American Journal of Infection Control 41 (2013) 885-91

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major article

Impact of a multidimensional infection control approach on catheter-associated urinary tract infection rates in adult intensive care units in 10 cities of Turkey: International Nosocomial Infection Control Consortium findings (INICC)

Hakan Leblebicioglu MD [a], Gulden Ersoz MD [b], Victor Daniel Rosenthal MD, MSc, CIC [c,*], Ata Nevzat-Yalcin MD [d], Özay Arıkan Akan MD [e], Fatma Sirmatel MD [f], Huseyin Turgut MD [g], Davut Ozdemir MD [h], Emine Alp MD [i], Cengiz Uzun MD [j], Sercan Ulusoy MD [k], Saban Esen MD [a], Fatma Ulger MD [a], Ahmet Dilek MD [a], Hava Yilmaz MD [a], Ali Kaya MD [b], Necdet Kuyucu MD [b], Ozge Turhan MD [d], Nurgul Gunay RN [d], Eylul Gumus RN [d], Oguz Dursun MD [d], Melek Tulunay MD [e], Mehmet Oral MD [e], Necmettin Ünal MD [e], Mustafa Cengiz MD [l], Leyla Yilmaz MD [l], Suzan Sacar MD [g], Hülya Sungurtekin MD [g], Doğaç Uğurcan MD [g], Mehmet Faruk Geyik MD [h], Ahmet Şahin MD [h], Selvi Erdogan RN [h], Bilgehan Aygen MD [i], Bilgin Arda MD [k], Feza Bacakoglu MD [k]

[a] *Ondokuz Mayis University Medical School, Samsun, Turkey*
[b] *Mersin University, Faculty of Medicine, Mersin, Turkey*
[c] *International Nosocomial Infection Control Consortium, Buenos Aires, Argentina*
[d] *Akdeniz University, Antalya, Turkey*
[e] *Ankara University School of Medicine Ibni-Sina Hospital, Ankara, Turkey*
[f] *Abant Izzet Baysal University, Bolu, Turkey*
[g] *Pamukkale University, Denizli, Turkey*
[h] *Duzce University Medical School Infectious Diseases and Clinical Microbiology, Duzce, Turkey*
[i] *Erciyes University, Faculty of Medicine, Kayseri, Turkey*
[j] *German Hospital, Istanbul, Turkey*
[k] *Ege University Medical Faculty, Izmir, Turkey*
[l] *Harran University, Faculty of Medicine, Sanliurfa, Turkey*

Key Words:
Hospital infection
Nosocomial infection
Health care-acquired infection
Device-associated infection
Catheter-related urinary tract infections
Urinary catheter
Developing countries
Limited resources countries
Low-income countries
Emerging countries
Surveillance
Critical care
Incidence density
Bundle
Hand hygiene
Handwashing

Background: We evaluate the effectiveness of a multidimensional infection control approach for the reduction of catheter-associated urinary tract infections (CAUTIs) in 13 intensive care units (ICUs) in 10 hospital members of the International Nosocomial Infection Control Consortium (INICC) from 10 cities of Turkey.

Methods: A before-after prospective active surveillance study was used to determine rates of CAUTI. The study was divided into baseline (phase 1) and intervention (phase 2). In phase 1, surveillance was performed applying the definitions of the Centers for Disease Control and Prevention/National Healthcare Safety Network. In phase 2, we implemented a multidimensional approach that included bundle of infection control interventions, education, surveillance and feedback on CAUTI rates, process surveillance, and performance feedback. We used random effects Poisson regression to account for clustering of CAUTI rates across time periods.

Results: The study included 4,231 patients, hospitalized in 13 ICUs, in 10 hospitals, in 10 cities, during 49,644 patient-days. We recorded a total of 41,871 urinary catheter (UC)-days: 5,080 in phase 1 and 36,791 in phase 2. During phase 1, the rate of CAUTI was 10.63 per 1,000 UC-days and was significantly decreased by 47% in phase 2 to 5.65 per 1,000 UC-days (relative risk, 0.53; 95% confidence interval: 0.4-0.7; *P* value = .0001).

* Address correspondence to Victor Daniel Rosenthal, MD, MSc, CIC, Corrientes Avenue 4580, Floor 12, Apartment D, Buenos Aires, ZIP 1195, Argentina.
E-mail address: victor_rosenthal@inicc.org (V.D. Rosenthal).

Funding for the activities carried out at INICC headquarters were provided by the corresponding author, Victor D. Rosenthal, and the Foundation to Fight against Nosocomial Infections.

