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Quality in Practice

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'Adiós Bacteriemias': a multi-country quality improvement collaborative project to reduce the incidence of CLABSI in Latin American ICUs

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Abstract

Quality Problem: The incidence of central line-associated bloodstream infections (CLABSI) in Latin America has been estimated at 4.9 episodes per 1000 central line (CL) days, compared to a pooled incidence of 0.9 in the United States. CLABSI usually result from not adhering to standardized health procedures and can be prevented using evidence-based practices.
Initial Assessment: The first phase of the 'Adiós Bacteriemias' Collaborative was implemented in 39 intensive care units (ICUs) from Latin America from September 2012 to September 2013 with a 56% overall reduction in the incidence of CLABSI.
Choice of Solution: Bundles of care for the processes of insertion and maintenance of CLs have proven to be effective in the reduction of CLABSI across different settings.
Implementation: Building on the results of the first phase, we implemented a second phase of the 'Adiós Bacteriemias' Collaborative between June 2014-July 2015. We adapted the Breakthrough Series (BTS) Collaborative model to guide the adoption of bundles of care for CLABSI prevention through virtual learning sessions and continuous feedback.
Evaluation: Eighty-three ICUs from five Latin American countries actively reported process and outcome measures. The overall reduction in the CLABSI incidence rate was 22% (incidence rate 0.78; 95% CI 0.65, 0.95), from 2.58 episodes per 1000 CL days at baseline to 2.02 episodes per 1000 CL days ($P < 0.01$) during the intervention period.
Lessons Learned: Adiós Bacteriemias was effective in reducing the incidence of CLABSI and improving the adherence to good practices for CL insertion and maintenance processes in participating ICUs in Latin America.

Key words: collaborative, quality improvement, health-care associated infections, intensive care, bundles of care, multi-county

Quality problem

Healthcare-associated infections (HAIs) are among the most common adverse events during hospital care [1, 2]. Bloodstream infections associated with the insertion and maintenance of central lines (CL) are the most common cause of HAIs to the bloodstream [3]. Approximately 90% of central line associated bloodstream infections (CLABSI) occur at the CL insertion site, which is contaminated either at the time of puncture or by migration of the patient's own bacterial flora in the days after placement [3, 4]. An International Nosocomial Infection Control Consortium (INICC) surveillance study (January 2007–December 2012) in 503 intensive care units (ICUs) in Latin America, Asia, Africa, and Europe reported a pooled rate of CLABSI of 4.9 episodes per 1000 central line days, compared to a pooled rate of 0.9 reported from comparable ICUs in the United States [5].

CLABSI is associated with a pooled crude mortality of 24.9%, a pooled extra mortality of 17%, a pooled average length of stay (LOS) of 19.47 days and a pooled average extra LOS of 13.37 days [5]. CLABSI-associated costs have been estimated at US $ 2619 on average [6]. In developing countries, these infections are usually the result of failure to follow standardized health procedures and can be prevented using evidence-based practices during the processes of insertion and maintenance of CLs; however, these practices are not yet sufficiently widespread [6–8]. Among the contributing factors are irregular adherence and compliance with infection control guidelines, lack of medical supplies, low nurse-to-patient staffing ratios, and insufficient number of trained health workers [9–11].

Initial assessment

The first phase of the 'Adiós Bacteriemias' ('Goodbye Bacteriemia' in English) Collaborative—a multi-country, quality-improvement, virtual initiative was implemented in 39 intensive care units (ICUs) in four Latin American countries from September 2012 to September 2013. This initiative was promoted by the Latin American Consortium for Innovation, Quality and Safety in Health (CLICSS)— and implemented with the support from the Avedis Donabedian Foundation, the Institute for Healthcare Improvement (IHI) and the Institute for Clinical Effectiveness and Health Policy.

Choice of solution

The use of bundles of care for the processes of insertion and maintenance of CLs has proven to be effective in the reduction of CLABSI across different settings [12–22]. Keystone ICU Project achieved a 66% reduction in CLABSI rates in 103 participating ICUs in the state of Michigan after 18 months of implementation bundles of care for the insertion of CLs [14], and a 100% reduction after 3 years, with an estimated impact of over USD $200 million and more than 15 000 lives potentially saved [15]. In 2011, the Centers for Disease Control and Prevention (CDC) issued new recommendations for preventing CLABSI, which included education to healthcare providers regarding indications for CL use, proper procedures for the insertion and maintenance of CLs, and appropriate infection control measures to prevent infections [23]. Building on the success of the Keystone ICU Project, and following CDC's recommendations, the Bacteremia Zero project achieved a reduction of 50% in the rate of CLABSI from baseline in 192 Spanish ICUs following the implementation of bundles of care for both the process of insertion and maintenance of CLs, plus active engagement and education [18, 19]. Similarly, the Target CLAB Zero campaign achieved a reduction of 90% (from a baseline of 3.32 to 0.28) in the rate of CLABSI in 23 participating ICUs from New Zealand in 12 months, following the implementation of bundles for both the insertion and maintenance processes [24].

