Surveillance Provinciale des Infections Nosocomiales (SPIN) Program: Implementation of a mandatory surveillance program for central line-associated bloodstream infections

Patricia S. Fontela, MD, MSc,[a] Robert W. Platt, PhD,[a,b] Isabelle Rocher, BSc, MSc,[c] Charles Frenette, MD,[d] Dorothy Moore, MD, PhD,[b] Élise Fortin, MSc,[c] David Buckeridge, MD, PhD,[a] Madhukar Pai, MD, PhD,[a] and Caroline Quach, MD, MSc[a,b,c]
Montreal, Quebec, Canada

Background: In 2003, the Surveillance Provinciale des Infections Nosocomiales (SPIN) program was launched to gather data on incidence rates of central line–associated bloodstream infections (CLABSIs) in intensive care units (ICUs) in the Province of Quebec. To improve the generalizability of SPIN benchmarks, in 2007 participation in SPIN became mandatory for all ICUs with ≥10 beds.
Objective: To describe the implementation process, surveillance methods, and overall results of the SPIN program between 2003 and 2009.
Methods: SPIN surveillance methods are based on the National Healthcare Safety Network. Participation is open to all Quebec ICUs and as of January 2007 is mandatory for all units with ≥10 beds. Data include CLABSI incidence rates for 2003-2009 and the epidemiology of CLABSI cases.
Results: Mandatory participation in the SPIN program increased the number of ICUs by 100% (from 30 to 60 units). For 2003-2009, the overall CLABSI incidence rates were 1.67 CLABSIs/1,000 catheter-days for adult ICUs, 2.24 CLABSIs/1,000 catheter-days for pediatric ICUs, and 4.40 CLABSIs/1,000 catheter-days for neonatal ICUs. The patients with CLABSI were predominately female (60%), mean patient age was 44 ± 32 years, and 64% of the patients had a regular central venous line in place.
Conclusion: The implementation of mandatory participation was essential to increase the generalizability of SPIN CLABSI incidence rates, which also improved the quality of these data for use as provincial benchmarks.
Key Words: Cross-infection; intensive care unit; central catheterization; epidemiology.

Central line-associated bloodstream infection (CLABSI) is a major problem in intensive care units (ICUs), associated with a considerable illness burden.[1] Moreover, CLABSI prolongs the length of hospital stay by an estimated 1-4 weeks, with an increased cost of hospitalization of up to $35,000 per patient (Canadian dollars).[2]

Given the clinical and public health importance of CLABSI, the Institut National de Santé Publique du Québec (INSPQ) launched the Surveillance Provinciale des Infections Nosocomiales (SPIN) program in 2003 to gather data on the epidemiology and incidence of CLABSI in ICUs in the Province of Quebec, Canada.

The SPIN program has the following objectives:[3-5]

1. To estimate the incidence and mortality rates of CLABSI in Quebec ICUs
2. To describe the underlying conditions associated with CLABSI
3. To identify the pathogens associated with this type of health care–associated infection
4. To create a database that allows for benchmarking of CLABSI incidence rates observed in hospitals across the Province of Quebec and to follow these rates over time

From the Department of Epidemiology, Biostatistics and Occupational Health,[a] and Department of Pediatrics,[b] McGill University, Montreal, QC, Canada; Division of Biological Risks and Occupational Health, Quebec Institute of Public Health, Montreal, QC, Canada[c]; and McGill University Health Center, McGill University, Montreal, QC, Canada.[d]

Address correspondence to Caroline Quach, MD, MSc, Montreal Children's Hospital, C1242, 2300 Tupper Street, Montreal, Quebec H3H 1P3, Canada. E-mail: caroline.quach@mcgill.ca.

Conflict of interest: None to report.

0196-6553/$36.00

doi:10.1016/j.ajic.2010.07.007

5. To provide data that can be used for interfacility comparisons
6. To reduce the CLABSI incidence rate in Quebec ICUs to a minimum level
7. To encourage all Quebec ICUs with ≥6 beds to participate in the SPIN program.

