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ORIGINAL ARTICLE

# Impact of International Nosocomial Infection Control Consortium (INICC) Strategy on Central Line–Associated Bloodstream Infection Rates in the Intensive Care Units of 15 Developing Countries

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BACKGROUND. The International Nosocomial Infection Control Consortium (INICC) was established in 15 developing countries to reduce infection rates in resource-limited hospitals by focusing on education and feedback of outcome surveillance (infection rates) and process surveillance (adherence to infection control measures). We report a time-sequence analysis of the effectiveness of this approach in reducing rates of central line–associated bloodstream infection (CLABSI) and associated deaths in 86 intensive care units with a minimum of 6-month INICC membership.

METHODS. Pooled CLABSI rates during the first 3 months (baseline) were compared with rates at 6-month intervals during the first 24 months in 53,719 patients (190,905 central line–days). Process surveillance results at baseline were compared with intervention period data.

RESULTS. During the first 6 months, CLABSI incidence decreased by 33% (from 14.5% to 9.7%). Over the first 24 months there was a cumulative reduction from baseline of 54% (from 16.0 to 7.4 CLABSIs per 1,000 central line–days; relative risk, 0.46 [95% confidence interval, 0.33–0.63]; $P < .001$). The number of deaths in patients with CLABSI decreased by 58%. During the intervention period, hand hygiene adherence improved from 50% to 60% ($P < .001$); the percentage of intensive care units that used maximal sterile barriers at insertion increased from 45% to 85% ($P < .001$), that adopted chlorhexidine for antisepsis increased from 7% to 27% ($P = .018$), and that sought to remove unneeded catheters increased from 37% to 83% ($P = .004$); and the duration of central line placement decreased from 4.1 to 3.5 days ($P < .001$).

CONCLUSIONS. Education, performance feedback, and outcome and process surveillance of CLABSI rates significantly improved infection control adherence, reducing the CLABSI incidence by 54% and the number of CLABSI-associated deaths by 58% in INICC hospitals during the first 2 years.

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Healthcare-associated infections from invasive medical devices in the intensive care unit (ICU)—particularly central line–associated bloodstream infection (CLABSI), ventilator-associated pneumonia, and catheter-associated urinary tract infection—have been shown to pose the greatest threat to patient safety.[1,2] Over the past decade, studies done in the industrialized Western countries have shown that a systematic institutional approach that assures a very high level of adherence to essential infection control practices has brought striking reductions in the incidence of CLABSI in patients in an ICU.[3,4]

In 2002, we established an International Nosocomial In-

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fection Control Consortium (INICC) in countries of the developing world and found that rates of device-associated infection in the ICUs of the hospitals of these countries, which have very limited resources, are 3–5 times higher than rates in North American ICUs.[5-7] Because of the resource limitations, we have focused our efforts to reduce the incidence of device-associated infection in these hospitals on education, outcome surveillance (rates of device-associated infection), process surveillance (adherence to hand hygiene and other basic infection control practices shown to reduce the incidence of device-associated infection), and performance feedback of each ICU's surveillance data to the healthcare personnel working in that unit.[8] We report a time-sequence analysis of the efficacy of this approach on controlling CLABSIs in 86 ICUs that have been members of the consortium for at least 6 months.

## METHODS

### Background on INICC

INICC is an international nonprofit, open, multicenter, collaborative healthcare-associated infection control program with a surveillance system based on that of the US National Healthcare Safety Network[9,10] (NHSN; formerly the National Nosocomial Infection Surveillance [NNIS] system), and it is the first multinational research network established to control healthcare−associated infections in hospitals through the analysis of data collected on a voluntary basis by its member hospitals. Gaining new members each month, INICC now comprises a dynamic network of almost 300 ICUs in approximately 40 countries from 4 continents, and at the present time it is the only source of aggregate standardized international data on healthcare-associated infection in the developing world.[5-7,11-24]