Adiós Bacteriemias Collaborative adapted the Institute for Healthcare Improvement (IHI) Breakthrough Series (BTS) Collaborative model [25]—a quality improvement collaborative (QIC) approach centered around shared learning and improvement —coupled with the Model for Improvement (MFI) [26] to promote the adoption and local-context adaptation of the CL insertion and maintenance bundles of care for CLABSI prevention through virtual learning sessions and continuous feedback (Fig. 1). The foundation of the BTS model is the idea that quality improvement teams working in collaboration towards a common goal are likely to be more effective than teams working in isolation [25]. During the implementation phase of the BTS, face-to-face learning sessions (LS) are held every three to four months, where participants convene to share progress and best practices as well as barriers, challenges, facilitators and lessons learned during the implementation of a project. LS are followed by Action Periods (AP) during which participating teams test and document change ideas using the MFI and Plan-Do-Study-

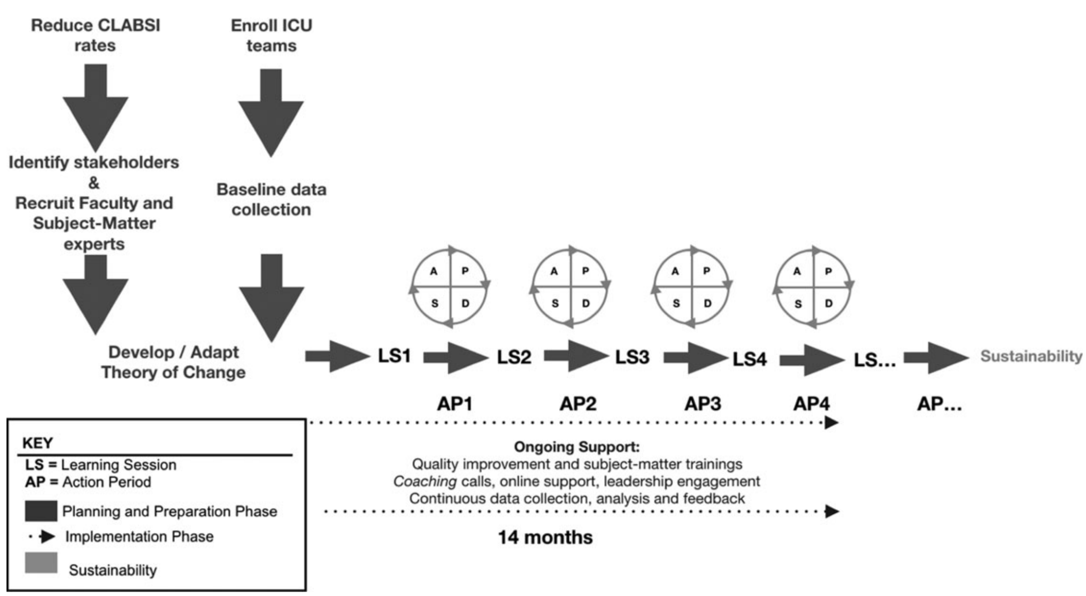

Figure 1 Adaptation of IHI's Breakthrough Series (BTS) Collaborative Model.

Act (PDSA) cycles. During these periods, teams also collect and report data on key measures on a monthly basis. Typically, a central data repository is made available for teams to report data [25].

Given the multi-country nature of the 'Adiós Bacteriemias' Collaborative and the fact that there was no funding available to host face-to-face meetings, the model was adapted to Webex® virtual learning sessions.

The second phase of the Collaborative began with a planning and preparation period and then moved to an implementation period:

Planning and preparation period (January–June 2014)