Since 2005, annually published SPIN results have been used as the provincial ICU benchmark. From the inception of the program in October 2003 up to December 2006, participation in SPIN was voluntary. This changed in January 2007, when the Quebec Ministry of Health made participation mandatory for all Quebec ICUs with ≥10 beds. In this article, we describe the implementation process and the current surveillance methods used by the SPIN program, and report the overall results for 2003-2009.

METHODS

Location

The Province of Quebec, situated in the central region of Canada, is the country's largest province and the second most populated. Its 2009 population was 7,828,900 inhabitants.[6]

Characteristics of participating hospitals

All adult ICUs, pediatric ICUs (PICUs), and neonatal ICUs (NICUs) in Quebec are eligible to participate in the SPIN program. Thirty ICUs (26 adult ICUs, 2 PICUs, and 2 NICUs) reported data to SPIN during the first surveillance period beginning in October 2003 and lasting 6 months. Up to January 2007, ICU participation in SPIN was voluntary, and increased participation was sought by educational activities, publicity, and active recruitment.

As of January 2007, all eligible ICUs with ≥10 beds are required to continuously participate in SPIN throughout the year. Cardiac ICUs are encouraged to participate but are not part of the mandatory surveillance, given that their CLABSI rates were close to 0% during the first year of the program.

Definitions

The definitions used by SPIN are in accordance with Nosocomial Infection Surveillance (NNIS)/National Healthcare Safety Network (NHSN) criteria.[7-9] Central venous catheters (CVCs) are defined as intravenous catheters that end at or near the heart, or in a great vessel close to the heart, such as the subclavian, internal jugular, or femoral vein. Peripherally inserted CVCs (eg, catheters inserted into the basilic, cephalic, or brachial veins that enter the superior vena cava), tunneled CVCs, totally implanted catheters, and umbilical vessel catheters (inserted into the umbilical artery or vein) are also considered CVCs.

Bloodstream infections (BSIs) are defined as (1) a recognized pathogen cultured from one or more blood cultures, not related to an infection at another site, or (2) at least one of fever (>38°C), chills, hypotension (or hypothermia [<37°C], apnea, or bradycardia in a patient age <1 year), and a common skin contaminant (eg, diphtheroids, *Bacillus* spp, *Propionibacterium* spp, coagulase-negative staphylococci, viridans group streptococci, or micrococci) cultured from two or more blood cultures, or from one or more blood cultures if appropriate antimicrobial therapy was initiated by the treating physician, and signs and symptoms and positive laboratory results are not related to an infection at another site.

The SPIN definition of CLABSI requires the presence of a CVC on diagnosis of BSI or in the previous 48 hours before disgnosis.[8] To be eligible for inclusion in the SPIN database, the CLABSI must occur while the patient was in an ICU or within 48 hours after discharge from an ICU. The CLABSI must not be present or incubating on admission to the ICU. The onset of CLABSI is defined as the time when the first positive blood culture was obtained or the time of the first clinical manifestation if earlier. Finally, ICUs are classified according to their academic profile.[3-5,10] An ICU is classified as a ''teaching'' unit if the majority of the clinical services of the hospital to which it belongs are part of a teaching and research program of a medical school at the undergraduate and postgraduate levels.

Data collection

SPIN requires all participating hospitals to perform active prospective surveillance of CLABSI in their ICUs throughout the year. This means that all CLABSI cases must be proactively sought while patients are still in the ICU or within 48 hours after their discharge from the ICU.[3-5,11] Annual data collection starts on April 1 and is divided into 13 surveillance subperiods of 4 weeks each.

Data are collected for 7 types of ICU: adult surgical, cardiac, medical, combined (medical and surgical or cardiac) and burn ICUs, PICUs, NICUs. In each of the ICUs, at least one hospital-based infection control practitioner, in collaboration with the hospital epidemiologist, is responsible for recording and uploading data on CLABSI cases and denominators.

