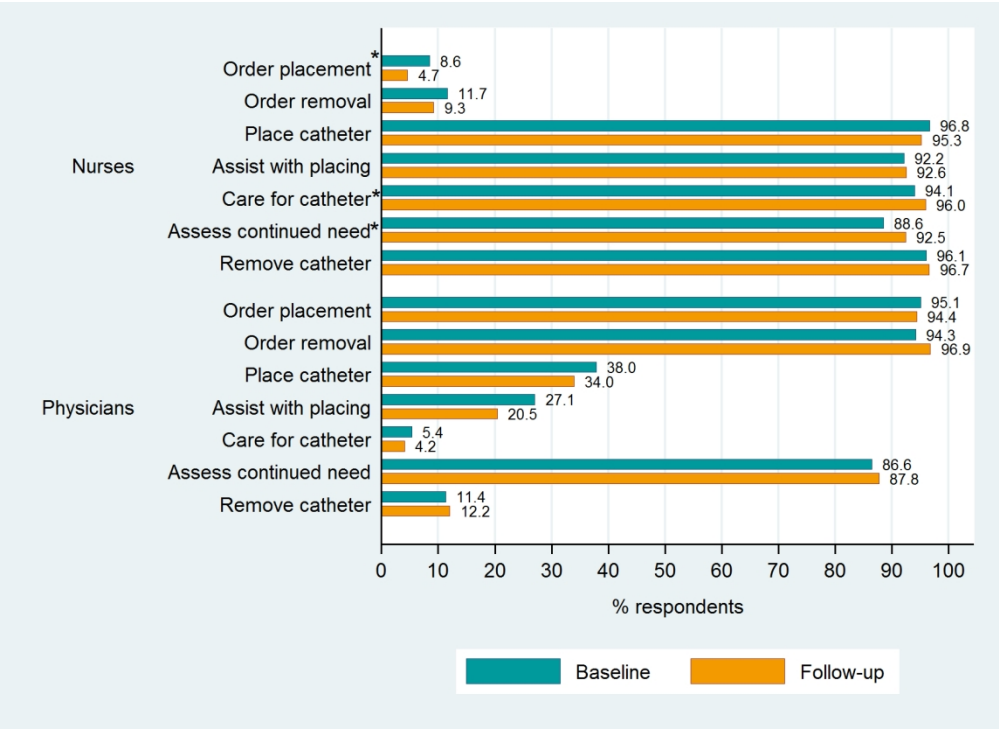

Figure 1. Self-reported responsibilities in regard to urinary catheters by profession

152x110mm (300 x 300 DPI)

Appendix 1. List of indications for indwelling urinary catheters

Note: This list does not cover urological emergencies. Treatment for these cases is decided by the urologist.

No indications for a urinary catheter are:

- Asymptomatic chronic urinary retention
- Urine output monitoring / fluid monitoring for stable patients, if daily weight control is possible
- Need for intensive care
- Urinary incontinence
- Immobilization, as long as alternative methods[1] for controlled bladder drainage have not been exhausted
- Comfort from the perspective of the patient (or their trusted representative) OR from the perspective of staff

Indication	Specification
Urinary retention	Acute urinary retention of any origin
	Symptomatic chronic outflow obstruction PLUS >300 ml residual urine
Urine output monitoring	In regular, short intervals (hourly or as defined by hospital) PLUS direct therapeutic consequences from monitoring, if body weight of patient cannot be measured
Surgery	Long surgery (>4h)
	Perioperative: for surgical reasons, if bladder has to be empty. Catheter is to be removed at the end of the surgery
	Urogenital surgery and/or pelvic floor surgery
	Epidural / peridural anesthesia/analgesia
Pressure ulcers PLUS incontinence	Pressure ulcers stage III or IV, or sacral/perineal skin transplants PLUS incontinence, if alternative methods[1] for controlled bladder drainage failed
Prolonged immobilization	Immobilization for medical reasons, especially for pain reduction, if alternative methods[1] for controlled bladder drainage failed
Palliation PLUS Comfort	Terminal-palliative situation PLUS dysfunction of bladder PLUS/OR difficulties with normal voiding, if alternative methods[1] for controlled bladder drainage failed
	Severe psychological strain PLUS at the request of the informed patient (or their trusted representative)

[1] Alternative methods are: condom catheter, urinal, bedpan, bedside commode, incontinence pads, pants

List was translated for this publication by the authors.

Appendix 2. Questionnaire

Personal ID

First we ask you to create a personal identification number (ID). As part of the program progress! Safe urinary catheterization, you will complete questionnaires at two different points in time. This ID will help us match the two different questionnaires to one person, and to recognize the information coming from one and the same person. At the same time, the ID protects your anonymity, as you cannot be personally identified. This is how you create your personal ID:

The ID consists of your mother's initials (maiden name), your father's initials and your mother's birth year. Example: Mother: Hannah Kaufmann, Father: Peter Muller, Mothers birth year: 1931 → ID: HKPM1931

Part 1 (correct answers provided in parentheses)

Please estimate:

How many patients in Switzerland receive a catheter during their hospital stay?
(10-25%)

Please indicate if the following statements are correct:

After 30 catheter-days, nearly all patients show bacteriuria. (correct)

The duration of catheterization is an important risk factor for the development of a urinary tract infection. (correct)

Most hospital-acquired urinary tract infections are associated with a urinary catheter. (correct)

Single-use urinary catheters carry a higher risk for infections as compared to indwelling catheters. (false)

A closed drainage system is essential for the prevention of catheter-associated urinary tract infections. (correct)

Compared to catheters, non-invasive methods for bladder draining (e.g., condom catheters, incontinence pads) have the advantage that they do not carry a risk for injuries. (correct)

Non-infectious complications (e.g., injuries or allergic reactions) only occur in absolutely rare instances during catheterization. (false)

The choice of an antiseptic for disinfecting the urethral meatus does not affect the correct asepsis when inserting a catheter. (false)

Up to 50 percent of catheters placed in an emergency department are not medically justified. (correct)

One effective measure to prevent catheter- associated urinary tract infections is to change catheters or drainage bags in regular intervals. (false)

In which of these situations is the placement of a urinary catheter indicated?

To monitor urine output in stable patients who can be weighed. (not indicated)

In case of distress at the request of a terminally ill patient. (indicated)

For patients requiring intensive care. (not indicated)

For patients with restricted mobility. (not indicated)

Part 2

Please indicate if you agree with the following statements:[1]

On my unit, IUCs are placed only as clearly indicated medical measure.

For medical leadership on my unit, restrictive use of IUCs is very important.

For nursing leadership on my unit, restrictive use of IUCs is very important.

Nursing workload plays an important role when a decision for placing an IUC is made.

People in charge on my unit make sure that everyone placing IUCs is sufficiently trained for this task.

Whenever possible, staff on my unit tries to use alternatives to an IUC (e.g., condom catheters, incontinence pads).

The daily assessment to evaluate if an IUC is still needed is a given for us.
Basic infection prevention measures are well complied with during placement and care of IUCs.
If someone needs help when placing an IUC, it is clear on my unit who can be contacted.
Medical and nursing staff on my unit have a similar attitude concerning the use of IUCs.
For staff members on my unit, it is a matter of course to openly question the placement of an IUC.
It is difficult on my unit to speak up when rules of hygiene are broken during placement and care of an IUC.
It is common on my unit that, whenever possible, two healthcare workers work together to place a catheter.

Part 3

What is your own role regarding the use of catheters? Please select all answers that apply.

It is part of my responsibility to…
…write orders for IUC placement
…write orders for IUC removal
…place an IUC
…assist another professional with placing an IUC
…care for an indwelling catheter
…assess the continued need for an IUC
…remove an IUC

Part 4

Please indicate if you agree with the following statements:[1]

I can properly estimate in which situations the use of an IUC is appropriate.
My colleagues appreciate my commitment to reduce the use of IUCs.
I can influence the use of IUCs in my daily work.
The risk from IUCs for patients is underestimated.
I find it difficult in my daily work to reduce the use of IUCs.
In my hospital I am expected to contribute to the reduction of IUCs.
I am convinced that I am proficient in caring for an indwelling catheter.
I am convinced that by reducing the use of IUCs, adverse events to patients can be avoided.
Our patients appreciate it when IUCs are avoided.
A reduced use of IUCs makes patient care more stressful for me.
My supervisors expect that everyone follows the internal protocols for inserting catheters.
I am convinced that I am proficient in inserting a urinary catheter.
I think that it's important to reduce the use of IUCs in the hospital.
My supervisors expect me to reduce the use of IUCs.
I am confident that I can reduce the use of IUCs in everyday work.