- **Task force formation.** The Adiós Bacteriemias task force consisted of experts in infection control, quality improvement, and patient safety.
- **Identify implementing partners.** The Adiós Bacteriemias Collaborative brought together leading organizations in patient safety and quality improvement from Latin America, Spain, and the United States to serve as implementation partners. Additionally, scientific societies (infection control, nursing, critical care, etc.) were invited to participate.
- **Development and adaptation of evidence-based interventions.** Two evidence-based bundles of care were adapted to the local context, one for the process of insertion and one for the process of maintenance of CLs (Fig. 2). Similarly, t an implementation and a measurement guide was distributed to all interested organizations. These documents described the Collaborative and its objectives, outlined core program components, and included a variety of data collection tools, such as standardized checklists and data collection forms.
- **ICU enrollment and commitment.** As a starting point, the hospitals that had participated in the first phase of the Collaborative and other acute care hospitals from across Latin America were invited to participate via email and through one-on-one connections. Hospitals that expressed interest were then invited to fill out a commitment form that summarized the intervention as well as the responsibilities of both the task force and the participating teams. The form required the signatures of an executive leader from the hospital and a representative of the local improvement team. All the ICUs that registered and submitted a commitment form were included in the Collaborative. There were no fees associated with participation in the Collaborative. No exclusion criteria were applied.

CL insertion bundle:

- hand hygiene
- maximum barrier precautions
- cutaneous antisepsis with chlorhexidine
- subclavian localization preference for insertion of central lines.

CL maintenance bundle:

- hand hygiene
- daily assessment of the dressing and change if necessary
- use of aseptic technique to access and change the central line
- standardization of central line replacement
- daily revision of the central line and withdrawal of unnecessary lines.

Figure 2 Components of the CL insertion and maintenance bundles.

- **Team formation**. A key driver of the Collaborative was effective teamwork. ICU teams that enrolled in the Collaborative were asked to form a multidisciplinary quality improvement team, and to assign roles and responsibilities to all team members: senior sponsors, project leader, a clinical expert, an improvement expert, and an infectious control or epidemiological surveillance expert. Leadership and senior sponsors were actively engaged and kept informed of the results of the participating ICUs throughout the Collaborative.
- **Set up of a shared data repository**. An online, shared data repository was created and made available to participating teams. The repository allowed for teams to report data on key outcome and process measures, document PDSAs, communicate with other participating teams, and access and share resources. This repository also automatically generated run charts for teams as they entered their monthly data, allowing for real-time data analysis to guide decision-making. The task force team used this repository to access and analyze aggregated and individual data, and to provide feedback on a regular basis.
- **Baseline data collection.** Participating ICUs were asked to collect and report baseline data on monthly CLABSI rates for at least the five months prior to the start of the intervention (January-May 2014).

Intervention period (June 2014–July 2015):

The intervention period of the second phase of the Adiós Bacteriemias Collaborative occurred between June 2014 and July 2015. This period consisted of biweekly, virtual Webex® LS followed by AP. LS covered: fundamentals of patient safety, epidemiological surveillance, quality improvement methods, effective teamwork and communication, and behavior change. The LS were designed as a space to promote the implementation of bundles of care for the insertion and maintenance of CLs, where participating hospitals could learn and share best practices and success factors, as well as reflect on barriers, challenges, and facilitators through virtual interaction. LS also allowed for participating teams to build quality improvement capability and to consult with experts, colleagues, and leaders on CL infection control. Additional support was provided by the Collaborative task force throughout the implementation period in the form of virtual, continuous feedback and coaching. Aggregated results for outcome and process measures were presented during the LS. Additionally, bright spots were identified and invited to present on PDSAs, results, barriers and challenges, and lessons learned during the LS.

During the AP, participating teams tested change ideas using PDSA cycles to promote the adoption of the bundles of care for the CL insertion and maintenance processes. Teams collected and reported data for outcome and process measures on a monthly basis.

Measures

Outcome measure

The outcome measure was the monthly rate of CLABSI, defined as the number of CLABSI episodes per 1000 CL days.

Process measures

Two process measures were used:

(1) Percentage compliance with the CL insertion bundle (number of patients with a CL for whom all the components of the CL insertion bundle were complete / number of patients with a CL placed)

(2) Percentage compliance with the CL maintenance bundle (number of patients with a CL for whom all the components of the CL maintenance bundle were complete / number of patients with a CL placed)

The process measures were treated as all-or-nothing: if any of the bundle components was missing for a patient with a CL, it was considered as non-compliant.

Data collection

An availability sample of 83 ICUs from 5 different Latin American countries was included. Standardized data collection forms for each of the measures were provided to participating teams. For reporting, an online centralized platform was made available for teams to enter raw data for each of the measures. Participating teams were trained on how to use the data repository. Process and outcome data were self-reported on a monthly basis.

Data analysis

Descriptive statistics were used to summarize the data, and an uncontrolled before-and-after comparison of CLABSI rates was conducted to estimate the association between the intervention with the reduction of CLABSI rates using Fisher's exact test. Random-effects Poisson regression analysis was used for CLABSI incidence rates, based on average monthly rates, and using type of hospital, size of hospital, size of ICU and starting phase as covariates. Control charts were also used to plot the data and analyze variation in the outcome measures over time. All p values are two sided, with $p \leq 0.05$ considered statistically significant. Descriptive and analytic statistics were computed using STATA 14.0.