The strategy used to identify CLABSI cases includes a daily search for new positive blood culture results in ICU patients. The infection control practitioner then goes to the ICU to check whether the patient with a positive blood culture currently has a CVC in place, or had a CVC in the previous 48 hours. If the presence

of a CVC is confirmed, then the medical and nursing charts are reviewed to determine if the case fulfills the criteria for CLABSI diagnosis. All CLABSIs with onset of symptoms before the patient's admission to the ICU are excluded. All patients with one or more CVCs are followed until 48 hours after CVC removal or ICU discharge, whichever comes first.

Once a diagnosis of CLABSI is confirmed, the following patient data are collected: date of birth, sex, birth weight (for NICU patients only), hospital and ICU admission date(s), CLABSI onset date, number of positive blood cultures, type of catheter, presence of infection at the catheter site, and death within 30 days and its association with the CLABSI episode (directly associated, indirectly associated, or unrelated). The presence of risk factors for CLABSI, including renal failure requiring dialysis or hemofiltration, use of total parenteral nutrition, neutropenia, leukemia, neoplasia, diabetes mellitus, and bone marrow or solid organ transplantion in the previous 3 months, is also noted. Finally, the microorganisms isolated from blood cultures and antimicrobial resistance patterns are recorded.

The denominator data collected for each of the surveillance subperiods include CVC-days and patient-days, both of which are defined according to NNIS/NHSN criteria.[9,12] The number of CVC-days is defined as the total number of days of exposure to CVCs for all patients in a selected ICU for each 28-day period. To calculate this, the number of patients with one or more CVCs is collected daily and summed at the end of the 28-day period. The use of multiple CVCs in a single patient is counted as 1 CVC-day.[9,10] The number of patient-days is defined as the total number of days that patients are in the ICU during the 28-day period.

Data upload

According to the SPIN protocol, nonnominative data must be uploaded within the month following the end of each surveillance subperiod on the SPIN web portal located on the Laboratoire de Santé Publique du Québec Web site.

Quality assurance

A operations manual containing detailed instructions for data collection was sent to all SPIN participants before the start of the surveillance program. This manual included definitions of CLABSI cases and denominators, as well as information about how and when to upload collected data on the SPIN Web portal.

Quality assurance was enhanced by built-in input field masks and automatic validation of fields and denominators entered. Given that background data on denominators (patient-days and CVC-days) were available in the SPIN database, validation rules were implemented to ensure that denominators entered were within 2 standard deviations (SD) of the background data for each given participating unit. Moreover, the patient's age had to be in concordance with the type of ICU (eg, patients aged $\geq$18 years cannot be reported as NICU patients), and the ICU admission date had to be after or the same as the hospital admission date. The program also ensured that mandatory fields were not left empty by precluding submission of the CLABSI to SPIN.

In addition, all hospital-based infection control practitioners involved in data collection were required to participate in a 1-day Web training session chaired by the SPIN CLABSI coordination team at the time that their hospital enrolled in the program. The objective of this activity was to make local staff thoroughly familiar with the SPIN methods. This session included training in the elements of a surveillance system, case definitions, data collection strategies and instruments, and uploading of data to the SPIN Web portal. This training ensured that data were collected in a standardized manner across ICUs, and that the case definitions were clearly understood.

Quality control

A hospital-based infection control practitioner, supported by a medical microbiologist or infectious disease specialist/hospital epidemiologist, adjudicates all CLABSI cases diagnosed in his or her hospital's ICU (s), to minimize outcome misclassification. Furthermore, a trained member of the SPIN coordination team reviews all data uploaded to the SPIN Web portal each month, and notifies the hospital by e-mail if any data seem out of the ordinary. Data are also monitored and adjudicated a second time, on a quarterly basis, at the INSPQ. Any data generating concerns about possible misclassification or incorrect values are sent back to the respective hospital for review.