Author contributions: Idea, conception, and design: V.D. Rosenthal. Software development: V.D. Rosenthal. Assembly of data: V.D. Rosenthal. Analysis and interpretation of the data: V.D. Rosenthal. Epidemiological analysis: V.D. Rosenthal. Statistical analysis: V.D. Rosenthal. Administrative, technical, and logistic support: V.D. Rosenthal. Drafting of the article: V.D. Rosenthal. Critical revision of the article for important intellectual content: All authors. Final approval of the article: All authors. Provision of study patients: All authors. Collection of data: All authors. Funding: Victor D. Rosenthal and the Foundation to Fight against Nosocomial Infections funds all the activities at INICC head quarters (www.inicc.org).

Conflicts of interest: None to report.

http://dx.doi.org/10.1016/j.ajic.2013.01.028

Conclusion: Our multidimensional approach was associated with a significant reduction in the rates of CAUTI in Turkey.

Catheter-associated urinary tract infections (CAUTIs) are among the most common device-associated health care-acquired infections (DA-HAI) in intensive care units (ICU).[1-3] CAUTIs are responsible for prolonged hospital length of stay, bacterial resistance, morbidity, and increased health care costs.[4,5] Recently published studies show divergence in terms of its association with excess mortality, which was found to result from confounding by unmeasured variables.[4,6-8]

DA-HAI rates in the ICUs of limited-resources countries are 3 to 5 times higher than rates in the ICUs of high-income countries, as reported from International Nosocomial Infection Control Consortium (INICC) hospitals.[9]

The considerable influence exerted by the socioeconomic level of a country and the type of hospital in DA-HAIs in developing countries has been assessed in 2 studies.[10,11] With regard to the country socioeconomic level, in a study conducted in pediatric ICUs, it was shown that lower middle-income countries had higher CAUTI rates than low-income countries or upper middle-income countries (5.9 vs 0.6 CAUTIs per 1,000 urinary catheter [UC]-days).[11]

It has been shown in different studies from developed countries that implementing infection control programs and practice bundles (including hand hygiene [HH],[12] training on care, maintenance, alternatives to indwelling catheters[13]; education and training on procedures for catheter insertion, management, and removal; inserting urinary catheters only when needed; removing them when not necessary[14]; and maintaining unobstructed urine flow, among other interventions; simultaneously outcome surveillance of CAUTI rates and their consequences, process surveillance, feedback on CAUTI rates and performance feedback,[15] among others) were associated with a reduction in the incidence density of CAUTI. There is a pressing need for implementing prevention strategies and programs in the developing world.[16]

With the aim of reducing these high CAUTI rates, we implemented a multidimensional infection control program, which included specific interventions for CAUTI prevention, such as a practice bundle, education, outcome surveillance, process surveillance, feedback of CAUTI rates, as well as performance feedback of infection control practices, in 13 adult ICUs of 10 hospitals from 10 cities of Turkey. The implementation of the INICC multidimensional program for CAUTI prevention for this study is based on the recommendations and guidelines published by the Society for Health Care Epidemiology of America and the Infectious Diseases Society of America from 1983[17] and as modified up to 2008.[18]

METHODS

Setting and study design

We implemented an active, prospective outcome and process surveillance before-after study in 13 adult ICUs in 10 hospitals members of the INICC in 10 cities of Turkey from September 2003 to June 2011. The participating ICUs have an infection control team (ICT) composed of infection control professionals (ICPs) and at least 1 medical doctor with formal education and background in internal medicine, critical care, infectious diseases, and/or hospital epidemiology. The INICC headquarters' team in Buenos Aires provided ICTs with centralized education, data analyses, and coordination functions. Every hospital's Institutional Review Board agreed to the study protocol, and patient confidentiality was protected by codifying the recorded information, making it only identifiable to the ICT.

Baseline period

The baseline period included only the performance of outcome surveillance and process surveillance. The length of the baseline period is 3 months because of the following 3 reasons:

1. This is the time needed to conduct the following activities at INICC headquarters (HQs) in Argentina on a monthly basis: receiving those case report forms (CRF) filled at all participating ICUs from Turkey; conducting a validation process of filled CRFs; sending queries to participating ICUs; receiving and analyzing replies to queries; uploading CRFs data with proprietary INICC software in Argentina; analyzing uploaded data; producing monthly reports containing charts and tables with the results of outcome and process surveillance; sending monthly reports to each ICUs; presenting the monthly report of outcome and process surveillance data to health care workers (HCWs) working at the participating ICUs in monthly infection control meetings, with the aim of providing feedback on CAUTI rates and consequences and performance feedback and increase the awareness about CAUTIs to improve compliance with infection control practices.
2. Sample size of patients and number of months of data collection during baseline period are sufficient enough to compare with sample size of patients and number of months of data collection during intervention period. From a statistical perspective, the issue is addressed by considering the changes in rates over time. The relatively short baseline period may impact the standard error of our estimates, but we found that this will not cause a bias in the results because there will not be systematic differences between the 2 groups.
3. Our priority is to start intervention as early as possible to achieve the desired results, that is, the reduction of CAUTI rates and its adverse effects, as soon as possible.