Part 5 (response categories in parentheses)

How old are you?
Gender (female, male)
In which professional role are you currently working?
(surgical positioning specialist, healthcare assistant, registered nurse, nursing manager, physician resident, attending physician, senior phyisican, chief physician, other)
How long have you been working in this hospital? (< 2 years, 2 to < 5 years, 5 to < 10 years, 10 to < 20 years, ≥ 20 years)
How many working hours do you spend in patient care during a typical working week? (less than 10 hours, between 10-24 hours, between 25-39 hours, 40 hours or more)

How often have you placed a urinary catheter throughout your professional career (estimate)? (never, 1-5 times, 6-20 times, > 20 times)
How often do you place a urinary catheter in your current position (estimate)?
(never, rarely (a few times a year), sometimes (a few times a month), often (a few times a week))
Where have you primarily been working in the past three months?
(ward, emergency department, intensive care unit, operating room, other)
In which medical area do you work primarily?
(Anesthesiology, Surgery, Obstetrics/Gynecology, Internal medicine, Neurology, orthopedics, Radiology, Urology, in several medical areas, other)
Do you have additional any additional comments?

Items only included at T_1

Are you familiar with the indication list that has been implemented as part of the program "progress! Safe urinary catheterization"? (yes, no)
Have you participated at a training as part of the program "progress! Safe urinary catheterization"?
- Theoretical training (yes, no)
- Practical training (yes, no)

How do you evaluate the participation of your unit in the program "progress! Safe urinary catheterization"? (very positive, rather positive, neutral, rather negative, very negative, don't know the program)

Items translated from German original by the authors.
[1] Items were answered on a Likert-scale from 1 (do not agree at all) to 7 (completely agree)

Appendix 3. Knowledge – % correct answers provided per item

	% T_0 n = 1,579	% T_1 n = 1,527
Please estimate:		
How many patients in Switzerland receive a catheter during their hospital stay? (10-25%)	37.6	39.1
Please indicate if the following statements are correct:		
After 30 catheter-days, nearly all patients show bacteriuria. (correct)	81.6	86.9
The duration of catheterization is an important risk factor for the development of a urinary tract infection. (correct)	98.0	98.9
Most hospital-acquired urinary tract infections are associated with a urinary catheter. (correct)	82.2	86.3
Single-use urinary catheters carry a higher risk for infections as compared to indwelling catheters. (false)	89.9	91.9
A closed drainage system is essential for the prevention of catheter-associated urinary tract infections. (correct)	77.4	82.0
Compared to catheters, non-invasive methods for bladder draining (e.g., condom catheters, incontinence pads) have the advantage that they do not carry a risk for injuries. (correct)	62.4	69.0
Non-infectious complications (e.g., injuries or allergic reactions) only occur in absolutely rare instances during catheterization. (false)	61.2	68.8
The choice of an antiseptic for disinfecting the urethral meatus does not affect the correct asepsis when inserting a catheter. (false)	80.6	82.6
Up to 50 percent of catheters placed in an emergency department are not medically justified. (correct)	61.4	73.8
One effective measure to prevent catheter-associated urinary tract infections is to change catheters or drainage bags in regular intervals. (false)	30.4	36.2
In which of these situations is the placement of a urinary catheter indicated?		
To monitor urine output in stable patients who can be weighed. (not indicated)	97.5	98.1
In case of distress at the request of a terminally ill patient. (indicated)	93.3	93.2
For patients requiring intensive care. (not indicated)	21.2	32.3
For patients with restricted mobility. (not indicated)	79.9	81.4

Correct answers for knowledge items are provided in parentheses. Items were translated for this publication by the authors. Sample size differs slightly for each item due to a varying number of missing values.

Appendix 4. Perception of practices and culture – Mean and standard deviation per item

	Mean T_0 (SD) n = 1,579	Mean T_1 (SD) n = 1,527	p-value
On my unit, IUCs are placed only as clearly indicated medical measure.	5.5 (1.4)	5.7 (1.3)	<0.001
For medical leadership on my unit, restrictive use of IUCs is very important.	5.1 (1.6)	5.4 (1.4)	<0.001
For nursing leadership on my unit, restrictive use of IUCs is very important.	5.1 (1.5)	5.7 (1.3)	<0.001
Nursing workload plays an important role when a decision for placing an IUC is made.	2.8 (1.8)	2.5 (1.6)	<0.001
People in charge on my unit make sure that everyone placing IUCs is sufficiently trained for this task.	5.4 (1.7)	5.6 (1.5)	<0.001
Whenever possible, staff on my unit tries to use alternatives to an IUC (e.g., condom catheters, incontinence pads).	4.7 (1.8)	5.1 (1.7)	<0.001
The daily assessment to evaluate if an IUC is still needed is a given for us.	5.3 (1.6)	5.6 (1.5)	<0.001
Basic infection prevention measures are well complied with during placement and care of IUCs.	6.0 (1.1)	6.1 (1.0)	0.0219
If someone needs help when placing an IUC, it is clear on my unit who can be contacted.	5.8 (1.5)	5.9 (1.4)	0.2649
Medical and nursing staff on my unit have a similar attitude concerning the use of IUCs.	5.1 (1.4)	5.3 (1.4)	0.0016
For staff members on my unit, it is a matter of course to openly question the placement of an IUC.	5.5 (1.4)	5.7 (1.2)	<0.001
It is difficult on my unit to speak up when rules of hygiene are broken during placement and care of an IUC.	2.9 (1.7)	2.8 (1.6)	0.0358
It is common on my unit that, whenever possible, two healthcare workers work together to place a catheter.	5.0 (1.9)	5.2 (1.7)	<0.001

Items were translated for this publication by the authors. Sample size differs slightly for each item due to a varying number of missing values.

Appendix 5. Determinants of personal behavior – Mean and standard deviation per item

	Mean T_0 (SD) n = 1,579	Mean T_1 (SD) n = 1,527	p-value
Perceived behavioral control			
I can properly estimate in which situations the use of an IUC is appropriate.	6.1 (1.0)	6.1 (1.0)	0.2587
I can influence the use of IUCs in my daily work.	5.5 (1.4)	5.7 (1.4)	0.0004
I am convinced that I am proficient in caring for an indwelling catheter.	5.5 (1.6)	5.6 (1.6)	0.0343
I am convinced that I am proficient in inserting a urinary catheter.	5.7 (1.5)	5.7 (1.4)	0.5490
I am confident that I can reduce the use of IUCs in everyday work.	5.0 (1.5)	5.5 (1.4)	<0.001
Subjective Norms			
My colleagues appreciate my commitment to reduce the use of IUCs.	5.1 (1.5)	5.4 (1.4)	<0.001
In my hospital I am expected to contribute to the reduction of IUCs.	4.6 (1.8)	5.7 (1.5)	<0.001
Our patients appreciate it when IUCs are avoided.	5.5 (1.4)	5.6 (1.4)	0.0442
My supervisors expect that everyone follows the internal protocols for inserting catheters.	6.0 (1.2)	6.1 (1.2)	0.0125
My supervisors expect me to reduce the use of IUCs.	4.5 (1.7)	5.5 (1.5)	<0.001
Attitudes			
The risk from IUCs for patients is underestimated.	5.1 (1.6)	5.0 (1.8)	0.0044
I find it difficult in my daily work to reduce the use of IUCs.	3.7 (1.7)	3.3 (1.6)	<0.001
I am convinced that by reducing the use of IUCs, adverse events to patients can be avoided.	5.8 (1.3)	6.1 (1.1)	<0.001
A reduced use of IUCs makes patient care more stressful for me.	3.0 (1.8)	2.9 (1.7)	0.0045
I think that it's important to reduce the use of IUCs in the hospital.	5.7 (1.3)	6.0 (1.2)	<0.001

Items were translated for this publication by the authors. Items are presented according to their construct (perceived behavioral control, subjective norm and attitudes). In the questionnaire, order of the items was randomized. Sample size differs slightly for each item due to a varying number of missing values.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	title page
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	p.2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	p.3-4
Objectives	3	State specific objectives, including any prespecified hypotheses	p.3-4
Methods			
Study design	4	Present key elements of study design early in the paper	p.5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	p.4 & p.5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	p.5 & p.6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	p.5-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	N/A
Bias	9	Describe any efforts to address potential sources of bias	N/A
Study size	10	Explain how the study size was arrived at	p.6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	p.6-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	p.6-7
		(*b*) Describe any methods used to examine subgroups and interactions	p.6-7
		(*c*) Explain how missing data were addressed	p.6-7
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	N/A

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	p.7
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	p.8 (table 1)
		(b) Indicate number of participants with missing data for each variable of interest	p.8 (table 1)
Outcome data	15*	Report numbers of outcome events or summary measures	p.9-11
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	N/A
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	p.9
Discussion			
Key results	18	Summarise key results with reference to study objectives	p.11-13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	p.13-14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	p.14
Generalisability	21	Discuss the generalisability (external validity) of the study results	p.13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	p14

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Change in staff perspectives on indwelling urinary catheter use after implementation of an intervention bundle in seven Swiss acute care hospitals: Results of a before/after survey study

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Change in staff perspectives on indwelling urinary catheter use after implementation of an intervention bundle in seven Swiss acute care hospitals: Results of a before/after survey study

Running title: Change in staff perspectives

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Abstract

Objective: To evaluate changes in staff perspectives towards indwelling urinary catheter (IUC) use after implementation of a one-year quality improvement project.