At the end of the surveillance year, before being analyzed, the SPIN data are adjudicated one last time by an infection control physician with training in epidemiology. Criteria for a diagnosis of CLABSI, such as interval between ICU admission and development of infection and pathogen identified, are reviewed. A search for discrepant values is performed, and any data suspected of having been entered erroneously are sent back to the respective hospital for revision.

Finally, the SPIN CLABSI coordination team organizes meetings every other year to allow participating hospitals to exchange experiences. At these meetings, the group discusses problems encountered by the infection control practitioners in collecting or uploading data. Workshops on case scenarios, calculation of rates, dissemination of data, and development of infection control programs are offered.

SPIN data analysis

SPIN uses descriptive statistics, including mean ± SD and median (interquartile range [IQR]), to summarize the characteristics of CLABSI cases and associated underlying conditions. Annual ICU CLABSI pooled mean incidence rates (per 1,000 CVC-days) and CVC utilization ratios (CVCURs) are calculated according to the NNIS/NHSN specifications and stratified by ICU type (adult ICU, PICU, and NICU) and academic profile (teaching and nonteaching units):[10,12]

ICU CLABSI pooled mean incidence rate

$$= \frac{\sum \text{annual ICU CLABSI cases}}{\sum \text{annual ICU CVC-days}} * 1000$$

$$\text{ICU CVCUR} = \frac{\text{Sum of annual ICU CVC-days}}{\text{Sum of annual ICU patient-days}}$$

Pooled annual CLABSI incidence rates and CVCURs stratified by ICU type are compared with the SPIN rates from previous years, as well as with data published by NHSN (data not shown). Annual ICU CLABSI incidence rates and CVCURs also are calculated for each individual center and used to produce medians and percentiles (10th, 25th, 75th, and 90th percentiles), which also are stratified by ICU type and academic profile. For categorical data, similar comparisons are performed, and the χ^2 or Fisher exact test is used to test for statistical significance.

Data dissemination

The SPIN CLABSI coordination team produces an annual report describing the status of CLABSI incidence rates in participating Quebec ICUs for the current year. A comparison of the current CLABSI incidence rates, CVCURs, and frequency distribution of pathogens and antimicrobial resistance patterns with data from previous surveillance years, as well as data from the NHSN program, is provided. The annual report is distributed to all ICUs participating in the SPIN program. Each participating ICU receives a code that allows personnel to confidentially compare its data with those from other similar ICUs in the province as well as with its own previous results.

Statistical analysis

For this study, we calculated the pooled CLABSI mean incidence rate, along with its 10th, 50th, and 90th percentiles, for the 2003-2009 period. Results were stratified according to ICU type (adult ICU, PICU, or NICU) and academic profile (teaching or nonteaching unit). Descriptive statistics, including mean ± SD and median (IQR), and frequency distribution were used to describe the CLABSI cases.

RESULTS

At the inception of the SPIN program in October 2003, 30 ICUs (26 adult ICUs, 2 PICUs, and 2 NICUs) contributed data to the SPIN database. The implementation of mandatory participation in January 2007 led to a substantial increase in the number of participating ICUs, bringing the total number of units from 30 to 60 (48 adult ICUs, 5 PICUs, and 7 NICUs).

Between October 2003 and March 2009, a total of 891 CLABSIs were identified for 446,137 CVC-days monitored. Table 1 presents the overall CLABSI incidence rates for the years 2003-2009, as well as the 10th and 90th percentiles, which are used by SPIN as the cutoff for low and high outliers, respectively.