Intervention period: Phase 2

The intervention period (phase 2) was initiated after 3 months of participation in the INICC outcome and process surveillance program. The average length of phase 2 was 22.4 months ± standard deviation 17.2 (range, 4-60).

The INICC multidimensional infection control approach included the following items: (1) bundle of infection control interventions, (2) education, (3) outcome surveillance, (4) process surveillance, (5) feedback on CAUTI rates, and (6) performance feedback on infection control practices.

Bundle for the prevention of CAUTI

The bundle consisted of the following interventions: (1) HH before insertion and manipulation of the urinary catheter (UC); (2) insertion of UCs only when needed and removal when unnecessary; (3) use of indwelling urethral catheters for perioperative and for selected surgical procedures, urine output monitoring in critically ill patients, management of acute urinary retention and urinary obstruction, and assistance in pressure ulcer healing for incontinent residents; (4) to consider other methods for management, including condom catheters or in-and-out catheterization, when appropriate; (5) to use as small a catheter as possible; (6) use of gloves, a drape, and sponges; a sterile or antiseptic solution for cleaning the urethral meatus; and a single-use packet of sterile lubricant jelly for insertion; (7) to insert catheters by use of aseptic technique and sterile equipment; (8) appropriate management of indwelling catheters: to properly secure indwelling catheters to prevent movement; to maintain a sterile, continuously closed drainage system; not to disconnect the catheter and drainage tube; to replace the collecting system by use of aseptic technique and after disinfecting the catheter-tubing junction when breaks in aseptic technique, disconnection, or leakage occur; (9) to maintain unobstructed urine flow, ie, UC on thigh without kinks; (10) to keep the collecting bag below the level of the bladder at all times; ie, UC with collecting bag hanging and not allowing urine reflux; (11) to empty the collecting bag regularly and to avoid allowing the draining spigot to touch the collecting container; (12) cleaning of the metal area as part of routine hygiene; (13) surveillance of CAUTI by using standardized criteria to identify patients with CAUTI and collecting UC-days as denominators.

Education

Education sessions and training were provided to HCWs on procedures for catheter maintenance, management, insertion and removal, and on the different alternatives to indwelling catheters.[18]

INICC surveillance program

The INICC Surveillance Program included 2 components: outcome surveillance (DA-HAI rates and their adverse effects, including mortality rates) and process surveillance (adherence to HH and other basic preventive infection control practices).[19] Investigators were required to complete outcome and process surveillance forms at their hospitals, which were then sent for their monthly analysis to the INICC headquarters office in Buenos Aires.

Outcome surveillance

For outcome surveillance, the ICTs applied the definitions for health care-associated infections (HAI) developed by the US Centers for Disease Control and Prevention (CDC) for the National Healthcare Safety Network (NHSN) program.[19] Outcome surveillance included rates of CAUTI per 1,000 UC-days, microorganism profile, bacterial resistance, length of stay, and mortality in the participating ICUs.[19]

Process surveillance

Process surveillance within the INICC multidimensional approach was designed to assess compliance with easily measurable key infection control practices, such as surveillance of compliance rates for HH practices and specific measures for the prevention of CAUTI. Although HCWs knew that HH practices were to be regularly monitored, they were not aware of the precise schedule and moment in which observations were actually taking place.[19] In our study, we collected process surveillance data only on HH compliance and UC care because we did not count on the necessary resources to collect data on the compliance with other measures included in the bundle for CAUTI prevention. Therefore, we could not evaluate the implications of all these interventions individually.

HH compliance

HH compliance by HCWs was determined by measuring the frequency on which HH was performed when clearly indicated by guidelines. HH practices were monitored by the ICP during randomly selected 1-hour direct observation periods, 3 times a week. ICPs recorded HH opportunities and compliance on a form specifically designed for the study's direct observation, which comprised the "Five Moments for Hand Hygiene" as recommended by the World Health Organization.[20]

UC care monitoring

UC care compliance was monitored once a day, every day. The observer supervised and recorded how infection control procedures were performed by HCWs, that is, UC on thigh without kinks, and UC with collecting bag hanging, and not allowing urine reflux. For this purpose, forms for UC care monitoring included information such as date, number of inserted catheters, number of catheters over thigh, and number of bags hanging. The observer checked whether the urine collecting bag was hanging on the side of the patient, on the contaminated floor, or elsewhere allowing the reflux and whether the catheter was placed on or under the patient's thigh.

Feedback of DA-HAI rates

Every month, the INICC research team at INICC headquarters in Buenos Aires prepared and sent to each ICT a final report on the results of outcome surveillance data sent by investigators at each hospital, that is, monthly DA-HAI rates, length of stay, bacterial profile and resistance, and mortality.[19] Feedback on DA-HAI rates was provided to HCWs working in the ICU by communicating the outcomes of patients. The resulting rates were reviewed by the ICT at monthly meetings in which charts were analyzed. Statistical graphs and visuals were displayed in prominent locations inside the ICU to provide an overview of rates of DA-HAIs. This infection control tool is important to increase HCWs' awareness about outcomes of patients at ICUs, enable the ICT and ICU staff to focus on the necessary issues, and apply specific strategies for improvement of high DA-HAI rates.

