

Effect of an infection control program using education and performance feedback on rates of intravascular device-associated bloodstream infections in intensive care units in Argentina

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Objective: Our aim was to ascertain the effect of an infection control program, using education and performance feedback on intensive care units, for intravascular device (IVD)-associated bloodstream infection (BSI).

Methods: Within 4 level III, adult, intensive care units in Argentina, all admitted, adult patients with a central vascular catheter in place for at least 24 hours were included. This was a prospective before-and-after trial in which rates of IVD-associated BSI determined during a period of active surveillance without education or performance feedback (phase 1) were compared after sequential implementation of an infection control program using education (phase 2) and performance feedback (phase 3).

Results: A total of 1219 IVD days were accumulated in phase 1; 586 during phase 2; and 4140 during phase 3. Compliance with central vascular catheter—site care improved significantly from baseline during the study period. Overall rates of IVD-associated BSI were lowered significantly from baseline after sequential implementation of education and performance feedback (11.10 vs 46.63 BSI/1000 IVD days; relative risk = 0.25; 95% confidence interval = 0.17-0.36; $P < .0001$). Rates of IVD-associated BSI decreased significantly after implementation of an educational program (phase 1 to phase 2) (relative risk 0.37; confidence interval 0.19-0.73; $P = .0026$) and further reductions were seen after implementation of a performance feedback program (phase 2 to phase 3), although the reduction did not reach statistical significance (9.9 vs 17.06 BSI/1000 IVD days; relative risk 0.58; confidence interval 0.29-1.18; $P = .11$). Additional analysis of the data using χ^2 for trends demonstrated that sequential implementation of an education and performance feedback program resulted in a significant trend toward reduced rates of IVD-associated BSI ($P < .001$).

Conclusion: Implementation of an infection control program, using education and performance feedback, resulted in significant reductions in rates of IVD-associated BSI. (*Am J Infect Control* 2003;31:405-9.)

Patients who are hospitalized and critically ill have a significant risk of having nosocomial bloodstream infection (BSI) develop. Most nosocomial BSIs are primary, the majority of which originate from an intravascular device (IVD) such as a nontunneled and noncuffed central venous catheter (CVC), arterial line,

or pulmonary artery catheter.¹⁻⁴ IVD-associated BSIs significantly increase the length of hospitalization and the cost of health care.⁵⁻⁷ More importantly, they are associated with a significantly increased attributable mortality^{7,8}

Many countries in Latin America, in particular, Argentina, lack mandatory infection control programs. This lack of governmental regulation has resulted in the absence of infection control programs in many Argentinean hospitals. As a result, many IVD-associated BSIs occur in health care facilities that lack caregivers who are familiar with published infection control guidelines.⁹

We report the results of a multicenter, prospective, before-and-after trial that assessed the effectiveness of implementing an infection control program that used education and performance feedback for reducing the rates of IVD-associated BSI in patients from 4 level III,

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cardiac and medical/surgical intensive care units (ICUs) in 2 Argentinean medical centers.

METHODS

Setting

The study was conducted in 2 medical centers in Buenos Aires, Argentina (Bernal Medical Center and Colegiales Medical Center). Each center has an infection control team comprised of a medical doctor (with formal education and background in internal medicine, infectious diseases, and hospital epidemiology) and an infection control nurse.¹⁰

Bernal Medical Center is a private, 150-bed hospital with 1 medical/surgical ICU (17 beds) and 1 coronary ICU (15 beds). Colegiales Medical Center is a private, 180-bed hospital with 1 medical/surgical ICU (10 beds) and 1 coronary ICU (10 beds). All ICUs in the study operate at a third level of complexity, caring for patients who have undergone open heart, neurosurgic, and orthopedic operation, and patients with severe medical illness. The institutional review board at each center approved the study protocol.

Data collection

All patients with a CVC for more than 24 hours who were admitted to the study ICUs were enrolled. An infection control nurse at each study center extracted patient data prospectively from charts. The principal investigator (V.D.R.) trained the data collectors at each center before initiation of the trial. Age, sex, duration of catheterization, antibiotic use, use of other invasive devices, and other sites of infection while catheterized were recorded for each study patient. Study center data collection sheets were checked for potential errors and missing items by the study coordinator to confirm each diagnosis of IVD-associated BSI.

Definitions

There were 2 criterion for "laboratory-confirmed BSI": (1) a recognized pathogen cultured from 1 or more percutaneous blood cultures, after 48 hours of vascular catheterization, and the pathogen cultured from the blood was not related to an infection at another site. With common skin commensals (eg, diphtheroids, *Bacillus* spp., *Propionibacterium* spp., coagulase-negative staphylococci, or micrococci), the organism was cultured from 2 or more blood cultures drawn on separate occasions; and (2) patient had at least 1 of the following signs or symptoms that was not considered to be related to an infection at another site: fever ($>100.4^{\circ}\text{F}$), chills, or hypotension.