The patients with CLABSI were predominately female (60%), with a mean age of 44 ± 32 years and a median age of 56 years (IQR, 4 months to 71 years). An analysis of the age distribution among CLABSI cases revealed two peaks, in neonates and elderly patients. Short-term CVCs were the most frequent catheter type associated with CLABSIs (64%). Previously reported risk factors for CLABSI were identified in the majority of cases: 13% had renal failure requiring dialysis or hemofiltration, 43% were receiving total parenteral nutrition, and 3% had undergone bone marrow or solid organ transplantation within the previous 3 months, 6% had neutropenia, 4% had leukemia, 5% had a neoplasm, and 21% had diabetes mellitus.

Coagulase-negative staphylococcus was the most frequent pathogen associated with CLABSI (53%), followed by *Staphylococcus aureus* (15%) and *Candida* spp (13%). Among the *S aureus* cases, the proportion of methicillin-resistant *S aureus* (MRSA) declined from 70% to less than 40% after the 2006-2007 period.

DISCUSSION

Surveillance is essential to provide information on the epidemiology of healthcare–associated infections, which are associated with high mortality and morbidity worldwide.[13] When monitoring CLABSIs, ICU patients are a priority, given the higher rate of CLABSI in this group compared with other patient populations. Of the 250,000 estimated CLABSI cases reported annually in the United States, approximately 80,000 (32%) occur in ICUs, despite the fact that these patients occupy only 5%-10% of all hospital beds.[1]

Table 1. Summary of mean pooled CLABSI incidence rates for 2003-2009 inclusive

ICU type	Number of ICUs	CLABSI cases	CVC-days	Pooled CLABSI incidence rate*	Percentile†		
					10th	50th	90th
Adult ICUs‡	49	618	369,209	1.67	1.40	1.61	1.83
Teaching	26	493	278,806	1.77	1.07	1.74	2.03
Nonteaching	23	125	90,403	1.38	1.03	1.33	2.45
PICUs	5	68	30,317	2.24	1.42	2.20	2.82
NICUs	7	205	46,611	4.40	3.23	4.06	5.17

*Per 1,000 CVC-days.
†Percentiles derived from the annual pooled CRBSI mean incidence rates for 2003-2009.
‡Combined ICU: medical and surgical or cardiac.

The clinical and public health importance of CLABSI in ICU patients led the INSPQ to create the SPIN program in 2003. SPIN results presented for the period 2003-2009 show that CLABSI is an important problem in Quebec ICUs, with summary pooled CLABSI incidence rates for 2003-2009 of 1.67 CLABSIs/1,000 CVC-days for adult ICUs, 2.24 CLABSIs/1,000 CVC-days for PICUs, and 4.40 CLABSIs/1,000 CVC-days for NICUs.

The surveillance methods used in the SPIN program are based on the NNIS/NHSN system. Table 2 compares the methodological aspects of the SPIN and NHSN programs. Both SPIN and NNIS/NHSN require that ICUs perform active prospective surveillance while patients are in the ICU as well as for the 48 hours after discharge from the ICU. This allows for detection of the estimated 10% of CLABSI cases that would be missed if surveillance after ICU discharge was not performed.[14]

In contrast to NNIS/NHSN, which included clinical sepsis as one of the CLABSI criteria in all ICUs up to 2006 and for patients aged ≤1 year up to 2010, SPIN includes only laboratory-confirmed CLABSIs, increasing the validity of the CLABSI data.[7,9,12] In addition, SPIN has not changed its definition of CLABSI, which remains based on the NNIS program, since the program inception in 2003. This has allowed SPIN to readily compare CLABSI rates over time. As of April 2010, SPIN now uses the new NHSN definition; however, comparability is maintained because incidence rates using both definitions have been calculated since January 2007.

Furthermore, the SPIN program collects data on characteristics of the CLABSI cases, providing more insight into the patients who develop a CLABSI. This knowledge allows informed decisions regarding the targeted prevention programs to implement at the hospital and provincial levels. Given the high proportion of MRSA causing CLABSIs in Quebec ICUs, surveillance results have been used to prioritize MRSA infection control guidelines and emphasize the importance of these guidelines. Moreover, with the objective of decreasing CLABSI rates to a minimum level, process surveillance for catheter insertion and maintenance has been prioritized as well. Hospitals with high CVCURs have audited their CVC use, and some have managed to decrease the duration of catheterization. The high CLABSI incidence rates found in NICUs also have served to set priorities in action plans and quality improvement.