Design: Repeated cross-sectional survey at baseline (October 2016) and 12-month follow-up (October 2017).

Setting: Seven acute care hospitals in Switzerland

Participants: The survey was targeted at all nursing and medical staff members working at the participating hospitals at the time of survey distribution. A total of 1,579 staff members participated in the baseline survey (49% response rate) and 1,527 participated in the follow-up survey (47% response rate).

Intervention: A multimodal intervention bundle, consisting of an evidence-based indication list, daily re-evaluation of ongoing catheter need and staff training, was implemented over the course of 9 months.

Main Outcome Measures: Staff knowledge (15 items), perception of current practices and culture (scale 1-7), self-reported responsibilities (multiple-response question) and determinants of behavior (scale 1-7) before and after implementation of the intervention bundle.

Results: The mean number of correctly answered knowledge questions increased significantly between the two survey periods (T_0: 10.4, T_1: 11.0, $p<0.001$). Self-reported responsibilities with regard to IUC management by nurses and physicians changed only slightly over time. Perception of current practices and culture in regard to safe urinary catheter use increased significantly (T_0: 5.3, T_1: 5.5, $p<0.001$). Significant changes were also observed for determinants of behavior (T_0: 5.3, T_1: 5.6, $p<0.001$).

Conclusion: We found small, but significant changes in staff perceptions after implementation of an evidence-based intervention bundle. Efforts now need to be targeted at sustaining and reinforcing these changes, so that restrictive use of IUCs becomes an integral part of the hospital culture.

ARTICLE SUMMARY

Strengths and limitations of this study

- The repeated survey design allowed us to assess changes in staff perspectives after implementation of a quality improvement intervention. Sustainability of the effects over time, however, could not be evaluated.
- By using self-generated identification codes to match respondents in the two surveys, it was possible to evaluate if results obtained on the group level (two cross-sections) represent results on the individual participant level (longitudinal).
- No control group was included in the study design. It is possible that other trends or measures within the hospitals may have affected the outcomes.

INTRODUCTION

Although indwelling urinary catheters (IUCs) are commonly used in acute care hospitals, an appropriate medical indication is often missing [1,2]. IUCs are associated with urinary tract infections (UTI) and non-infectious complications such as hematuria and urethral injury. The reduction of IUC use is therefore a key measure to increase patient safety [3–7].

Several quality improvement (QI) studies have shown that avoiding inappropriate IUC use prevents urinary catheter harm [8–11]. Common to these studies is the implementation of a multimodal intervention bundle focusing on the reduction of unnecessary catheter use, proper insertion techniques and safe catheter maintenance. Successful bundles consist of catheter restriction protocols providing appropriate indications for catheter use and suggesting alternative urine collection methods, evaluation strategies such as reminders and/or stop orders to assess ongoing catheter need and prompt removal of unnecessary catheters, as well as educational interventions to increase awareness among healthcare workers and ensure safe catheter handling [12].

In addition to best practices, changes in behavior and culture – the so-called socio-adaptive component – are considered a core element of quality improvement efforts [13,14]. The organizational culture, which may be described as “the way we do things around here” [15] is known to have a favorable influence on patient safety, although the evidence for a direct causative effect on patient outcome is weak [16,17]. Several studies suggest that changes in staff knowledge and attitudes are needed to improve practice in regard to appropriate catheter utilization and prevention of catheter-associated infections [18–23]. However, to our knowledge only few studies [24–26] have reported the effects of a multi-modal intervention bundle on staff knowledge and socio-adaptive components, such as perceptions and beliefs, but none of them addressed all these factors together.

To promote safe urinary catheter use in Swiss hospitals, a national QI project was developed and conducted by the Swiss Patient Safety Foundation in partnership with Swissnoso, the National Center for Infection Control. The QI project was modeled after other successful QI initiatives in the US [8,9]. The overall project goal was to reduce IUC use and to promote safe catheter insertion and maintenance by implementing an evidence-based intervention bundle in seven Swiss acute care hospitals.

With the present study, we aimed to assess the changes in staff perspectives in the participating hospitals using survey data collected before and after implementation of the intervention bundle. We hypothesized that the intervention bundle may affect staff members differently depending on their tasks, responsibilities and familiarity with catheterization. We therefore stratified results

according to professional group, managerial function (a proxy for hierarchical status and clinical proximity) and frequency of catheter use in order to explore changes within these groups over time. In before/after study designs, data from two (or more) cross-sectional survey waves are commonly analyzed on group level to evaluate short term effects of an intervention [27–29]. However, given the high staff turnover in hospitals and self-selection of participants, it is possible that survey participants are not identical at the different measurement points. Thus, documented changes in staff perspectives between two time points may merely be due to a different composition of participant groups. We therefore used the self-generated identification code technique [30] to anonymously match respondents in the two surveys. This allowed us to compare the effects observed in the overall sample to the effects observed in a sub-sample of matched participants, for whom we can assume that they had been working at the hospitals for the entire duration of the project.

METHODS

Setting

The QI project consisted of two parts, a campaign to raise awareness among health care workers and an intervention that was implemented in seven pilot hospitals. For the campaign, recommendations on safe IUC use in acute care hospitals [31] were developed and disseminated to all acute care hospitals (including pilot hospitals) in Switzerland after collection of baseline data in the pilot hospitals (November 2016). The intervention focused on the implementation of an evidence-based intervention bundle in seven pilot hospitals over the course of nine months (Feb-Oct 2017). The participating hospitals contractually committed to implement the three main components of the bundle: an evidence-based indication list for urinary catheterization (appendix 1), a process to evaluate and document the continued need for catheterization on a daily basis, and staff education on proper catheter insertion and maintenance. For the latter, hospitals were required to provide theoretical trainings on safe urinary catheter utilization and catheter-associated complications to all nursing and medical staff members working on the pilot units. They were also encouraged to offer practical training sessions for catheter insertion. Local project teams received templates for training materials from the program team, but they were free to design and organize the trainings according to their local structure and processes. In theoretical trainings, information on risk factors for, and prevention of catheter-associated complications, correct indications for urinary catheters and proper catheter insertion techniques was conveyed either by means of presentations at staff events and/or through completion of an e-learning tool. In most hospitals, theoretical trainings were mandatory for nursing and medical staff. In two hospitals, theoretical inputs were immediately followed by practical training sessions for catheter insertion; in four

hospitals, practical trainings were offered on separate occasions and attendance was voluntary. One hospital did not offer practical training sessions. No exact data could be elicited in regard to the percentage of staff members from the pilot units that actually completed theoretical and/or practical trainings. Strategies to implement the intervention bundle in pilot hospitals included designated champions, internal newsletters, posters and screen savers with key project messages.

The hospitals (1 small local hospital, 4 mid-sized regional hospitals and 2 university hospitals) were recruited to represent different organizational types and geographic regions. Each hospital could decide which wards participated in the project; however, the participation of the emergency department was mandatory. Participating wards included internal medicine, general surgery and neurosurgery and gynecology/obstetrics. At each site, interdisciplinary project teams, generally consisting of physicians, nurses and representatives from quality management and the infection prevention unit were responsible for implementing the intervention bundle in the participating organizational units. To encourage knowledge exchange between the local project teams, two full-day workshops were organized at the beginning and the end of the intervention phase. The intervention was accompanied by a before/after surveillance and a before/after staff survey. The results of the before/after surveillance, which measured urinary catheter utilization ratio and catheter-associated complications, will be reported elsewhere. Our publication will focus on the results from the staff surveys and their changes over time.

Study design

To collect data on staff perspectives regarding IUC use, we conducted a written survey during two time periods. The baseline survey (T_0) took place in October 2016, four months before the participating hospitals started to implement the intervention bundle. The follow-up survey (T_1) took place one year later in October 2017. At that point, all hospitals had implemented the intervention bundle and had been working with the new processes for six to eight months. The target population consisted of surgical positioning specialists, nurses (healthcare assistants, registered nurses and nursing managers) and physicians (residents, senior and chief physicians) working on the participating units in one of the seven pilot hospitals at the time of the survey. Staff members not involved in direct patient care, healthcare workers in education and affiliated physicians were excluded.