From its inception, the consortium has focused on surveillance and control of device-associated infection in the ICU, the healthcare setting with the most vulnerable patients with the heaviest exposure to invasive devices and highest rates of nosocomial infection.[9] INICC has employed the surveillance methods and definitions for healthcare-associated infection developed by the Centers for Disease Control and Prevention's long-standing NNIS/NHSN program in US hospitals[10] and has vigorously promoted the consistent implementation of simple, inexpensive, evidence-based measures for prevention of healthcare-associated infection.[5-8]

The limited knowledge regarding healthcare-associated infection worldwide, especially in developing countries, the need for more precise measurement of risk and outcomes in individual patient groups, and recognition of the importance of surveillance,[25] especially *feedback of surveillance data,* to an effective infection control program led from the outset to the development and implementation of the 2 INICC surveillance components, *outcome* surveillance and *process* surveillance.[8]

Outcome surveillance includes rates of CLABSI, ventilator-associated pneumonia, and catheter-associated urinary tract infection per 1,000 device-days. Process surveillance includes rates of adherence to hand hygiene and selected infection control measures for prevention of vascular catheter–related bloodstream infection, catheter-associated urinary tract infection, and ventilator-associated pneumonia.[8]

Process surveillance is designed to monitor adherence to easily measurable, important control steps, such as hand hygiene, and is limited at this time by the resources available in the member hospitals. Hand hygiene adherence by healthcare workers, based on the frequency with which hand hygiene is performed when clearly indicated, is monitored by the hospital infection control practitioner during randomly selected 1-hour observation periods 3 times perweek; healthcare workers are aware that hand hygiene practices are monitored but are not informed of when the observations are taking place. Adherence to vascular catheter care is also monitored and recorded 5 days per week: hand hygiene before and after catheter insertion or redressing a vascular catheter; the presence of a sterile gauze or polyurethane dressing on the insertion site; recording of the date of catheter insertion and last administration set change; replacement of the gauze dressing every 48 hours and transparent semipermeable membrane dressings at least every 7 days, with the date and time of the dressing change recorded; replacement of peripheral venous catheters within 72 hours; and replacement of the administration set every 72 hours. Striving to limit catheter placements in the femoral vein, use of maximal sterile barrier precautions during the insertion procedure, disinfection of the insertion site with 2%–4% chlorhexidine, and prompt removal of catheters when they are no longer needed have not yet been incorporated into formal process surveillance; however, they are vigorously promulgated in the INICC ICUs.

### Targeted Use of Surveillance Data as a Control Measure

The concept of using performance feedback of outcome surveillance and process surveillance as a valuable control measure in hospitals with limited resources was based on its proven effectiveness in studies within individual Argentine hospitals before the establishment of INICC as an international network in 2002.[26-28] On a monthly basis, the INICC Headquarters team prepares and sends to each participating hospital a final report on their institutional rates of device-associated infection, bacterial profile, bacterial resistance, length of stay, and mortality in their ICU(s) and their adherence to hand hygiene, central line and urinary catheter care, and measures to prevent ventilator-associated pneumonia. To provide feedback to ICU staff in the unit, charts providing a running tally of rates of device-associated infections compiled by the infection control practitioner and the INICC Headquarters Team are reviewed at monthly staff meetings and posted in a prominent location in the ICU.[8]

### Definitions

*Laboratory-confirmed CLABSI.* If CLABSI is suspected, the central venous line is removed aseptically and the distal 5 cm of the catheter is amputated and cultured, using the standardized semiquantitative method.[29] Concomitant blood samples for culture are drawn percutaneously in most cases. In each hospital, standard laboratory methods are used to identify microorganisms, and standardized susceptibility testing is performed.