Performance feedback

Upon processing the hospitals' process surveillance data on a monthly basis, the INICC research team at INICC headquarters located in Buenos Aires prepared and sent to each ICT a final report on the results of process surveillance rates, including compliance with HH, and care of UC.[19]

Performance feedback was provided to HCWs working in the ICU by communicating the assessment of practices routinely performed by them. The resulting rates were reviewed by the ICT at monthly meetings in which charts were analyzed and statistical graphs and visuals were posted inside the ICU to provide an overview of rates measuring compliance with infection control practices. This infection control tool is fundamental to enable the ICT and ICU staff to focus on the necessary strategies for improvement of low compliance rates. As mentioned before, because of our limited resources, we were not able to collect data on all the interventions included in the bundle for CAUTI prevention.

Definition of CAUTI

For the diagnosis of CAUTI, the patient must have met 1 of 2 criteria. The first criterion was satisfied when a patient with a UC

Table 1
Characteristics of patients and hand hygiene compliance in phase 1, the baseline period, and phase 2, the intervention period

Patient characteristics	Baseline	Intervention	RR*	95% CI	*P* value
Number of patients	627	3,604	-	-	-
Study period by hospital in months, mean ± SD (range)	3	22.4 ± 17.2 (4-60)	-	-	-
UC duration, mean ± SD	8.1 ± 11.5	10.2 ± 18.0	-	-	.003
Age, y, mean ± SD	53.22 ± 21.4	50.4 ± 22.0	-	-	.0001
ASIS score, mean ± SD	3.1 ± 1.0	3.44 ± 1.0	-	-	.0001
Male, n (%)	349 (58)	2,205 (62)	1.06	0.93	1.2
Female, n (%)	251 (42)	1,377 (38)	-	-	-
Surgical stay, n (%)	144 (23)	557 (16)	0.7	0.57-0.83	.0001
Pulmonary disease, n (%)	55 (9)	174 (5)	0.55	0.42-0.74	.0001
Abdominal surgery, n (%)	56 (9)	307 (9)	0.95	0.725-1.3	.72
Cardiac surgery, n (%)	18 (3)	59 (2)	0.6	0.36-0.97	.03
Chronic obstructive, n (%)	14 (2)	52 (1)	0.82	0.7-0.99	.04
Cancer, n (%)	8 (3)	155 (5)	1.9	0.93-3.84	.075
Trauma, n (%)	78 (12)	575 (16)	1.3	1.01-1.6	.034
Previous infections, n (%)	87 (14)	447 (13)	0.9	0.7-1.13	.33
Cardiac failure, n (%)	47 (7)	156 (4)	0.6	0.43-0.8	.0007
Endocrine diseases, n (%)	45 (7)	218 (6)	0.84	0.62-1.2	.3
Renal impairment, n (%)	48 (8)	191 (5)	0.7	0.52-0.95	.02
Hepatic failure, n (%)	14 (2)	52 (1)	0.65	0.4-1.2	.123
Thoracic surgery, n (%)	40 (6)	100 (3)	0.435	0.32-0.61	.0001
Stroke, n (%)	8 (1)	74 (2)	1.6	0.8-3.74	.17
Immune compromise, n (%)	40 (6)	46 (1)	0.2	0.14-0.3	.0001
Hand hygiene compliance % (n/n)	33 (397/1,191)	58 (5,026/8,677)	1.7	1.6-2.0	.0001
Compliance with UC on thigh % (n/n)	92 (4,593/4,969)	99 (48,684/49,360)	1.1	1.0-1.1	.0001
Collective bag hanging % (n/n)	98 (4,858/4,969)	99 (48,960/49,360)	1.0	0.98-1.0	.34

ASIS, Average severity of illness score; *CI*, confidence interval; *CAUTI*, catheter-associated urinary tract infection; *RR*, rate ratio; *SD*, standard deviation; *UC*, urinary catheter.
*For HH, relative risk rather than rate ratios are calculated.

had 1 or more of the following symptoms with no other recognized cause: fever (temperature ≥ 38°C), urgency, or suprapubic tenderness. The urine culture was positive for 10^5 colony-forming units per milliliter or more, with no more than 2 microorganisms isolated. The second criterion was satisfied when a patient with a UC had at least 2 of the following criteria with no other recognized cause: positive dipstick analysis for leukocyte esterase or nitrate and pyuria (≥10 leukocytes/mL).[21]

Statistical methods

Patients' characteristics during baseline and during the last 3 months of the intervention period in each ICU were compared using Fisher exact test for dichotomous variables and unmatched Student *t* test for continuous variables. 95% confidence intervals (CI) were calculated using VCStat (Castiglia, Argentina). Relative risk (RR) ratios with 95% confidence intervals (CI) were calculated for comparisons of rates of CAUTI using EPI Info V6 (CDC, Atlanta, GA). *P* values <.05 by 2-sided tests were considered significant.