Questionnaire

The 55-item standardized questionnaire was developed specifically for this study by the authors based on prior survey research conducted during a similar improvement project [32,33], and a review of existing surveys reported in the literature [18–22] (appendix 2). The German version of

the questionnaire was pretested among 42 physicians and nurses from three hospitals not participating in the project. Based on their feedback, minor modifications were made to increase validity. The final version was translated into French and Italian by professional translators. Translations were reviewed by four native speakers per language.

The questionnaire consisted of four thematic sections. The first section entailed a 15-item knowledge test on prevalence, risk factors and prevention of catheter-associated complications, as well as appropriate reasons for catheter placement. The second section included 13 items assessing respondents' perception regarding good practices and cultural factors for safe IUC use within the organization. Items were rated on a 7-point Likert scale from "strongly disagree" (1) to "strongly agree" (7). Two items were negatively worded and were reverse coded for data analysis. The content of the first two sections of the questionnaire was in line with the above-mentioned recommendations for safe catheter use [31]. The third section examined self-perceived responsibilities in regard to catheter prescription, placement and care by means of one multiple-response question. The fourth section assessed determinants of personal behavior in regard to the reduction of urinary catheters. Items for this section were developed based on the theory of planned behavior [34]. This theory states that an individual's intention to perform a behavior is largely determined by three factors, namely a favorable or unfavorable evaluation of the behavior (attitudes), the perceived social expectations to perform or not perform the behavior (subjective norms) and the perceived capability to perform the behavior (perceived behavioral control) [34,35]. In our questionnaire, the three constructs (attitudes, subjective norms and perceived behavioral control) were measured with five items each. All 15 items were rated on a 7-point Likert scale from "strongly disagree" (1) to "strongly agree" (7). Two items were negatively worded and were reverse coded for analysis.

The questionnaire also included a section on demographics and experience with placing urinary catheters. On the first page of the questionnaire, participants were asked to generate an 8-digit code consisting of three elements. To do this, respondents were asked to link the following three elements into a string of letters and numbers: the mother's initials (maiden name), father's initials and mother's birth year (for an example see appendix 2). These three elements were selected because they do not change over time and refer to personal information usually known by the respondent [30]. With this technique, it is possible to clearly identify data from the same subject and, at the same time, ensure anonymity. We used the same questionnaire at both time points. For the follow-up survey, we included four additional questions that specifically referred to the intervention bundle. All other items remained unaltered.

Data collection

Each local project team was required to identify all eligible staff members from the target population, inform and invite them to participate in the survey and distribute and collect the print version of the questionnaire. In some sites, questionnaires were handed out during shift reports or other staff events; in others they were distributed to internal mail boxes. In one hospital, questionnaires were sent to private home addresses. Participation in the survey was voluntary and anonymous. The returning of the questionnaire was considered informed consent.

Ethics

Approval for the study was obtained from the Lead Ethics Committee of the Canton of Bern, Switzerland (no. 2016-00682).

Data analysis

Descriptive statistics were calculated for each item. Missing values were excluded from analysis (pairwise exclusion). A large proportion of subjects participating in the baseline survey did not participate in the follow-up survey. Thus, responses to both surveys cannot be assumed to stem from the same sample. Therefore, tests for unpaired samples were used for the main analyses comparing results between time points (see below for analyses of matched individuals). Chi-squared tests were used to determine differences in sample composition. A “knowledge score” was generated consisting of the number of correctly answered questions out of 15. Cronbach’s alpha was calculated to determine internal consistency of the 13-item perception scale and the 15-item behavior scale. For both scales a mean scale score and 95% confidence interval was computed. Knowledge score and mean scale scores were computed for the overall sample and stratified by professional group (nurses/physicians), managerial function (with/without) and frequency of catheter placement (frequent/infrequent user). Frequent users were defined as healthcare workers placing a catheter a few times a month or more often; infrequent users as placing a catheter a few times a year or less often. Frequency was determined based on the self-reported frequency of placing a catheter in the current work position. Changes between time points were determined for the overall sample and each subgroup by means of *t*-tests for independent samples.

To analyze the sub-sample of matched participants, self-generated IDs were matched based on the 8-digit code and hospital affiliation. For these sub-analyses, cases with identical codes or missing data were dropped. For matched participants, knowledge score and mean scale scores were computed. To determine changes between time points in this sub-sample of matched participants, we used paired analysis. Changes between time points were determined by means of *t*-test for paired samples. Mixed analysis of variance was conducted to determine if participation in theoretical and practical training had an effect on knowledge scores over time. In addition, we

performed difference-in-difference analyses to compare results for group-level data (cross-sectional data of two unmatched groups) and individual-level data (longitudinal data of matched participants). For each of the main outcomes, we compare average change over time among matched participants to the average change over time among unmatched participants.

All tests were two-sided and a p-value <0.05 was considered statistically significant. Cohen's *d* was calculated as a measure of effect size. For paired samples, the formula t_c as described in Dunlap et al [36] was used to calculate *d*. As an orientation for interpreting the importance of the effect, we used the following classification: 0.2=small effect, 0.5=medium effect and 0.8=large effect [37]. All analyses were performed with Stata version 14.1 (StataCorp, College Station, Texas).

Patient and public involvement

Patients or the public were not involved in the design or planning of this study.

RESULTS

Response rate and study sample

1,579 out of 3,245 invited staff members participated in the baseline survey (48.7% response rate) and 1,527 out of 3,235 invited staff members participated in the follow-up survey (47.2% response rate). The proportion of questionnaires received from each hospital in the total sample was similar in both waves (p=0.39). The characteristics of the study samples at T_0 and T_1 are provided in table 1. Sample composition differed slightly in regard to age (p=0.03), profession (p=0.04) and work unit between the two time points (p=0.02).

Almost all of the 3,106 participants in both survey periods generated an 8-digit ID. At baseline, 35 respondents (2.2%) had missing values on each of the three code elements and the sample contained 3 sets of identical IDs. At follow-up, 51 respondents (3.3%) did not provide an 8-digit ID and 2 sets of identical IDs were found. For 420 respondents, we were able to successfully match the 8-digit identification code and hospital affiliation. This represents 27.5% of the 1,527 potential matches. 1,118 IDs were only present at T_0 and 1,052 IDs were only present at T_1.

Table 1. Study sample characteristics

	T_0 n = 1,579	T_1 n = 1,527	p-value+
Participants per hospital, n (%) *			0.385
Hospital A (approx. 900 beds)	221 (14.0)	223 (14.6)	
Hospital B (approx. 800 beds)	154 (9.8)	170 (11.1)	
Hospital C (approx. 500 beds)	138 (8.7)	127 (8.3)	
Hospital D (approx. 500 beds)	362 (22.9)	325 (21.3)	
Hospital E (approx. 400 beds)	347 (22.0)	342 (22.4)	
Hospital F (approx. 300 beds)	284 (18.0)	250 (16.4)	
Hospital G (approx. 100 beds)	73 (4.6)	90 (5.9)	
Females, n (%)	1,187 (77.6)	1,191 (79.7)	0.173
Age in years (mean, SD)	36.8 (10.5)	35.9 (10.5)	0.0255
Profession, n (%)			0.043
Nurse	1,050 (69.1)	1,084 (72.8)	
Physician	350 (23.0)	288 (19.3)	
Other	120 (7.9)	117 (7.9)	
With managerial function, n (%)	232 (16.4)	193 (13.9)	0.066
Years working in this hospital, n (%)			0.849
< 2 years	376 (24.5)	380 (25.4)	
2 to < 5 years	385 (25.0)	357 (23.9)	
5 to < 10 years	264 (17.2)	271 (18.1)	
10 to < 20 years	307 (20.0)	297 (19.9)	
≥ 20 years	206 (13.4)	190 (12.7)	
Work unit in the past three months, n (%)			0.020
Ward	906 (58.5)	963 (63.9)	
Emergency department	248 (16.0)	190 (12.6)	
Intensive care unit	144 (9.3)	129 (8.6)	
Operating room	146 (9.4)	141 (9.4)	
Other	104 (6.7)	85 (5.6)	
Overall experience with catheter placement throughout career, n (%)			0.300
Never	26 (1.7)	30 (2.0)	
1-5 times	169 (11.0)	171 (11.4)	
6-20 times	341 (22.2)	370 (24.6)	
> 20 times	1,002 (65.2)	931 (62.0)	
Frequency of catheter placement in current position, n (%)			0.084
Frequent user	690 (44.2)	618 (41.1)	
Infrequent user	871 (55.8)	885 (58.9)	

Note: Due to rounding percentages may not always add up to 100%.