Our definition of a laboratory-confirmed CLABSI requires that a patient with a central line has a recognized pathogen isolated from 1 or more percutaneous blood cultures after 48 hours of catheterization, that the pathogen cultured from the blood is not related to an infection at another site, and that the patient has 1 or more of the following signs or symptoms: fever (temperature, at least 38°C), chills, or hypotension. With skin commensals (diphtheroids, *Bacillus* species, *Propionibacterium* species, or coagulase-negative staphylococci or micrococci), the organism has been recovered from 2 or more separate blood cultures.[10]

*Clinically suspected CLABSI.* Our definition of a clinically suspected CLABSI requires a patient with a central line who has at least 1 of the following clinical signs, with no other recognized cause: fever (temperature, at least 38°C), hypotension (systolic blood pressure less than or equal to 90 mm Hg), or oliguria (less than or equal to 20 mL/hr), but either blood cultures were not obtained or no organisms were recovered from blood cultures; there is no apparent infection at another site; and the physician institutes antimicrobial therapy.[10]

### Data Analysis

The time-sequence analysis of INICC data on CLABSI was restricted to hospitals that were active members of the consortium through December 31, 2008, and had submitted monthly surveillance data for at least 6 months. Rates of CLABSI and deaths in patients with CLABSI during months 5–7, 11–13, 17–19, and 23–25 were compared with rates in the baseline period, months 1–3, for the cohort of ICUs represented in each intervention period analyzed. The baseline rate of each time cohort was unique. Trends in process surveillance for hand hygiene and vascular catheter care, as reported monthly, and representative infection control practices within each ICU, based on periodic surveys, over the intervention period were also summarized.

### Statistical Methods

The aggregate characteristics of all patients hospitalized during the baseline period and during the last 3 months of the intervention period in each hospital were compared using the Fisher exact test for dichotomous variables and the unmatched Student *t* test for continuous variables. Relative risk (RR) ratios with 95% confidence intervals (CIs) were calculated for comparison of rates of CLABSI and CLABSI-associated all-cause ICU mortality at baseline and subsequent intervention periods, using the baseline data appropriate to each cohort. *P* values less than .05 by 2-sided tests were considered to be significant.

## RESULTS

### Patient Population

During the first 8 years of INICC, 2002–2009, 86 ICUs in 15 countries participated in INICC for at least 6 months; the countries, the types of hospitals, and the types of ICUs represented are summarized in Table 1. During the baseline period, 7,751 patients were hospitalized in 86 member ICUs (30,889 central line–days); during the intervention period, there were 45,968 patients (160,016 central line–days). The

TABLE 1. Characteristics of the Participating Intensive Care Units (ICUs)

| Characteristic | No. of ICUs |
|---|---|
| Location | |
| Argentina | 15 |
| Turkey | 14 |
| Colombia | 13 |
| India | 13 |
| Mexico | 7 |
| Philippines | 6 |
| Brazil | 5 |
| Peru | 5 |
| El Salvador | 2 |
| Costa Rica | 1 |
| Cuba | 1 |
| Lebanon | 1 |
| Macedonia | 1 |
| Morocco | 1 |
| Panama | 1 |
| Type of hospital[a] | |
| Academic teaching | 26 |
| Private community | 16 |
| Public | 15 |
| Type of ICU | |
| Medical-surgical | 51 |
| Pediatric | 6 |
| Newborn | 9 |
| Coronary | 8 |
| Burn | 1 |
| Surgical | 4 |
| Neurosurgical | 3 |
| Medical | 3 |
| Trauma | 1 |

[a] By type of hospital, 46% of the ICUs were in academic teaching hospitals, 28% were in private community hospitals, and 26% were in public hospitals.

characteristics of patients during the baseline period and the intervention period were very similar, including Average Severity of Illness Scores[5] (Table 2).

### Process Surveillance and Changes in Practice

Representative infection control practices in the member ICUs and the results of process surveillance during the baseline period and during the intervention period in each hospital are shown in Table 3. Adherence to hand hygiene improved significantly, from 50% to 60% ($P = .001$). The percentage of ICUs starting to consistently use maximal sterile barriers at catheter insertion rose from 46% to 85% ($P = .017$), the percentage adopting chlorhexidine for insertion site antisepsis rose from 7% to 27% ($P = .018$), and the percentage making proactive efforts to promptly remove unneeded catheters rose from 37% to 83% ($P = .004$); the mean duration of central line placement decreased from 4.1 to 3.5 days ($P = .001$).