Furthermore, we used Poisson regression to compare the rates of CAUTI with baseline for the follow-up period, divided into 9- to 24-month periods. We compared the CAUTI rates in each period with the CAUTI rate at baseline for each follow-up period using as the baseline only the hospitals that contributed to follow-up in that period (ie, excluding hospitals that only contributed a shorter length of surveillance from the baseline for comparisons with long lengths of follow-up). We used random effects Poisson regression to account for within hospital clustering of CAUTI rates across time periods. These models were estimated using Stata 11.0 (Stata Corp, College Station, TX).

RESULTS

During the whole study, a total of 4,231adult inpatients was hospitalized in 13 ICUs in 10 hospitals, in 10 cities, during 49,644 patient-days, amounting to 41,871 UC-days. Participating hospitals were classified according to type of hospital, type of ICU, number of ICUs, and number of patients in each ICU. The first ICUs to participate in the study were enrolled in September 2003, and the most updated data included our analysis date from June 2011. Twelve of the 13 participating hospitals were academic, and the remaining one was private. The types ICUs included were as follows: surgical (1 ICU), surgical cardiac (1 ICU), medical (1 ICU), medical surgical (9 ICUs), and recovery (1 ICU).

Table 2
Catheter-associated urinary tract infection rates, mortality rates, and device use in phase 1, the baseline period, and phase 2, the intervention period

Patient outcomes	Baseline	Intervention	RR	95% CI	*P* value
Patients, n	627	3,604			
Patient-days, n	5,651	43,993			
UC days, n	5,080	36,791			
UC use, mean	0.90	0.84	0.93	0.9-0.96	.0001
CAUTI, n	54	208			
CAUTI rate per 1,000 UC-days	10.63	5.65	0.53	0.4-0.7	.0001

CI, Confidence interval; *CAUTI*, catheter-associated urinary tract infection; *RR*, rate ratio; *SD*, standard deviation; *UC*, urinary catheter.

Patients' characteristics, such as gender and presence of underlying diseases, did not vary during the whole study period. However, in phase 2, there was a significant increase in trauma admissions and in the mean of the average severity of illness score (ASIS) (Table 1). In relation to process compliance rates, during phase 2, HH compliance improved significantly from 33.3% to 58%. Compliance with UC on thigh and with collective bag hanging was and remained high during both phases (Table 1).

Regarding CAUTI rates, during phase 1 (baseline period), there were 5,080 documented UC-days. There were 54 CAUTIs, for an overall baseline rate of 10.63 CAUTIs per 1,000 UC-days (Table 2).

In phase 2, considering all the pool of data collected during the intervention period, after the implementation of the multidimensional infection control approach, there were 36,791 UC-days. There were 208 CAUTIs for an incidence density of 5.65 per 1,000 UC-days. These results showed a CAUTI rate reduction by 47% from baseline (10.66 to 5.65 CAUTIs per 1,000 UC-days; RR, 0.53; 95% CI: 0.4-0.7, $P = .0001$) (Table 2).

Table 3
Catheter-associated urinary tract infection rates stratified by length of participation of the intensive care units in the International Nosocomial Infection Control Consortium

Months since joining INICC	No. of ICUs, n	Urinary catheter-days, n	CAUTI, n	Crude CAUTI rate/1,000 UC-days	IRR accounting for clustering by ICU	*P* value
1-3 Months (baseline)	13	5,080	54	10.63	1	-
4-12 Months	13	13,827	69	5.0	0.46 (0.32-0.66)	.001
Second year	8	10,520	70	6.65	0.71 (0.5-1.1)	.12
Third year	5	6,362	39	6.13	0.57 (0.343-0.96)	.034
Fourth year	3	6,082	30	4.93	0.352 (0.2-0.643)	.001

CAUTI, Catheter-associated urinary tract infection; *IRR*, incidence rate ratio; *UC*, urinary catheter.