Ethics and permissions

Every participating hospital received information about the motivation for the Collaborative. Anonymity and confidentiality of their demographic information and reported data were ensured. Besides the commitment form signed by each participating hospital, there was not an informed consent required for patients because CLABSI prevention was considered a standard of care.

Evaluation

Eighty-three ICUs from 32 hospitals from across five Latin American countries (Argentina, Chile, Colombia, Mexico, and Uruguay) actively reported process and outcome measures. Senior sponsors from all 32 hospitals signed a pledge agreeing to participate. CLABSI rates were submitted on 1070 (92.1%) ICU-months of a maximum of 1162. Complete data were submitted for all months by 72 (86.7%) ICUs. Twenty-seven (69.2%) of the 39 ICUs that participated in the first phase of the Adiós Bacteriemias Collaborative also participated in this second phase, representing 32.5% of the 83 participating ICUs. Table 1 summarizes the demographic characteristics of the participating ICUs. The mean (range) number of beds per hospital was 191 (51–683) and the mean (range) number of beds per ICU was 12 (2–55). Of the participating ICUs, 43 (52%) ICUs belonged to public hospitals, and 38 (46%) ICUs were from teaching hospitals. As for the type of ICU, 37 (45%) were mixed, 14 (17%) were adult ICUs, 13 (16%) were pediatric ICUs, 10 (12%) were neonatal, and 9 (11%) were either surgical or cardiovascular ICUs (classified as Other).

Table 1 Characteristics of participating ICUs ($N = 83$)

Characteristic	*n* (%)
ICUs per participating country	
Mexico	34 (41.0)
Argentina	28 (33.7)
Colombia	18 (21.7)
Chile	3 (3.6)
Uruguay	1 (1.2)
ICU size (number of beds)	
1–10	36 (43.4)
11–25	18 (21.7)
>25	29 (35.8)
Teaching/Non-teaching	
Teaching	38 (45.8)
Non-teaching	45 (54.2)
Type of ICU	
Mixed	37 (44.6)
Adult	14 (16.9)
Pediatric	13 (15.7)
Neonatal	10 (12.1)
Other	9 (10.8)
Type of hospital	
Public	43 (51.8)
Private	40 (48.2)
Hospital size (number of beds)	
51–150 (Medium)	36 (43.4)
151–500 (Large)	41 (49.4)
>500 (Extra-large)	6 (7.2)

During the intervention period of the second phase of the Collaborative, a total of 24 learning sessions were held. During these, quality improvement, teamwork, process control, infection control, data analysis, reliability, and patient safety topics were covered. An average of 28 (87.5%) of the 32 hospitals participated in each session.

Table 2 shows the number of CLABSI episodes and CL days for the baseline and intervention periods and the crude before and after CLABSI incidence rates and incidence rate ratios. These are reported for all participating ICUs (aggregated), and stratified by ICU type, hospital size, type of hospital (public or private), and by the phase in which ICUs joined the Collaborative. During the baseline period of the study, a total of 157 episodes of CLABSI were registered per a total of 60 919 CL days, for a baseline incidence rate of 2.58. During the intervention period, a total of 381 episodes were registered per a total of 188 368 CL days, for a rate of 2.02. The overall reduction in CLABSI rate between the baseline and intervention periods was 22% (incidence rate [IR], 0.78; 95% CI 0.61, 0.92), which was statistically significant ($P < 0.01$). The highest baseline CLABSI incidence rates were those reported by mixed ICUs (3.79), ICUs that belonged to medium size (51–150 beds) hospitals (5.5), ICUs that participated only in the second phase of the Collaborative (3.67), and ICUs that belonged to public hospitals (2.6). Neonatal and ICUs classified as Other showed a statistically significant reduction in CLABSI incidence rates with a 63% (P-value <0.01) and a 41% (P-value <0.05) reduction respectively. Similarly, the reduction in CLABSI incidence rates for medium size (51–150 beds) hospitals, ICUs with one to 10 beds, ICUs that started on the second phase of the Adiós Bacteriemias Collaborative, and private hospitals was statistically significant.