### CLABSIs

The overall baseline rate of CLABSI in the 86 ICUs was 14.5 per 1,000 central line–days, with a higher rate among the earliest members of the consortium and a modest decrease in the baseline rate among hospitals that have joined most recently (Table 3). By the time hospitals had been members of INICC for 6 months (86 ICUs), the incidence of CLABSI had decreased 33% relative to their baseline period (14.5 vs 9.7 CLABSIs per 1,000 central line–days; RR, 0.67 [95% CI, 0.58–0.77]; $P < .001$), which was sustained at 12 months (10.0 CLABSIs per 1,000 central line–days) and 18 months (9.8 CLABSIs per 1,000 central line–days); however, by 24 months, there was a further decrease, yielding a cumulative reduction from baseline of 54% (16.0 vs 7.4 CLABSIs per 1,000 central line–days; RR, 0.46 [95% CI, 0.33–0.63]; $P < .001$).

### CLABSI-Associated Mortality

During the 24-month intervention period, all-cause deaths in patients with CLABSI decreased commensurately, reaching a 58% decrease by 24 months (Table 4).

## DISCUSSION

Percutaneously inserted, short-term, noncuffed, and nontunnelled central venous lines are widely used in patient care around the world, most often in critically ill patients who have sustained major trauma, who have undergone extensive surgery, or who are critically ill with sepsis or organ failure. The most frequent life-threatening complication of central venous access is CLABSI,[5,6,9] which is associated with major morbidity, prolongation of hospitalization, excess hospital costs ranging in developing countries from US$5,000 to $14,000 per episode, and significant attributable mortality.[30,31] Nearly two-thirds of all nosocomial bloodstream infections in US ICUs are CLABSIs.[32]

Federal governments have become very interested in enhancing the safety of central venous access. In 2007 the US Congress passed legislation denying federal reimbursement for the incremental healthcare costs of CLABSIs.[33] A number of recent prospective studies in the Western industrialized countries have shown that hospitals that take a highly organized, multidisciplinary, systematic approach to the management of central lines have reported striking reductions in the incidence of CLABSI in ICUs.[3,4] This systematic approach starts with formal training of all personnel who insert and care for central venous catheters and focuses on limiting the

TABLE 2. Characteristics of Patients at Baseline and During the Intervention Period

| Characteristic | Baseline | Intervention | RR (95% CI) | *P* |
|---|---|---|---|---|
| No. of patients | 7,751 | 45,968 | … | |
| No. of central line–days | 30,889 | 160,016 | … | |
| Age, mean (IQR), years | 53.6 (40– 70) | 55.7 (42– 72) | … | |
| Sex, no. (%) of patients | | | | |
| Male | 4,756 (61) | 27,603 (60) | 0.98 (0.95–1.01) | .169 |
| Female | 2,995 (39) | 18,365 (40) | 1.03 (0.99–1.07) | .090 |
| Service, no. (%) of patients | | | | |
| Adult | 6,247 (81) | 41,540 (90) | … | |
| Pediatric | 430 (6) | 1,459 (3) | … | |
| Neonatal | 874 (11) | 2,966 (6) | … | |
| ASIS, mean (IQR) | 2.96 (2–4) | 2.91 (2–4) | … | .806 |
| Underlying diseases, no. (%) of patients | | | | |
| Cardiac surgery | 228 (3) | 1,464 (3) | 1.00 (0.87–1.15) | .967 |
| Cancer | 205 (3) | 1,320 (3) | 1.00 (0.86–1.16) | .999 |
| Abdominal surgery | 323 (4) | 1,882 (4) | 0.90 (0.80–1.02) | .096 |
| Thoracic surgery | 43 (1) | 212 (0.5) | 0.77 (0.55–1.106) | .109 |
| Trauma | 188 (2) | 1,111 (2) | 0.92 (0.79–1.07) | .276 |

NOTE. ASIS, Average Severity of Illness Score; CI, confidence interval; IQR, interquartile range; RR, relative risk.