"Clinical primary nosocomial sepsis" was defined by at least 1 of the following clinical signs, with no other recognized cause: fever ($>100.4^{\circ}\text{F}$), hypotension

(systolic pressure < 90 mm Hg), or oliguria (< 20 mL/h). The definition also specified that blood cultures were not obtained or no organisms were recovered from blood cultures, but that there was no apparent infection at another site and that the physician instituted treatment for sepsis.¹¹

Culture techniques

Decisions to remove catheters and obtain blood cultures were made independently by patients' attending physicians. CVCs were removed aseptically and the last 5 cm of the catheter tip were cultured using a semiquantitative method.¹² Specimens not immediately cultured were refrigerated at 4°C . All cultures were inoculated within 8 hours of catheter removal. Standard laboratory methods were used to identify micro-organisms colonizing the CVC tips.^{13,14}

Compliance

Placement of gauze on IVD insertion sites, marking of the date on the intravascular (IV) administration set, and condition of the gauze dressing were assessed and entered into a standard form by a research nurse who observed health care worker (HCW) behavior in the study units twice a week. Compliance with insertion site and administration set care required placement of a gauze dressing during the CVC insertion and a label on the IV administration set documenting the date it was replaced. The criteria for gauze condition were as follows: absence of blood, absence of moisture, absence of gross soilage, and coverage of insertion site.

Intervention

Active surveillance for IVD-associated infections and compliance with IVD site care were begun with phase 1 and continued through phase 3.¹⁵ The intervention period was incrementally implemented in 2 phases (phases 2 and 3). In phase 2 (education) HCWs from the study ICUs underwent education and training for CVC care on the basis of infection control practices published by the Centers for Disease Control and Prevention, and Hospital Infection Control Practices Advisory Committee.⁹ This phase occurred during 1 month at Bernal Medical Center and during 3 months at Colegiales Medical Center. At the completion of phase 2, HCW compliance with IVD site care was provided to the ICU staff (performance feedback).

Performance feedback was provided on a monthly basis at infection control meetings in the form of bar charts documenting rates of compliance with hand-washing, gauze on CVC insertion sites, dates on IV administration sets, and maintaining the condition of catheter gauze dressings. Furthermore, a formal report of compliance rates was forwarded to administrators in each study ICU.

Table 1. Timeline for implementing baseline surveillance (phase 1), education (phase 2), and performance feedback (phase 3)

Phase	Bernal Medical Center		Colegiales Medical Center	
	IVD site care program, mo/y	Handwashing program, mo/y	IVD site care program, mo/y	Handwashing program, mo/y
1	4/99 - 5/99	4/99 - 5/99	9/00 - 11/00	9/00 - 12/00
2	6/99 - 7/99	6/99 - 7/99	12/00	1/01 - 4/01
3	8/99 - 3/2001	8/99 - 3/01	1/01 - 7/01	5/01 - 7/01

IVD, Intravascular device-associated.

A similar study to improve HCW compliance with handwashing was undertaken at each institution resulting in overlap with the current trial (Table 1).

Outcomes

The primary outcome was the combined rate of IVD-associated BSI in phases 2 and 3 as compared with the rate in phase 1. Secondary outcomes included the rate of IVD-associated BSI in phase 2 versus phase 1, and in phase 3 versus phase 2.

Statistical methods

Software (Epiinfo v. 6.04b, CDC, Atlanta, Ga) was used for data analysis. Baseline differences among treatment groups were analyzed using χ^2 analyses for dichotomous variables and Student *t* test for continuous variables. When appropriate, Fisher exact test was used. Relative risk ratios, 95% confidence intervals, and *P* values were determined for all primary and secondary outcomes. Additional analysis using χ^2 for trends was performed after completion of the primary data analysis.

RESULTS

During the study period (April 1999 to July 2001), 840 adult patients in the study ICUs required CVCs and all of these patients were enrolled in the study. Patients from phase 1 were very similar to patients from phases 2 and 3 with regard to sex, age, diabetes mellitus, cancer, and HIV (Table 2).

During the study periods we evaluated compliance with catheter care for a total of 347 observations in phase 1; 169 observations in phase 2; and 5165 observations in phase 3. Compliance with IVD site care did not improve significantly with education alone, however, compliance was dramatically enhanced after implementing a performance feedback program (Table 3).

A total of 5945 IVD days were accumulated during the course of the trial with 1219 during phase 1; 586 during phase 2; and 4140 during phase 3. The overall rate of IVD-associated BSI during phases 2 and 3, combined, was significantly lower than during phase 1 (11.10 vs 45.94 BSI/1000 IVD days) (Table 4).

Table 2. Baseline characteristics of patients at study entry

	Preintervention (%)	Intervention (%)	<i>P</i>
Male sex, %	84 (48.8)	358 (53.6)	.265
Age (y), mean \pm SD	71.98 \pm 13.45	71.91 \pm 12.19	.944
Diabetes, %	32 (18.6)	103 (15.4)	.314
Cancer, %	9 (4.8)	33 (4.9)	.925
HIV, %	1 (0.6)	0 (0.0)	.205*

*Fisher exact test.