* In the larger hospitals, not all of the departments participated in the project

+ p-values for changes between the two time periods

T_0=baseline survey, T_1=follow-up survey

Frequent user=places a catheter a few times a month or more often
Infrequent user=places a catheter a few times a year or less often

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Knowledge

For the overall study sample, the mean number of correctly answered knowledge items increased significantly between T_0 and T_1 ($p<0.001$) (table 2). Subgroup analysis indicates that knowledge scores increased in particular for nurses, staff members without managerial function and staff members frequently placing catheters. Effect sizes for the changes between the time points were small to moderate. Percentages of correct answers for each of the 15 items are provided in appendix 3.

Table 2. Mean number of correct answers provided for 15 knowledge items

	Mean $_{T0}$ (95% CI)	n_{T0}	Mean $_{T1}$ (95% CI)	n_{T1}	p-value	Effect size
Overall sample	10.4 (10.3;10.5)	1,579	11.0 (10.9;11.1)	1,527	<0.001	0.29
Professional group						
Nurses	10.2 (10.1;10.4)	1,050	10.9 (10.8;11.0)	1,084	<0.001	0.35
Physicians	11.1 (11.0;11.3)	350	11.4 (11.2;11.6)	288	0.047	0.16
Managerial function						
With	11.3 (11.1;11.5)	232	11.6 (11.4;11.9)	193	0.058	0.19
Without	10.3 (10.1;10.4)	1,187	10.9 (10.8;11.0)	1,199	<0.001	0.33
Frequency of catheter placement						
Frequent user	10.0 (9.8;10.1)	690	10.7 (10.6;10.9)	618	<0.001	0.40
Infrequent user	10.8 (10.7;10.9)	871	11.2 (11.1;11.3)	885	<0.001	0.22
Matched ID	10.4 (10.3;10.6)	420	11.3 (11.1;11.5)	420	<0.001	0.49
Unmatched ID	10.5 (10.3;10.6)	1,118	11.0 (10.9;11.1)	1,052	<0.001	0.31

T_0=baseline survey, T_1=follow-up survey
Frequent user=places a catheter a few times a month or more often
Infrequent user=places a catheter a few times a year or less often

We used the sub-sample of matched participants to examine the effect of training on the change in knowledge score over time. Among all matched respondents, 102 (25.3%) indicated having participated in *both* theoretical and practical training; 130 (32.2%) respondents had participated in *either* theoretical or practical training and 172 (42.6%) respondents did not participated in *any* training (missing values n=16). Results from the mixed analysis of variance showed that there was no significant interaction effect between time and training ($F_{2,401}$ =1.05, p=0.35). In other words, knowledge scores between participants with practical and/or theoretical training did not change differently over time as compared to participants without training.

Perception of practices and culture

The mean scale score for perception of current practices and culture increased significantly within the overall sample and within all subgroups between the two time points ($p<0.001$) (table 3).

Generally, agreement to the statements was moderate at baseline and strengthened over time. Yet, agreement remained moderately strong, with no group reaching a mean scale score above 6 even after implementation of the intervention bundle. Mean scores for each item are provided in appendix 4.

Table 3. Perception: mean scale score

	Mean $_{T0}$ (95% CI)	n_{T0}	Mean $_{T1}$ (95% CI)	n_{T1}	p-value	Effect size
Overall sample	5.3 (5.3; 5.3)	1,568	5.5 (5.5; 5.6)	1,521	<0.001	0.31
Professional group						
Nurses	5.4 (5.3; 5.4)	1,044	5.6 (5.6; 5.7)	1,082	<0.001	0.33
Physicians	5.1 (5.0; 5.1)	347	5.3 (5.2; 5.4)	286	<0.001	0.29
Managerial function						
With	5.2 (5.1; 5.3)	230	5.6 (5.5; 5.7)	191	<0.001	0.52
Without	5.3 (5.3; 5.4)	1,180	5.6 (5.5, 5.6)	1,197	<0.001	0.29
Frequency of catheter placement						
Frequent user	5.2 (5.1; 5.3)	690	5.4 (5.3, 5.5)	618	<0.001	0.22
Infrequent user	5.4 (5.3; 5.4)	861	5.7 (5.6, 5.7)	880	<0.001	0.37
Matched ID	5.4 (5.3; 5.4)	416	5.6 (5.5; 5.7)	416	<0.001	0.32
Unmatched ID	5.3 (5.2; 5.3)	1,108	5.5 (5.5; 5.6)	1,049	<0.001	0.31

Note: Scale consisted of 13 items.
Items were answered on a scale from 1 (strongly disagree) to 7 (strongly agree).
Cronbach's alpha for the scale: T_0 α=0.79 and T_1 α=0.80
T_0=baseline survey, T_1=follow-up survey
Frequent user=places a catheter a few times a month or more often
Infrequent user=places a catheter a few times a year or less often

Responsibilities

Self-reported responsibilities concerning IUC management by nurses and physicians changed only slightly over time (figure 1). At baseline and at follow-up, nurses mainly felt responsible for placing, maintaining and removing an IUC. However, at T_1, fewer nurses felt responsible for prescribing catheter placement (p<0.001) as compared to T_0 and a higher percentage felt responsible for assessing the need for continued catheterization (p=0.002). Physicians perceived themselves to be mainly responsible for ordering catheter placement and removal at both time points. At T_1, fewer of them felt responsible for placing or assisting with placing an IUC as compared to T_0, but differences were not statistically significant.

Determinants of behavior

The mean score for the scale assessing the determinants of behavior increased significantly between baseline and follow-up (p<0.001). Positive changes in mean scores were observed for all

three constructs (attitudes, subjective norms and perceived behavioral control). They were particularly strong for items assessing perceived social expectations to use catheters restrictively (see appendix 5). The positive trends could also be observed for professional group, managerial function and frequency of catheter placement (table 4). Medium effect sizes indicate practical relevance of these changes.

Table 4. Determinants of behavior: mean scale score

	Mean $_{T0}$ (95% CI)	n_{T0}	Mean $_{T1}$ (95% CI)	n_{T1}	p-value	Effect size
Overall sample	5.3 (5.3; 5.3)	1,539	5.6 (5.6; 5.6)	1,502	<0.001	0.43
Professional group						
Nurses	5.3 (5.2; 5.3)	1,046	5.6 (5.6; 5.7)	1,083	<0.001	0.56
Physicians	5.4 (5.3; 5.5)	349	5.6 (5.5; 5.6)	287	0.005	0.23
Managerial function						
With	5.6 (5.5; 5.7)	230	5.8 (5.7; 5.9)	192	<0.001	0.38
Without	5.2 (5.2; 5.3)	1,184	5.6 (5.5; 5.6)	1,198	<0.001	0.50
Frequency of catheter placement						
Frequent user	5.2 (5.2; 5.3)	675	5.6 (5.5; 5.6)	615	<0.001	0.46
Infrequent user	5.3 (5.3; 5.4)	847	5.6 (5.6; 5.7)	884	<0.001	0.41
Matched ID	5.3 (5.3; 5.4)	405	5.7 (5.6; 5.8)	405	<0.001	0.58
Unmatched ID	5.3 (5.3; 5.3)	1,090	5.6 (5.5; 5.6)	1,038	<0.001	0.37

Note: Scale consisted of 15 items.
Items were answered on a scale from 1 (strongly disagree) to 7 (strongly agree).
Cronbach's alpha for scale: T_0 α=0.72 and T_1 α=0.74
T_0=baseline survey, T_1=follow-up survey
Frequent user=places a catheter a few times a month or more often
Infrequent user=places a catheter a few times a year or less often

Difference-in-difference analyses of group and individual level data

Knowledge scores increased slightly more among participants with a matched ID compared to unmatched participants (p=0.047). Mean scale sores for perception of current practices and culture increased for both matched and unmatched participants to a similar extent (p=0.894). Mean scale scores for determinants of behavior increased slightly more for participants with a matched ID compared to unmatched participants (p=0.033).

DISCUSSION

We observed positive changes in staff knowledge, perceptions and attitudes regarding IUC use following the implementation of a multimodal intervention bundle in seven hospitals. Observed effects were small to moderate, requiring a closer look at the challenges of implementing and evaluating a multi-faceted intervention bundle in a large scale, national program. We found that in

two of the thematic sections – knowledge and determinants of behavior - the scores for matched participants increased slightly more than for unmatched participants. This seems plausible as the unmatched group includes participants of various levels of program exposition. It suggests that data analyzed on group level (two unmatched cross-sections) to evaluate short term effects of an intervention can to some extent, but not fully represent longitudinal effects on the individual participant level.