TABLE 3. Representative Infection Control Practices and the Results of Process Surveillance

| Variable | Baseline | Intervention | RR (95% CI) | *P* |
|---|---|---|---|---|
| Representative infection control practice, % | | | | |
| Hand hygiene practices | | | | |
| Hand washing with soap and water | 76 | 44 | 0.58 (0.34–0.99) | .043 |
| Alcohol-based hand rub | 20 | 66 | 3.37 (1.60–7.08) | .001 |
| Hand washing with povidone-iodine | 20 | 39 | 1.96 (0.88–4.36) | .094 |
| Hand washing with CHG | 23 | 53 | 2.27 (1.12–4.62) | .020 |
| Hospital intravenous team | 13 | 26 | 2.00 (0.75–5.33) | .157 |
| Femoral lines frequent | 9 | 9 | 1.00 (0.25–4.00) | >.99 |
| Use of maximal sterile barriers at insertion | 46 | 85 | 1.86 (1.11–3.13) | .017 |
| Cutaneous antisepsis with CHG | 7 | 27 | 4.09 (1.15–4.49) | .018 |
| Insertion site dressing | | | | |
| None | 32 | 12 | 0.37 (0.13–1.04) | .050 |
| Nonsterile dressing | 37 | 5 | 0.13 (0.03–0.57) | .001 |
| Sterile gauze | 57 | 76 | 1.32 (0.79–3.63) | .071 |
| Sterile transparent dressing | 28 | 52 | 1.85 (0.94–3.63) | .071 |
| Topical antibiotic on insertion sites | 2 | 0 | … | .322 |
| Intravenous container vented with a needle | 63 | 36 | 0.58 (0.32–1.05) | .068 |
| Scheduled replacement of central lines | 69 | 29 | 0.43 (0.41–0.45) | <.001 |
| Proactive efforts to promptly remove unneeded catheters | 37 | 83 | 2.25 (1.27–3.97) | .004 |
| 3-way stopcocks used widely | 94 | 88 | 0.94 (0.62–1.41) | .756 |
| Special technologies | | | | |
| Antimicrobial-coated central catheters | 6 | 4 | 0.68 (0.11–4.07) | .671 |
| CHG sponge dressings | 2 | 8 | 4.08 (0.46–6.52) | .172 |
| Results of process surveillance | | | | |
| Adherence to hand hygiene,[a] % | 50[b] | 60[c] | 1.21 (1.18–1.24) | .001 |
| Central line usage,[d] % | 53[e] | 52[f] | 0.99 (0.98–1.01) | .120 |
| Duration central line, mean (IQR), days | 4.1 (0–5) | 3.5 (0–4) | 0.85 (…) | .001 |
| Sterile dressing, in good condition | 81 | 82 | 1.01 (0.99–1.00) | .669 |
| Administration set replaced every 72–96 hours, % | 18 | 50 | 2.73 (2.52–2.96) | .001 |

NOTE. CHG, chlorhexidine gluconate; CI, confidence interval; IQR, interquartile range; IV, intravenous; RR, relative risk.

[a] No. of times hand hygiene performed/no. of opportunities where indicated, during random periods of process surveillance.

[b] 7,831/15,728.

[c] 48,574/80,557.

[d] No. of central line–days/no. of patient-days.

[e] 30,889/58,742.

[f] 160,016/306,340.

number of femoral site insertions, uniform use of maximal sterile barriers during catheter insertion, disinfecting catheter insertion sites with tincture of chlorhexidine rather than iodine-based antiseptics, promptly removing unneeded catheters, and providing feedback of CLABSI rates.