Table 4
Microorganism related to catheter-associated urinary tract infection in pediatric intensive care units in phase 1, the baseline period, and phase 2, the intervention period

Isolated microorganisms	Baseline	Intervention	*P* value
Escherichia coli spp, % (n)	31 (15)	16 (31)	.0300
Candida spp, % (n)	27 (13)	30 (57)	.5606
Pseudomonas spp, % (n)	16 (8)	17 (32)	.8724
Klebsiella spp, % (n)	6 (3)	6 (12)	.8138
Acinetobacter spp, % (n)	4 (2)	11 (21)	.2112
Proteus spp, % (n)	4 (2)	2 (3)	.6147
Staphylococcus aureus spp, % (n)	4 (2)	3 (6)	.8768
Serratia spp, % (n)	4 (2)	2 (3)	.6147
Enterobacter spp, % (n)	2 (1)	5 (9)	.6370
Enterococcus spp, % (n)	2 (1)	3 (6)	.4419
Aeromona spp, % (n)	0 (0)	1 (1)	-
Citrobacter spp, % (n)	0 (0)	1 (1)	-
Morgane, % (n)	0 (0)	1 (1)	-
Coagulasa-negative staphylococci, % (n)	0 (0)	1 (1)	-
Streptococcus spp, % (n)	0 (0)	1 (1)	-
Total	100 (49)	100 (185)	

When using Poisson regression to compare the rates of CAUTI in both phases, divided into 9- to 12-month periods during the first year, and yearly after the second and third year, our findings show a progressive and steady reduction in the incidence of CAUTI (Table 3). The microorganisms profile shows that, during phase 1, the predominant isolated uropathogens were *Escherichia coli* spp (31%) and *Candida* spp (27%). In phase 2, the predominant uropathogen was *Candida* spp (Table 4).

DISCUSSION

If compared with rates of developed countries, the baseline rate of CAUTI found in this study (10.63 per 1,000 UC-days) was 10-fold higher than the 1.5 CAUTI rate per 1,000 UC-days determined by the CDC/NSHN for ICUs in the United States[22] and higher than the 2.5 CAUTI rate determined by KISS (Krankenhaus Infektions Surveillance System, by its name in German) in Europe.[23] In comparison with pooled CAUTI rates from developing countries, our CAUTI baseline rate was similar to the international INICC reports published in 2012 (6.3 CAUTIs per 1,000 UC-days).[9] Within the few studies addressing the burden of CAUTIs in Turkey to our knowledge, the CAUTI rate of our study was similar to the rate found in another study conducted in Turkey, showing 8.3 CAUTIs per 1,000 UC-days.[24]

The INICC multidimensional approach for CAUTI included the following elements: First, the implementation of a practice bundle consisting of training on care,[18] maintenance, alternatives to indwelling catheters[13]; HH[12]; education and training on procedures for catheter insertion, management, and removal; inserting UCs only when needed; removing them when not necessary[14]; and maintaining unobstructed urine flow, among other interventions. Second, education and training sessions provided to HCWs about infection preventive practices. Third, CAUTI outcome surveillance by applying the definitions for CAUTI developed by the US CDC/NHSN.[21] Fourth, process surveillance to monitor compliance with easily measurable infection control measures for CAUTI prevention, including HH performance. Fifth, feedback on CAUTI rates. Sixth, performance feedback on process surveillance,[15] particularly by reviewing and discussing charts results at monthly infection control meetings.

In different previous studies performed by INICC member hospitals, it was shown that implementation of a multidimensional approach for CAUTI—which includes a bundle of interventions, education, outcome and process surveillance, feedback of CAUTI rates, and performance feedback—resulted in significant reductions in rates of CAUTI in Argentina (21.3 vs 12.39 CAUTIs per 1,000 UC-days, respectively),[25] in adult ICUs (7.86 vs 4.95 CAUTIs per 1,000 UC-days, respectively),[26] and in pediatric ICUs (5.9 vs 2.6 CAUTIs per 1,000 UC-days, respectively).[27]

In a previous study of INICC, we included this population of Turkey merged with the population of other 15 countries, but the reason why we have now reported these data of Turkey as a separate subgroup lies in the fact that this population has significantly different features and outcomes from the overall population of the previous study.[26] In the present study, patients' characteristics, such as gender and presence of underlying diseases, did not vary during the whole study period, showing similar patient intrinsic risk in both study phases. However, there was a significant increase in the proportion of trauma admissions and in the mean of average severity of illness score during phase 2, meaning that the patient intrinsic risks were higher in the intervention period.

After the implementation of the INICC multidimensional approach, we found an improvement in process surveillance rates, with higher HH compliance and high compliance with other measures, such as correct position of UC (without obstructing the urine flow) and collecting bag hanging (to avoid urine reflux). During the study period, the high CAUTI rate at baseline was reduced from 10.63 to 5.65 per 1,000 UC-days, showing a 47% CAUTI rate reduction and evidencing the effectiveness of the applied multidimensional approach. Regarding the microorganisms profile, we identified predominance of *E coli* spp and *Candida* spp during both periods, which is similar to other studies conducted in limited resources countries.[9]