Mandatory ICU participation in the SPIN program is the major difference from the NHSN program. Whereas NHSN allows ICUs to report a minimum of one surveillance period per year, SPIN requires participating units to continuously report data throughout the year. The SPIN CLABSI coordination team deemed the introduction of mandatory participation necessary to increase the participation of Quebec ICUs in the program with the objective of better estimating the magnitude of the CLABSI problem in the province. This measure increased not only the generalizabitiy of SPIN results, but also their quality when they are used as the provincial benchmark.

The establishment of mandatory participation in SPIN was clearly successful, with the number of participants increasing from 30 to 60 ICUs after 2007. Currently, 93% of all eligible ICUs in Quebec report data to SPIN. Nonparticipating ICUs cite a lack of adequate resources as the reason for not yet joining SPIN. The number of participating ICUs is expected to continue to increase as more nonparticipating ICUs acquire the infrastructure and human resources needed to join the program.

The use of sound surveillance methods to ensure collection of high-quality data is essential to achieve the objectives of estimating the magnitude of the CLABSI problem in Quebec ICUs and to use the SPIN data as the provincial benchmark. The SPIN CLABSI coordinating team trained all hospital-based infection control practitioners to perform active surveillance in a standardized manner and is available to discuss more complex cases as needed. A quality assurance system was developed to reduce the risk of misclassification of CLABSI cases and risk factors. Even with these measures, however, ensuring accuracy of collected data remains a priority. Consequently, a study to evaluate the reporting validity of CLABSI data to the SPIN program is now underway.

Table 2. Methodological features of the SPIN and NHSN (device-associated module) programs

Feature	SPIN	NHSN
Surveillance type	Targeted, active, and prospective	Targeted, active, and prospective
Post-ICU discharge surveillance	Yes	Yes
Participation	Mandatory	Voluntary
Minimal participation	Continuous throughout the year	Minimum of 1 calendar month
Definitions	Centers for Disease Control and Prevention Includes only LCBSI LCBSI may be diagnosed by • ≥1 positive blood culture for a recognized pathogen not related to an infection at another site OR • ≥1 sign of sepsis AND ≥2 positive blood cultures for usual skin contaminants AND signs/symptoms and positive laboratory result not related to an infection at another site OR • ≥1 sign of sepsis AND ≥1 positive blood culture for usual skin contaminants AND institution of appropriate antimicrobial therapy AND signs/symptoms and positive laboratory result not related to infection at another site	Centers for Disease Control and Prevention Includes BSIs defined by clinical sepsis criteria for neonates and infants age ≤1 year until December 2009 LCBSI is diagnosed by • ≥1 positive blood culture for a recognized pathogen not related to an infection at another site OR • ≥1 sign of sepsis AND ≥2 positive blood cultures for usual skin contaminants AND signs/symptoms and positive laboratory result not related to infection at another site
Data collection on CLABSI risk factors	Yes	No
NICU component	Results not stratified by birth weight Results not stratified by CVC type	Results stratified by birth weight Results stratified by CVC type
Data report	Internet-based data interface Upload within 30 days of the end of each surveillance subperiod	Internet-based data interface Upload within 30 days of the end of the month
Training of data collectors	Yes	Yes

LCBSI, laboratory-confirmed bloodstream infection.