We have previously shown[5,6] and reaffirm in this report that ICUs in developing countries have rates of CLABSI, ventilator-associated pneumonia, and catheter-associated urinary tract infection that are 3–5 times higher than rates reported from North American ICUs. Most resource-limited countries do not have laws mandating healthcare−associated infection control programs, and hospital accreditation is rarely required. Funds and resources for infection control are very limited, nurse-to-patient staffing ratios are far lower on average than in ICUs of the developed countries, and there are larger proportions of inexperienced nurses, all of which have been shown to have a powerful association with increased risks of device-associated infection.[34] Finally, the use of outdated technology also may be a factor. For example, open intravenous infusion systems that in developing countries appear to be associated with a substantially increased risk of infusion-associated bloodstream infection[35] are used almost universally in resource-limited countries instead of the closed intravenous systems that are the standard of care in most developed countries. Measures considered to be mandatory in US ICUs—oversight of the entire catheter insertion procedure by an ICU nurse who is following a checklist and who is empowered to stop the procedure if a break in protocol is detected, maximal sterile barrier precautions during catheter insertion, and routine use of 2% tincture of chlorhexidine for cutaneous antisepsis[4]—have been untenable in the hospitals of most developing countries.

TABLE 4. Deaths in Patients with Central Line–Associated Bloodstream Infection (CLABSI) during Baseline and Intervention Periods

| Cohort | No. of ICUs | No. of patients at risk | CLABSI-associated deaths | | RR[a] (95% CI) | *P* |
|---|---|---|---|---|---|---|
| | | | No. | No. per 100 patients, % | | |
| Months 1–3 (baseline) | 86 | 7,376 | 77 | 1.04 | Reference | |
| Months 5–7 | 86 | 7,522 | 46 | 0.61 | 0.59 (0.41–0.84) | .004 |
| Months 11–13 | 68 | 4,718 | 22 | 0.47 | 0.45 (0.28–0.72) | .001 |
| Months 17–19 | 43 | 3,527 | 16 | 0.45 | 0.43 (0.25–0.74) | .002 |
| Months 23–25 | 28 | 2,264 | 10 | 0.44 | 0.42 (0.22–0.82) | .008 |

NOTE. CI, confidence interval; RR, relative risk.

[a] All periods compared with the first 3 months (baseline).

We believe there is a moral imperative to bring current knowledge of the epidemiology and control of healthcare-associated infection to the many thousands of hospitals and millions of patients of the developing world, and we believe that INICC provides a unique opportunity to move rapidly toward achieving this goal. In this study in a large and diverse patient population of nearly 60,000 patients hospitalized in 86 ICUs of 15 developing countries around the world, we have shown that certain steps were followed by very substantial improvements in process indicators—most notably in hand hygiene, maximal barrier precautions during the insertion procedure, and limiting the duration of catheterization (Table 2). These steps were as follows: (1) providing basic education in hospital epidemiology and infection control (accomplished by a single infection control practitioner in nearly every hospital), (2) conducting surveillance of CLABSI and process surveillance, and (3) providing continuous performance feedback in each ICU. The improvements were paralleled by a 33% decrease in CLABSIs by 5–7 months and a 54% decrease in CLABSIs by 23–25 months of active participation in INICC (Table 5).

The concept of providing continuous feedback to industrial workers of the results of monitoring of the quality of the final product to improve the efficiency of production and product quality stems from the epochal contributions of Deming[36] and others in the industrial engineering movement following World War II, and it was given even greater traction by the more recent Six Sigma movement in American industry.[37] The first attempt to apply industrial engineering to prevent hospital-acquired infections followed the establishment of the NNIS program by the Centers for Disease Control and Prevention in 1969.[38] Hospitals participating in that nascent program were expected to communicate the results of surveillance of nosocomial infections to physicians, nurses, and hospital administrators with the expectation that these data would fuel efforts to improve adherence to basic infection control practices being promulgated at the time and ultimately would reduce the incidence of nosocomial infections in patients. Mandated by the Joint Commission on Accreditation of Hospitals in the early 1970s, surveillance of nosocomial infections rapidly became a basic feature of all US hospital infection control programs, and rates of infection decreased modestly but progressively over the decades. From its inception,[5,6,26-28] INICC has brought the use of feedback of surveillance data as a simple but powerful strategy to improve quality in healthcare to a new level, monitoring and providing continuous feedback not only of outcome data (rates of nosocomial infection) but also of the results of process surveillance (rates of adherence to hand hygiene and other simple but effective evidence-based infection control practices) (Table 2). Also, INICC has shown that combining education with feedback of both outcome and process surveillance can bring quantum reductions in the incidence of CLABSI in ICUs (Table 5) as well as deaths associated with CLABSI (Table 4).[9,25] Recently, other countries have also successfully applied feedback of infection surveillance data to achieve significant reductions in rates of nosocomial infection.[39,40] The hospitals of developed industrialized countries might consider adding process surveillance and its feedback to their current use of surveillance data on nosocomial infection rates.