Study limitations

This study has many limitations. First, our findings are not to be generalized to all ICU patients from Turkey. However, in this study, it was proved that a multidimensional approach is fundamental to understand and fight against the occurrence of CAUTI in the ICU setting of Turkey. Second, we did not count on the necessary resources to collect more data on process surveillance and measure compliance with all the elements included in our bundle. Therefore, we could not evaluate the implications of individual interventions or other contextual factors related to the ICU or hospital. These data would greatly contribute to advance the knowledge on quality improvement in this setting of hospitals from Turkey and an accurate description of the successful results of our approach. Nevertheless, our main goal was to reduce the high baseline CAUTI rates found in our ICUs, and, although our interventions were inexpensive, the individual evaluation would have required more allocation of time, contributing to unnecessary harm for ICU patients. Third, the setting of 3-month baseline period may be short and might have overestimated the effect of our intervention. From the statistical perspective, we obtained a sufficient sample size during the baseline period, and confidence intervals for the baseline rate were narrow. Although this relatively short baseline period may impact the standard error of our estimates, we consider this did not cause a bias in the results because there are not systematic differences between the compared groups. Finally, another limitation was the lack of a control group in our study, which would have been highly relevant to account for any confounders during the intervention period.

CONCLUSION

This study is the first multicenter study to report a substantial reduction in CAUTI rates in the ICU setting of Turkey, proving this kind of infection control approach successful. Although some patients' intrinsic risks were higher during the intervention period, a multidimensional approach including improved compliance with CAUTI preventive measures resulted in significant reductions in the CAUTI incidence rate. These systematically collected data serve to guide ICPs in their strategies for improvement of patient care practices. Additionally, these findings can promote a wider acceptance of infection control programs in hospitals, leading to significant CAUTI reductions worldwide. Within the INICC network, investigators are provided with training and methodological tools to implement an effective infection prevention programs. Furthermore, the publication of these findings contributes to foster relevant scientific evidence-based literature from developing countries. For this reason, every hospital is invited to participate in the INICC project, which was set up to respond to the compelling need in the developing world to significantly prevent CAUTIs and their adverse effects.

Acknowledgment

The authors thank the many health care professionals at each member hospital who assisted with the conduct of surveillance in their hospital, including the surveillance nurses, the clinical microbiology laboratory personnel, and the physicians and nurses providing care for the patients during the study (without their cooperation and generous assistance this INICC would not be possible); Mariano Vilar, Débora López Burgardt, Santiago Suárez, Denise Brito, Julieta Sayar, Eugenia Manfredi, Luciana Soken, Dario Pizzuto, Ding Yuan, and Isaac Kelmeszes who work at INICC headquarters in Buenos Aires, for their hard work and commitment to achieve INICC goals; the INICC country coordinators (Altaf Ahmed, Carlos A. Álvarez-Moreno, Anucha Apisarnthanarak, Luis E. Cuéllar, Bijie Hu, Namita Jaggi, Hakan Leblebicioglu, Eduardo A. Medeiros, Yatin Mehta, Toshihiro Mitsuda, and Lul Raka); the INICC Advisory Board (Carla J. Alvarado, Nicholas Graves, William R. Jarvis, Patricia Lynch, Dennis Maki, Cat Murphy, Russell N. Olmsted, Didier Pittet, Wing Hong Seto, Syed Sattar, and William Rutala), who have so generously supported this unique international infection control network; and specially Patricia Lynch, who inspired and supported us to follow our dreams despite obstacles.