Knowledge scores increased significantly between baseline and follow-up, indicating that staff members in our pilot hospitals had more factual knowledge about the use and potential harm of urinary catheters after the intervention. Interestingly, however, we could not verify that participation in education and training sessions contributed to knowledge increases. When analyzing the results in our sub-sample of matched participants (i.e. individuals for whom we know that they worked in the hospital throughout the entire program), we found that changes in knowledge scores did not differ between staff members with and without training. The findings indicate that other factors, such as the dissemination of the indication list or the presence of champions may have contributed to the observed effects in knowledge. Regarding respondents' perception of current practices and cultural factors within their organization, we also found a small, but significant effect at the end of the intervention. The moderate effect size suggests that staff members indeed perceived positive changes in IUC management and safety climate within their organization. Factors determining intentions to perform a certain behavior, namely personal attitudes, perceived behavioral control and subjective norms changed over the course of the project too. At follow-up, staff members generally expressed higher willingness to contribute to a safe and restrictive use of IUCs. In particular, participants felt higher expectations from their social environment to reduce catheters, suggesting that a change in culture could indeed be initiated.

Even though there was a clear positive trend, the differences between survey periods on all three sections of the questionnaire (knowledge, perception of practices and culture, and determinants of behavior) where only small to moderate. Recommended practices and socio-adaptive components were thus, from the perspective of participants, not fully established even after the intervention. These results are not surprising, because change in organizational culture is a slow process, requiring endurance and continuous effort that could not be provided within the short time frame of the QI program. Studies that have collected long-term data on surgical checklist implementation state suggest that it takes time for cultural change to develop and for positive effects to fully become evident [38,39]. For example, an Australian study that has examined compliance with surgical safety checklist use reports that reduction in mortality rates reached significance only in the 2-3 year period after implementation [38]. In addition, we did not strictly define implementation strategies in order to allow pilot hospitals to adapt the intervention bundle to their local context.

Therefore, implementation fidelity could not systematically be assessed. Informal feedback from local project coordinators suggests that it was not always possible to deliver the intervention bundle as intended. For example, even though training sessions were mandatory, not all staff from the target population could eventually be reached.

Another explanation could be high staff turnover rates. Almost all of the respondents generated an 8-digit code. Interestingly, however, only 28% of the IDs provided could be matched between the two surveys. Participants at follow-up were thus, for the most part, not the same individuals as at baseline. This could be a sign for high staff turnover rates during the intervention period. However, it is also possible that unmatched participants had been working at the hospital throughout the intervention, but had been unwilling or unable to participate in the same survey twice. Nevertheless, this finding points to the importance of ensuring that hospitals continuously offer training, education and policy reinforcement. Continued efforts to incorporate recommended practices into routine care even after completion of the actual project phase are needed to move the intervention from a time-limited "project" to a continuous commitment and ensure that motivation to reduce urinary catheters is kept at a high level [40,41].

In our QI program, a before/after surveillance for catheterization and catheter-associated complications was conducted in the same time periods as the staff survey. Results show a significant decrease in catheter utilization rates in all pilot hospitals (unpublished data, manuscript in preparation). Secondary data analysis would be needed to examine the relationship between catheter utilization rates and staff perspectives. Some hypotheses can be put forward to explain the observation that while changes in staff perspectives were rather small, we did see a decrease in catheter utilization. It is possible that even small changes in staff knowledge and perception can have a substantial practical relevance. However, it is also possible that the items in our questionnaire do not adequately measure knowledge and perceptions required to reduce IUC use (content validity). To our knowledge, no other study has assessed the effects of an intervention bundle on staff behavior with similar measures; therefore it is not possible to relate our findings to existing research. Wakefield and colleagues found that perceptions about the behavior of professional peers, and the personal belief that engaging in a certain behavior will lead to better safety outcomes, are the strongest factors influencing safety behavior [15]. The authors conclude that interventions too often rely on educational measures in order to change behavior and argue that using behavioral models to design interventions may be more effective. Our results provide additional support for this argument. We saw the strongest effects in perceived norms to reduce catheter use, suggesting that efforts aimed at changing organizational culture may be particularly effective. We would however argue that staff education and training can offer an important platform

to disseminate and reinforce new norms and expectations, especially if they are used by clinical leaders to demonstrate their commitment to the cause and to foster interprofessional collaboration.

Promoting collaboration among nurses and physicians is especially important because urinary catheter management is a strongly interprofessional topic and roles and responsibilities need to be clear for all of the involved health care workers. In a previous study with data from the baseline survey, we analyzed how nurses and physicians perceived their respective responsibilities for IUC management [42]. We found that physicians mainly felt responsible for prescribing catheter placement and removal, while nurses generally considered themselves responsible for placing, managing and removing them. However, both nurses and physicians felt equally responsible for assessing the need for continued catheterization. The results from the present study show that at the end of the intervention, the perceived division of tasks between the two groups remained largely the same. This could either indicate that because of the intervention bundle, both groups were encouraged to assume responsibility in this area and interprofessional commitment was strengthened. However, it could also mean that tasks especially in regard to the re-evaluation of the need for a catheter were not clarified over the course of the project.

Limitations

This study has several limitations. We used the theory of planned behavior to model intention to reduce urinary catheter use. However, it is not possible to know if changes observed in staff perceptions led to a true change in practice. In a future study, staff survey data should be linked with surveillance data on hospital-level to examine if specific changes in staff perceptions are associated with changes in specific clinical outcomes. Direct observations of catheter placements may be considered as another method to gain insight into compliance with protocols for safe catheterization and changes in clinical practice [43]. This method was originally proposed to participating hospitals in our project, but was rejected due to the additional resources required. For practical purposes, we did not include a control group in the study design. The single-group design does therefore not allow any causal inferences about the contribution of the intervention bundle on the observed effects. It is possible that other secular trends or measures within the hospitals may have affected the outcomes. A stepped wedge design could present an alternative to this design. This design randomizes participating sites into sequential cohorts. All cohorts eventually implement the intervention, each providing their own control data in the meantime and offering researchers the chance to investigate implementation challenges and make adjustments along the way [44]. In addition, conducting focus groups or interviews with staff from each site could have provided a more in-depth understanding of staff perceptions after the intervention and the contextual factors that shape the implementation of a complex intervention in a new setting. The before/after study

design does not allow us to evaluate sustainability of the intervention over time. A further follow-up survey or a time-series approach could have shed more light on the long-term effects in the hospitals. We chose to administer paper instead of electronic versions of the survey to minimize coverage error because not all staff members in participating hospitals had access to individual e-mail addresses. Furthermore, paper surveys have been shown to generate higher response rates than surveys administered online [45]. With this method, we were able to attain reasonable response rates at both survey periods. Since data collection was organized by local project teams, however, we have no information on non-participants. It is possible that only highly motivated staff members participated in the survey, which may result in more positive responses. The two survey samples were comparable with respect to participants per hospital. For some of the socio-demographic characteristics, notably profession and work unit, we found significant differences between the two time periods. We cannot differentiate if this is due to selective non-responses or staff fluctuation. Lastly, it is possible that only high performing units open to change have been chosen to participate in the intervention project. This may limit generalizability of our findings to other units and hospitals.

Conclusion

Changing staff attitudes, knowledge and behavior are important prerequisites for an effective reduction of catheter use and catheter-associated complications. We found small, but significant changes in staff perceptions after implementation of an evidence-based intervention bundle. The positive trends were present in all subgroups, indicating that regardless of responsibilities and practice of catheter placement, perspectives on urinary catheter use changed over time. Efforts now need to be targeted at reinforcing and sustaining these changes, so that restrictive use of IUCs becomes an integral part of the hospital culture.

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Figure legends

Figure 1. Self-reported responsibilities in regard to urinary catheters by profession

* Change between time periods significant on p<0.05.