The SPIN program has grown in importance since its inception. Since its first report in 2005, annual results have been used as Quebec benchmark rates. In addition, hospital-based and provincial infection control committees have used SPIN data to plan CLABSI prevention and control strategies. Finally, the Quebec Ministry of Health is now using SPIN data as performance indicators for infection prevention and control programs for hospitals across the province. Aware of the importance of SPIN's contribution to public health in Quebec, the coordination team continues to work on developing strategies that can lead to more effective surveillance, including a linkage between the provincial surveillance system and hospital databases to avoid duplicate data entry, as well as a program to monitor the process of health care practices.

CONCLUSION

CLABSIs are associated with a substantial burden of illness in hospitalized patients. The SPIN program launched in 2003 by the INSPQ has helped define the importance of this problem in Quebec ICUs. The implementation of mandatory participation in SPIN was essential to increase the generalizability of results and ensure high-quality data for use as provincial benchmarks. To continue to provide high-quality data, the SPIN research team is working on improving current surveillance methods and expanding the program.

References

1. Klevens RM, Edwards JR, Richards CL, Horan TC, Gaynes RP, Pollock DA, et al. Estimating health care associated infections and deaths in US hospitals, 2002. Public Health Rep 2007;122:160-6.
2. Laupland KB, Lee H, Gregson DB, Manns BJ. Cost of intensive care unit–acquired bloodstream infections. J Hosp Infect 2006;63:124-32.
3. Quach C, Frenette C, Gilca R, Rocher I, Moore D. Rapport de la surveillance provinciale des bactériémies nosocomiales sur cathéters centraux aux soins intensifs: Avril 2006–Mars 2007. Montreal, Canada: Institut National de Santé Publique du Québec; 2007.
4. Quach C, Moore D, Rocher I, Frenette C. Rapport de la surveillance provinciale des bactériémies nosocomiales sur cathéters centraux aux soins intensifs: Octobre 2003–Mars 2005. Montreal, Canada: Institut National de Santé Publique du Québec; 2005.
5. Quach C, Moore D, Rocher I, Frenette C, Gilca R. Rapport de la surveillance provinciale des bactériémies nosocomiales sur cathéters centraux aux soins intensifs: Avril 2005–Mars 2006. Montreal, Canada: Institut National de Santé Publique du Québec; 2006.
6. Statistics Canada. Population by year, by province and territory. Available from: http://www40.statcan.gc.ca/l01/cst01/demo02a-eng.htm. Accessed February 2, 2010.
7. Horan TC, Andrus M, Dudeck MA. CDC/NHSN surveillance definition of health care–associated infection and criteria for specific types of infections in the acute care setting. Am J Infect Control 2008;36:309-32.
8. O'Grady NP, Alexander M, Dellinger EP, Gerberding JL, Heard SO, Maki DG, et al. Guidelines for the prevention of intravascular catheter–related infections. MMWR Morb Mortal Wkly Rep 2002;51:1-26.
9. Centers for Disease Control and Prevention. Device-associated (DA) module. Available from: http://www.cdc.gov/nhsn/psc_da.html. Accessed February 26, 2010.
10. National Nosocomial Infections Surveillance System. National Nosocomial Infections Surveillance (NNIS) System report, data summary from January 1992 through June 2004, issued October 2004. Am J Infect Control 2004;32:470-85.

11. Horan TC, Gaynes RP. Surveillance of nosocomial infection. In: Mayhall CG, editor. Hospital epidemiology and infection control. 3rd ed Philadelphia: Lippincott Williams & Wilkins; 2004. p. 1659-702.
12. Edwards JR, Peterson KD, Andrus ML, Tolson JS, Goulding JS, Dudeck MA, et al. National Healthcare Safety Network (NHSN) report, data summary for 2006, issued June 2007. Am J Infect Control 2007;35:290-301.
13. World Health Organization. Guidelines on hand hygiene in health care. Geneva, Switzerland: World Health Organization; 2009.
14. Geffers C, Gastmeier P, Bräuer H, Daschner F, Rüden H. Surveillance of nosocomial infections in ICUs: is postdischarge surveillance indispensable? Infect Control Hosp Epidemiol 2001;22: 157-9.