References

1. Xie DS, Lai RP, Nie SF. Surveys of catheter-associated urinary tract infection in a university hospital intensive care unit in China. Braz J Infect Dis 2011;15:296-7.
2. Hameed A, Chinegwundoh F, Thwaini A. Prevention of catheter-related urinary tract infections. Br J Hosp Med (Lond) 2010;71:148-52.
3. Trautner BW. Management of catheter-associated urinary tract infection. Curr Opin Infect Dis 2010;23:76-82.
4. Rosenthal VD, Dwivedy A, Calderon ME, Esen S, Hernandez HT, Abouqal R, et al. Time-dependent analysis of length of stay and mortality due to urinary tract infections in ten developing countries: INICC findings. J Infect 2010;62:136-41.
5. Tambyah PA, Knasinski V, Maki DG. The direct costs of nosocomial catheter-associated urinary tract infection in the era of managed care. Infect Control Hosp Epidemiol 2002;23:27-31.
6. Chant C, Smith OM, Marshall JC, Friedrich JO. Relationship of catheter-associated urinary tract infection to mortality and length of stay in critically ill patients: a systematic review and meta-analysis of observational studies. Crit Care Med 2011;39:1167-73.
7. Clec'h C, Schwebel C, Francais A, Toledano D, Fosse JP, Garrouste-Orgeas M, et al. Does catheter-associated urinary tract infection increase mortality in critically ill patients? Infect Control Hosp Epidemiol 2007;28:1367-73.
8. Bagshaw SM, Laupland KB. Epidemiology of intensive care unit-acquired urinary tract infections. Curr Opin Infect Dis 2006;19:67-71.
9. Rosenthal VD, Bijie H, Maki DG, Mehta Y, Apisarnthanarak A, Medeiros EA, et al. International Nosocomial Infection Control Consortium (INICC) report, data summary of 36 countries, for 2004-2009. Am J Infect Control 2012;40:396-407.
10. Rosenthal VD, Lynch P, Jarvis WR, Khader IA, Richtmann R, Jaballah NB, et al. Socioeconomic impact on device-associated infections in limited-resource neonatal intensive care units: findings of the INICC. Infection 2011;39:439-50.
11. Rosenthal VD, Jarvis WR, Jamulitrat S, Silva CP, Ramachandran B, Duenas L, et al. Socioeconomic impact on device-associated infections in pediatric intensive care units of 16 limited-resource countries: International Nosocomial Infection Control Consortium findings. Pediatr Crit Care Med 2012;13:399-406.
12. Cetinkaya Y, Yildirim G, Iskit AT, Özgultekin A, Turan G, Akgün N, et al. Nosocomial infection (NI) risk factors in intensive care units (ICU) From Turkey. Proceedings and Abstracts of the Fifth Pan-American Congress of Infection Control and Hospital Epidemiology; October 7-10, 2004; Lima, Peru; 2004.
13. Tsuchida T, Makimoto K, Ohsako S, Fujino M, Kaneda M, Miyazaki T, et al. Relationship between catheter care and catheter-associated urinary tract infection at Japanese general hospitals: a prospective observational study. Int J Nurs Stud 2008;45:352-61.
14. Crouzet J, Bertrand X, Venier AG, Badoz M, Husson C, Talon D. Control of the duration of urinary catheterization: impact on catheter-associated urinary tract infection. J Hosp Infect 2007;67:253-7.
15. Willson M, Wilde M, Webb ML, Thompson D, Parker D, Harwood J, et al. Nursing interventions to reduce the risk of catheter-associated urinary tract infection: part 2: staff education, monitoring, and care techniques. J Wound Ostomy Continence Nurs 2009;36:137-54.
16. Malt G, Robertson-Malt S. A rapid quality control initiative to reduce the incidence of urinary tract infection in the paediatric intensive care patient: part one. Int J Nurs Pract 2007;13:348-53.
17. Wong ES. Guideline for prevention of catheter-associated urinary tract infections. Am J Infect Control 1983;11:28-36.
18. Lo E, Nicolle L, Classen D, Arias KM, Podgorny K, Anderson DJ, et al. Strategies to prevent catheter-associated urinary tract infections in acute care hospitals. Infect Control Hosp Epidemiol 2008;29(Suppl 1):S41-50.
19. Rosenthal VD, Maki DG, Graves N. The International Nosocomial Infection Control Consortium (INICC): goals and objectives, description of surveillance methods, and operational activities. Am J Infect Control 2008;36:e1-12.
20. Sax H, Allegranzi B, Chraiti MN, Boyce J, Larson E, Pittet D. The World Health Organization hand hygiene observation method. Am J Infect Control 2009;37:827-34.
21. McGeer A, Campbell B, Emori TG, Hierholzer WJ, Jackson MM, Nicolle LE, et al. Definitions of infection for surveillance in long-term care facilities. Am J Infect Control 1991;19:1-7.
22. Dudeck MA, Horan TC, Peterson KD, Allen-Bridson K, Morrell G, Pollock DA, et al. National Healthcare Safety Network (NHSN) Report, data summary for 2010, device-associated module. Am J Infect Control 2011;39:798-816.
23. Geffers C, Gastmeier P. Nosocomial infections and multidrug-resistant organisms in Germany: epidemiological data from KISS (the Hospital Infection Surveillance System). Dtsch Arztebl Int 2011;108:87-93.
24. Leblebicioglu H, Rosenthal VD, Arikan OA, Ozgultekin A, Yalcin AN, Koksal I, et al. Device-associated hospital-acquired infection rates in Turkish intensive care units. Findings of the International Nosocomial Infection Control Consortium (INICC). J Hosp Infect 2007;65:251-7.
25. Rosenthal VD, Guzman S, Safdar N. Effect of education and performance feedback on rates of catheter-associated urinary tract infection in intensive care units in Argentina. Infect Control Hosp Epidemiol 2004;25:47-50.

26. Rosenthal VD, Todi SK, Alvarez-Moreno C, Pawar M, Karlekar A, Zeggwagh AA, et al. Impact of a multidimensional infection control strategy on catheter-associated urinary tract infection rates in the adult intensive care units of 15 developing countries: findings of the International Nosocomial Infection Control Consortium (INICC). Infection 2012;40: 517-26.
27. Rosenthal VD, Ramachandran B, Duenas L, Alvarez-Moreno C, Navoa-Ng JA, Armas-Ruiz A, et al. Findings of the International Nosocomial Infection Control Consortium (INICC), Part I: effectiveness of a multidimensional infection control approach on catheter-associated urinary tract infection rates in pediatric intensive care units of 6 developing countries. Infect Control Hosp Epidemiol 2012;33:696-703.