Because risk factors for nosocomial bacteremia were comparable during the 2 phases of this time-sequence analysis (Table 2), our study has limitations. Because the individual participating ICUs were not concurrently randomized to participate in INICC or to not participate (control subjects), we cannot exclude the possibility that the observed decrease in CLABSIs after joining INICC simply represented a spontaneous downward trend in the incidence of CLABSI in most or all ICUs over the study period, unrelated to the activities of the institutional infection control practitioner and the continuous feedback of institutional data from the central INICC office. We think this is unlikely because there has been only a modest decrease in the baseline rate of CLABSI in new hospitals joining INICC over the tenure of the program to date, far less than the striking reductions seen in each cohort analyzed over the first 24-month intervention period. Secondly, the study design does not permit accurate determination of the epidemiologic mechanisms responsible for the striking decrease in CLABSIs during the intervention period—that is, was it due to education or to targeted performance feedback of surveillance data? If it was due to performance feedback, which had the greater impact, outcome surveillance or process surveillance? If process surveillance

TABLE 5. Comparison of Rates of Central Line–Associated Bloodstream Infection (CLABSI) during Baseline (Months 1–3) and Intervention Periods

| Cohort | No. of ICUs | No. of CLABSIs/no. of central line–days | | No. of CLABSIs/1,000 central line–days | | | |
|---|---|---|---|---|---|---|---|
| | | Baseline | Intervention | Baseline (95% CI) | Intervention (95% CI) | RR[a] (95% CI) | *P* |
| Baseline to months 5–7 | 86 | 447/30,889 | 290/30,026 | 14.5 (13.2–15.9) | 9.7 (8.6–10.8) | 0.67 (0.58–0.77) | .001 |
| Baseline to months 11–13 | 68 | 325/19,981 | 146/14,516 | 16.3 (14.6–18.1) | 10.1 (8.5–11.8) | 0.62 (0.51–0.75) | .001 |
| Baseline to months 17–19 | 43 | 207/12,214 | 108/11,029 | 16.9 (14.7–19.4) | 9.8 (8.0–11.8) | 0.58 (0.46–0.73) | .001 |
| Baseline to months 23–25 | 28 | 134/8,378 | 53/7,206 | 16.0 (13.4–18.9) | 7.4 (5.5–9.6) | 0.46 (0.33–0.63) | .001 |

NOTE. CI, confidence interval; RR, relative risk.
[a] All periods are compared with baseline.

had the greater feedback, which data had the greatest influence on practice?

In summary, although the magnitude of reduction in the INICC hospitals achieved to date is gratifying, rates of CLABSI in the range of 7 cases per 1,000 central line–days are still too high, but we believe greater reductions are achievable. Our immediate goals are to enhance and to strengthen the simple surveillance and performance feedback program that has proven effective to date and to find ways to assure that maximum sterile barrier precautions are used for every central line insertion, femoral vein insertions are reduced to a minimum, 2% chlorhexidine is made available in every hospital and used for all catheter insertions, 3-way stopcocks are replaced by closed connectors, and systems are established to assure immediate removal of central catheters that are no longer necessary— ideally, to incorporate as many of these key measures as feasible into ongoing process surveillance.

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