Appendices

Appendix 1. List of indications for indwelling urinary catheters

Appendix 2. Questionnaire

Appendix 3. Knowledge: % correct answers provided per item at T0 and T1

Appendix 4. Perception: mean and standard deviation per item at T0 and T1

Appendix 5. Behavior: mean and standard deviation per item at T0 and T1

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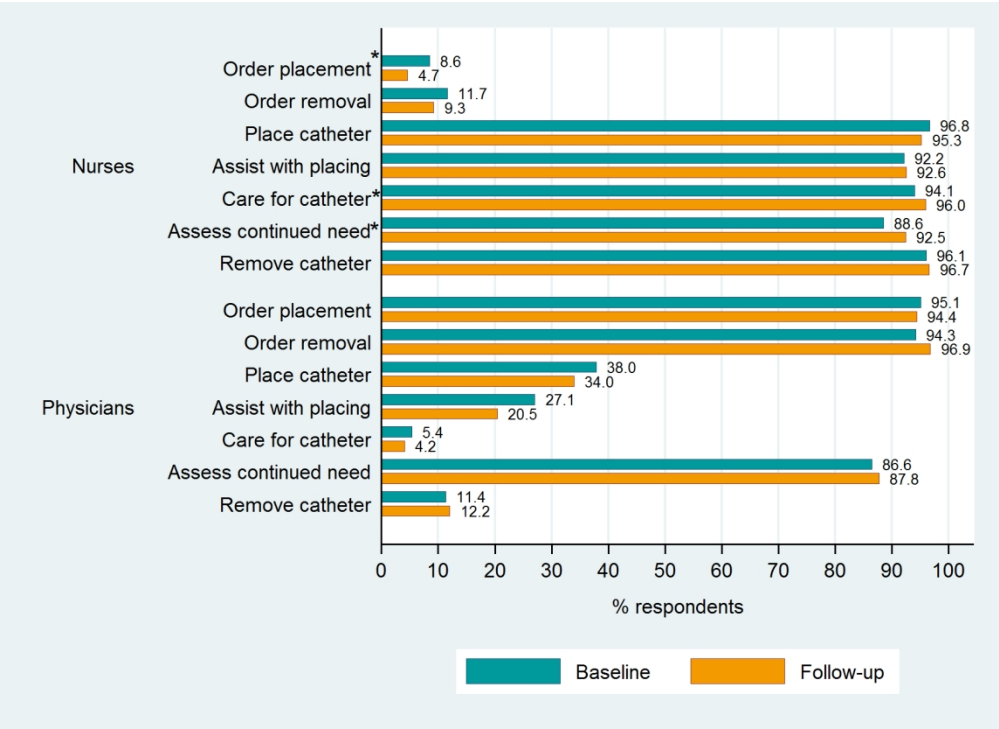

Figure 1. Self-reported responsibilities in regard to urinary catheters by profession

152x110mm (300 x 300 DPI)

Appendix 1. List of indications for indwelling urinary catheters

Note: This list does not cover urological emergencies. Treatment for these cases is decided by the urologist.

No indications for a urinary catheter are:

- Asymptomatic chronic urinary retention
- Urine output monitoring / fluid monitoring for stable patients, if daily weight control is possible
- Need for intensive care
- Urinary incontinence
- Immobilization, as long as alternative methods[1] for controlled bladder drainage have not been exhausted
- Comfort from the perspective of the patient (or their trusted representative) OR from the perspective of staff

Indication	Specification
Urinary retention	Acute urinary retention of any origin
	Symptomatic chronic outflow obstruction PLUS >300 ml residual urine
Urine output monitoring	In regular, short intervals (hourly or as defined by hospital) PLUS direct therapeutic consequences from monitoring, if body weight of patient cannot be measured
Surgery	Long surgery (>4h)
	Perioperative: for surgical reasons, if bladder has to be empty. Catheter is to be removed at the end of the surgery
	Urogenital surgery and/or pelvic floor surgery
	Epidural / peridural anesthesia/analgesia
Pressure ulcers PLUS incontinence	Pressure ulcers stage III or IV, or sacral/perineal skin transplants PLUS incontinence, if alternative methods[1] for controlled bladder drainage failed
Prolonged immobilization	Immobilization for medical reasons, especially for pain reduction, if alternative methods[1] for controlled bladder drainage failed
Palliation PLUS Comfort	Terminal-palliative situation PLUS dysfunction of bladder PLUS/OR difficulties with normal voiding, if alternative methods[1] for controlled bladder drainage failed
	Severe psychological strain PLUS at the request of the informed patient (or their trusted representative)

[1] Alternative methods are: condom catheter, urinal, bedpan, bedside commode, incontinence pads, pants

List was translated for this publication by the authors.

Appendix 2. Questionnaire

Personal ID

First we ask you to create a personal identification number (ID). As part of the program progress! Safe urinary catheterization, you will complete questionnaires at two different points in time. This ID will help us match the two different questionnaires to one person, and to recognize the information coming from one and the same person. At the same time, the ID protects your anonymity, as you cannot be personally identified. This is how you create your personal ID:

The ID consists of your mother's initials (maiden name), your father's initials and your mother's birth year. Example: Mother: Hannah Kaufmann, Father: Peter Muller, Mothers birth year: 1931 → ID: HKPM1931

Part 1 (correct answers provided in parentheses)

Please estimate:

How many patients in Switzerland receive a catheter during their hospital stay?
(10-25%)

Please indicate if the following statements are correct:

After 30 catheter-days, nearly all patients show bacteriuria. (correct)

The duration of catheterization is an important risk factor for the development of a urinary tract infection. (correct)

Most hospital-acquired urinary tract infections are associated with a urinary catheter. (correct)

Single-use urinary catheters carry a higher risk for infections as compared to indwelling catheters. (false)

A closed drainage system is essential for the prevention of catheter-associated urinary tract infections. (correct)

Compared to catheters, non-invasive methods for bladder draining (e.g., condom catheters, incontinence pads) have the advantage that they do not carry a risk for injuries. (correct)

Non-infectious complications (e.g., injuries or allergic reactions) only occur in absolutely rare instances during catheterization. (false)

The choice of an antiseptic for disinfecting the urethral meatus does not affect the correct asepsis when inserting a catheter. (false)

Up to 50 percent of catheters placed in an emergency department are not medically justified. (correct)

One effective measure to prevent catheter- associated urinary tract infections is to change catheters or drainage bags in regular intervals. (false)

In which of these situations is the placement of a urinary catheter indicated?

To monitor urine output in stable patients who can be weighed. (not indicated)

In case of distress at the request of a terminally ill patient. (indicated)

For patients requiring intensive care. (not indicated)

For patients with restricted mobility. (not indicated)

Part 2

Please indicate if you agree with the following statements:[1]

On my unit, IUCs are placed only as clearly indicated medical measure.

For medical leadership on my unit, restrictive use of IUCs is very important.

For nursing leadership on my unit, restrictive use of IUCs is very important.

Nursing workload plays an important role when a decision for placing an IUC is made.

People in charge on my unit make sure that everyone placing IUCs is sufficiently trained for this task.

Whenever possible, staff on my unit tries to use alternatives to an IUC (e.g., condom catheters, incontinence pads).

The daily assessment to evaluate if an IUC is still needed is a given for us.
Basic infection prevention measures are well complied with during placement and care of IUCs.
If someone needs help when placing an IUC, it is clear on my unit who can be contacted.
Medical and nursing staff on my unit have a similar attitude concerning the use of IUCs.
For staff members on my unit, it is a matter of course to openly question the placement of an IUC.
It is difficult on my unit to speak up when rules of hygiene are broken during placement and care of an IUC.
It is common on my unit that, whenever possible, two healthcare workers work together to place a catheter.

Part 3

What is your own role regarding the use of catheters? Please select all answers that apply.

It is part of my responsibility to…
…write orders for IUC placement
…write orders for IUC removal
…place an IUC
…assist another professional with placing an IUC
…care for an indwelling catheter
…assess the continued need for an IUC
…remove an IUC

Part 4

Please indicate if you agree with the following statements:[1]

I can properly estimate in which situations the use of an IUC is appropriate.
My colleagues appreciate my commitment to reduce the use of IUCs.
I can influence the use of IUCs in my daily work.
The risk from IUCs for patients is underestimated.
I find it difficult in my daily work to reduce the use of IUCs.
In my hospital I am expected to contribute to the reduction of IUCs.
I am convinced that I am proficient in caring for an indwelling catheter.
I am convinced that by reducing the use of IUCs, adverse events to patients can be avoided.
Our patients appreciate it when IUCs are avoided.
A reduced use of IUCs makes patient care more stressful for me.
My supervisors expect that everyone follows the internal protocols for inserting catheters.
I am convinced that I am proficient in inserting a urinary catheter.
I think that it's important to reduce the use of IUCs in the hospital.
My supervisors expect me to reduce the use of IUCs.
I am confident that I can reduce the use of IUCs in everyday work.