The rate of IVD-associated BSI during phase 2 was significantly lower than during phase 1 (17.06 vs 45.94 BSI/1000 IVD days) (Table 4). Although rates of IVD-associated BSI were further reduced with implementation of performance feedback program (17.06 to 9.9 BSI/1000 IVD days) this reduction did not reach statistical significance (Table 4). Further analysis of the data using χ^2 for trends demonstrated that sequential implementation of an education and performance feedback program resulted in a significant trend toward reduced rates of IVD-associated BSI ($P < .001$) (Table 4).

DISCUSSION

Patients who are critically ill often require central venous access for the administration of fluids, medicines, and blood products. Unfortunately the use of CVCs is associated with a considerable risk of infection.^{16,17} When infection does occur, studies have repeatedly demonstrated an increased length of hospitalization, excess costs,^{5,7} and an increased attributable mortality.^{7,8} For example, Digiovine et al⁶ found that IVD-associated BSIs resulted in an excess length of hospitalization of 10 days and increased direct medical costs by an average of nearly \$35,000; whereas Rello et al⁵ found that IVD-associated BSIs prolonged hospitalization by almost 20 days and increased the cost of health care by 3124 euros. When measured previously in Argentina, the extra days were 7 and the extra cost was \$2622.¹⁸ More importantly, IVD-associated BSIs may be associated with an increased attributable mortality; Collignon⁸ found that IVD-associated BSI resulted in an excess mortality of 12%, whereas Pittet et al⁷ found an excess mortality of 25%.

Table 3. Compliance with intravascular device site care

	Phase 1	Phase 2	Phase 3
Presence of gauze on IVD site	53.02% (184/347)	56.21% (95/169)	96.53% (4986/5165)
	—	RR = 1.06*	RR = 1.72 [†]
	—	95% CI = 0.86–1.30	95% CI = 1.40–2.10
	—	P = .64*	P < .001 [†]
Date on IV administration set	0.57% (2/347)	0.00% (0/169)	74.00% (3839/5165)
	—	—	—
	—	P = .32*	P < .001 [†]
Good gauze condition	48.70% (169/347)	43.19% (73/169)	89.56% (4626/5165)
	—	RR = 0.89*	RR = 2.07 [†]
	—	95% CI = 0.67–1.17	95% CI = 1.65–2.62
	—	P = .39*	P < .001 [†]

Phase 1, Baseline; phase 2, education; phase 3, performance feedback; IVD, intravascular device-associated; RR, relative risk; CI, confidence interval.

*Phase 2 vs phase 1.

[†]Phase 3 vs phase 2.

Table 4. Rates of intravascular device-associated bloodstream infection

	BSIs/1000 IVD days	RR	95% CI	P
Phase 1	45.94 (56/1219)			
Phase 2 + 3	11.10 (51/4726)	0.25*	0.17 - 0.36	< .001
Phase 2	17.06 (10/586)	0.37 [†]	0.19 - 0.73	< .001
Phase 3	9.90 (41/4140)	0.58 [‡]	0.29 - 1.18	.11

Phase 1, Baseline; phase 2, education; phase 3, performance feedback; BSI, bloodstream infection; IVD, intravascular device-associated; RR, relative risk; CI, confidence interval.

*Phase (2 + 3) vs phase 1.

[†]Phase 2 vs phase 1.

[‡]Phase 3 vs phase 2 = χ^2 for trends; P < .001.

IVD-associated BSIs are largely preventable and innumerable studies have been published documenting the effectiveness of interventions such as full-barrier precautions with IVD insertion,¹⁹ use of chlorhexidine for skin antisepsis,²⁰ and anti infective—impregnated catheters^{21,22} for reducing the rates of IVD-associated BSI. Unfortunately, most health care institutions in Latin America, including Argentina, lack the resources to implement many of these preventative technologies. Furthermore, many hospitals lack basic infection control programs and most caregivers are unaware of simple, yet economical and effective, methods for preventing IVD-associated BSI.

We have shown that education and training of HCWs can result in significant reduction in rates of IVD-associated BSI. Implementation of a program in which performance feedback is given to HCWs results in significant improvements in compliance with IVD site care and a further reduction in rates of IVD-associated BSI. Although the implementation of a performance feedback program did not result in a significant further reduction in rates of IVD-associated BSI, there was a significant trend toward reduced rates of infection after implementation of this program, which may have reached statistical significance with

a larger sample size. The parallel implementation of a handwashing program likely had an impact on the results of this study. In particular, it is possible that the earlier implementation of a handwashing program at both institutions enhanced the impact of the educational phase of this study, potentially reducing the overall impact of performance feedback.

In conclusion, education can significantly improve infection control practices and reduce the rates of IVD-associated infection. Combining education with performance feedback appears to increase rates of compliance with infection control practices and may allow for further reduction in rates of IVD-associated BSI. Larger studies are needed to confirm this latter finding, but given the relatively low costs associated with implementation of such a program, we believe that its use should be considered at institutions where compliance with infection control measures are inappropriately low.

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Correction

In the article, "Nosocomial infections in medical-surgical intensive care units in Argentina: Attributable mortality and length of stay" (*Am J Infect Control* 2003;31:291-5), Nasia Safdar, MD, MS, should be added as the fourth author. She is affiliated with the Section of Infectious Diseases, Department of Medicine, University of Wisconsin Medical School, Madison, Wisconsin.