Part 5 (response categories in parentheses)

How old are you?
Gender (female, male)
In which professional role are you currently working?
(surgical positioning specialist, healthcare assistant, registered nurse, nursing manager, physician resident, attending physician, senior phyisican, chief physician, other)
How long have you been working in this hospital? (< 2 years, 2 to < 5 years, 5 to < 10 years, 10 to < 20 years, ≥ 20 years)
How many working hours do you spend in patient care during a typical working week? (less than 10 hours, between 10-24 hours, between 25-39 hours, 40 hours or more)

How often have you placed a urinary catheter throughout your professional career (estimate)? (never, 1-5 times, 6-20 times, > 20 times)
How often do you place a urinary catheter in your current position (estimate)?
(never, rarely (a few times a year), sometimes (a few times a month), often (a few times a week))
Where have you primarily been working in the past three months?
(ward, emergency department, intensive care unit, operating room, other)
In which medical area do you work primarily?
(Anesthesiology, Surgery, Obstetrics/Gynecology, Internal medicine, Neurology, orthopedics, Radiology, Urology, in several medical areas, other)
Do you have additional any additional comments?

Items only included at T_1

Are you familiar with the indication list that has been implemented as part of the program "progress! Safe urinary catheterization"? (yes, no)
Have you participated at a training as part of the program "progress! Safe urinary catheterization"?
- Theoretical training (yes, no)
- Practical training (yes, no)

How do you evaluate the participation of your unit in the program "progress! Safe urinary catheterization"? (very positive, rather positive, neutral, rather negative, very negative, don't know the program)

Items translated from German original by the authors.
[1] Items were answered on a Likert-scale from 1 (do not agree at all) to 7 (completely agree)

Appendix 3. Knowledge – % correct answers provided per item

	% T_0 n = 1,579	% T_1 n = 1,527
Please estimate:		
How many patients in Switzerland receive a catheter during their hospital stay? (10-25%)	37.6	39.1
Please indicate if the following statements are correct:		
After 30 catheter-days, nearly all patients show bacteriuria. (correct)	81.6	86.9
The duration of catheterization is an important risk factor for the development of a urinary tract infection. (correct)	98.0	98.9
Most hospital-acquired urinary tract infections are associated with a urinary catheter. (correct)	82.2	86.3
Single-use urinary catheters carry a higher risk for infections as compared to indwelling catheters. (false)	89.9	91.9
A closed drainage system is essential for the prevention of catheter-associated urinary tract infections. (correct)	77.4	82.0
Compared to catheters, non-invasive methods for bladder draining (e.g., condom catheters, incontinence pads) have the advantage that they do not carry a risk for injuries. (correct)	62.4	69.0
Non-infectious complications (e.g., injuries or allergic reactions) only occur in absolutely rare instances during catheterization. (false)	61.2	68.8
The choice of an antiseptic for disinfecting the urethral meatus does not affect the correct asepsis when inserting a catheter. (false)	80.6	82.6
Up to 50 percent of catheters placed in an emergency department are not medically justified. (correct)	61.4	73.8
One effective measure to prevent catheter-associated urinary tract infections is to change catheters or drainage bags in regular intervals. (false)	30.4	36.2
In which of these situations is the placement of a urinary catheter indicated?		
To monitor urine output in stable patients who can be weighed. (not indicated)	97.5	98.1
In case of distress at the request of a terminally ill patient. (indicated)	93.3	93.2
For patients requiring intensive care. (not indicated)	21.2	32.3
For patients with restricted mobility. (not indicated)	79.9	81.4

Correct answers for knowledge items are provided in parentheses. Items were translated for this publication by the authors. Sample size differs slightly for each item due to a varying number of missing values.

Appendix 4. Perception of practices and culture – Mean and standard deviation per item

	Mean T_0 (SD) n = 1,579	Mean T_1 (SD) n = 1,527	p-value
On my unit, IUCs are placed only as clearly indicated medical measure.	5.5 (1.4)	5.7 (1.3)	<0.001
For medical leadership on my unit, restrictive use of IUCs is very important.	5.1 (1.6)	5.4 (1.4)	<0.001
For nursing leadership on my unit, restrictive use of IUCs is very important.	5.1 (1.5)	5.7 (1.3)	<0.001
Nursing workload plays an important role when a decision for placing an IUC is made.	2.8 (1.8)	2.5 (1.6)	<0.001
People in charge on my unit make sure that everyone placing IUCs is sufficiently trained for this task.	5.4 (1.7)	5.6 (1.5)	<0.001
Whenever possible, staff on my unit tries to use alternatives to an IUC (e.g., condom catheters, incontinence pads).	4.7 (1.8)	5.1 (1.7)	<0.001
The daily assessment to evaluate if an IUC is still needed is a given for us.	5.3 (1.6)	5.6 (1.5)	<0.001
Basic infection prevention measures are well complied with during placement and care of IUCs.	6.0 (1.1)	6.1 (1.0)	0.0219
If someone needs help when placing an IUC, it is clear on my unit who can be contacted.	5.8 (1.5)	5.9 (1.4)	0.2649
Medical and nursing staff on my unit have a similar attitude concerning the use of IUCs.	5.1 (1.4)	5.3 (1.4)	0.0016
For staff members on my unit, it is a matter of course to openly question the placement of an IUC.	5.5 (1.4)	5.7 (1.2)	<0.001
It is difficult on my unit to speak up when rules of hygiene are broken during placement and care of an IUC.	2.9 (1.7)	2.8 (1.6)	0.0358
It is common on my unit that, whenever possible, two healthcare workers work together to place a catheter.	5.0 (1.9)	5.2 (1.7)	<0.001

Items were translated for this publication by the authors. Sample size differs slightly for each item due to a varying number of missing values.

Appendix 5. Determinants of personal behavior – Mean and standard deviation per item

	Mean T_0 (SD) n = 1,579	Mean T_1 (SD) n = 1,527	p-value
Perceived behavioral control			
I can properly estimate in which situations the use of an IUC is appropriate.	6.1 (1.0)	6.1 (1.0)	0.2587
I can influence the use of IUCs in my daily work.	5.5 (1.4)	5.7 (1.4)	0.0004
I am convinced that I am proficient in caring for an indwelling catheter.	5.5 (1.6)	5.6 (1.6)	0.0343
I am convinced that I am proficient in inserting a urinary catheter.	5.7 (1.5)	5.7 (1.4)	0.5490
I am confident that I can reduce the use of IUCs in everyday work.	5.0 (1.5)	5.5 (1.4)	<0.001
Subjective Norms			
My colleagues appreciate my commitment to reduce the use of IUCs.	5.1 (1.5)	5.4 (1.4)	<0.001
In my hospital I am expected to contribute to the reduction of IUCs.	4.6 (1.8)	5.7 (1.5)	<0.001
Our patients appreciate it when IUCs are avoided.	5.5 (1.4)	5.6 (1.4)	0.0442
My supervisors expect that everyone follows the internal protocols for inserting catheters.	6.0 (1.2)	6.1 (1.2)	0.0125
My supervisors expect me to reduce the use of IUCs.	4.5 (1.7)	5.5 (1.5)	<0.001
Attitudes			
The risk from IUCs for patients is underestimated.	5.1 (1.6)	5.0 (1.8)	0.0044
I find it difficult in my daily work to reduce the use of IUCs.	3.7 (1.7)	3.3 (1.6)	<0.001
I am convinced that by reducing the use of IUCs, adverse events to patients can be avoided.	5.8 (1.3)	6.1 (1.1)	<0.001
A reduced use of IUCs makes patient care more stressful for me.	3.0 (1.8)	2.9 (1.7)	0.0045
I think that it's important to reduce the use of IUCs in the hospital.	5.7 (1.3)	6.0 (1.2)	<0.001

Items were translated for this publication by the authors. Items are presented according to their construct (perceived behavioral control, subjective norm and attitudes). In the questionnaire, order of the items was randomized. Sample size differs slightly for each item due to a varying number of missing values.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	title page
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	p.2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	p.3-4
Objectives	3	State specific objectives, including any prespecified hypotheses	p.3-4
Methods			
Study design	4	Present key elements of study design early in the paper	p.5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	p.4 & p.5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	p.5 & p.6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	p.5-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	N/A
Bias	9	Describe any efforts to address potential sources of bias	N/A
Study size	10	Explain how the study size was arrived at	p.6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	p.6-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	p.6-7
		(*b*) Describe any methods used to examine subgroups and interactions	p.6-7
		(*c*) Explain how missing data were addressed	p.6-7
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	N/A

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	p.7
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	p.8 (table 1)
		(b) Indicate number of participants with missing data for each variable of interest	p.8 (table 1)
Outcome data	15*	Report numbers of outcome events or summary measures	p.9-11
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	N/A
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	p.9
Discussion			
Key results	18	Summarise key results with reference to study objectives	p.11-13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	p.13-14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	p.14
Generalisability	21	Discuss the generalisability (external validity) of the study results	p.13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	p14

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.