Table 2 Parameters estimated by time-series Poisson regression analysis ($N = 83$ ICUs)

	Baseline (Jan–May '14)			Intervention Period (Jun '14 –Jul '15)			IRR (95% CI)	P-value**
	CLABSI episodes	No. of central line days	CLABSI incidence rate*	CLABSI episodes	No. of central line days	CLABSI incidence rate		
All ICUs	157	60 919	2.58	381	188 368	2.02	0.78 (0.61, 0.92)	<0.01
ICU type								
Adult ICUs	23	10 310	2.23	62	31 659	1.96	0.88 (0.54, 1.48)	0.293
Mixed ICUs	55	14 531	3.79	139	46 128	3.01	0.80 (0.59, 1.11)	0.078
Pediatric ICUs	51	22 242	2.29	137	67 569	2.03	0.88 (0.64, 1.24)	0.226
Neonatal ICUs	11	7316	1.50	13	23 548	0.55	0.37 (0.15, 0.91)	<0.01
Other ICUs	17	6520	2.61	30	19 464	1.54	0.59 (0.32, 1.14)	<0.05
Hospital Size (number of beds)								
51–150	66	12 030	5.5	150	41 405	3.62	0.66 (0.49, 0.90)	<0.01
151–500	81	42 054	1.93	209	128 619	1.63	0.84 (0.65, 1.1)	0.197
>500	10	6835	1.5	22	18 344	1.2	0.82 (0.37–1.95)	0.594
ICU Size (number of beds)								
1–10	52	17 526	2.97	103	57 568	1.79	0.6 (0.43, 0.86)	<0.01
11–25	78	29 535	2.64	202	92 607	2.18	0.83 (0.63, 1.09)	0.08
>25	27	13 858	1.95	76	38 193	1.99	1.02 (0.65, 1.65)	0.94
Start Phase								
Phase 1	67	36 393	1.84	151	104 838	1.44	0.78 (0.58, 1.06)	0.1
Phase 2	90	24 526	3.67	230	83 530	2.76	0.75 (0.59, 0.97)	<0.05
Public/Private								
Public	103	39 639	2.60	268	125 134	2.14	0.82 (0.65, 1.04)	0.1
Private	54	21 280	2.54	113	63 234	1.80	0.70 (0.5, 0.99)	<0.05

IRR = incidence rate ratio; CI = confidence interval.

*Incidence rate per 1000 central line days

**Wald Chi-squared test.

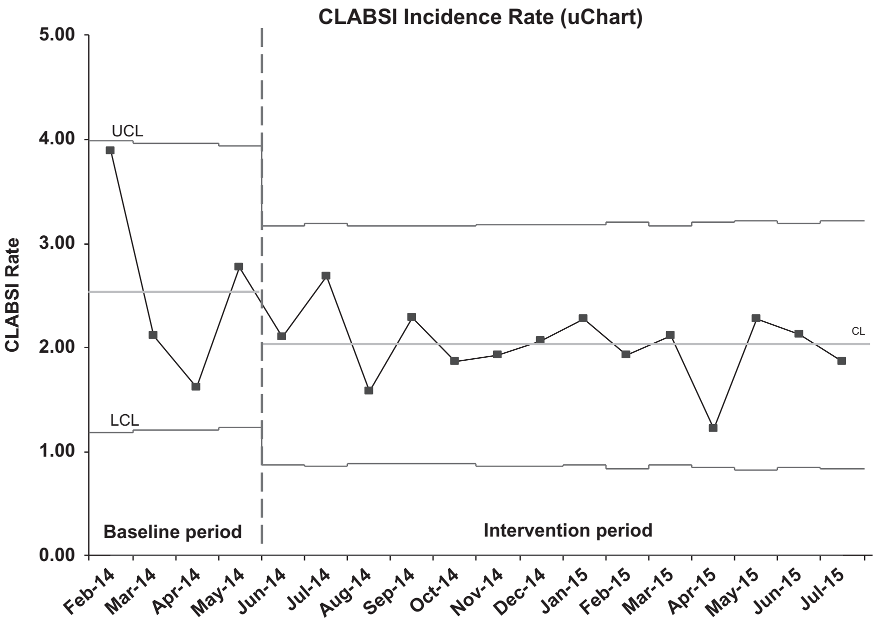

Figure 3 CLABSI Rate Control chart.

For the process measures, during the baseline period (January to May 2014 for the Compliance with Central Line Insertion Bundle measure and April to May 2014 for the Compliance with Central Line Maintenance Bundle measure) the mean percentage compliance with the insertion bundle of care was 67.8%, compared to a mean percentage compliance of 81.3% during the implementation phase. This represented an increase of 20% in the mean percentage compliance with the insertion bundle of care. The mean percentage compliance with the CL maintenance bundle of care during the second phase of the Collaborative was 87.8%. Fig. 3 graphically displays monthly data for CLABSI incidence rates, including self-reported baseline data.

Random-effects Poisson regression analysis (Table 3) showed that ICUs from public hospitals had an average of 1.29 higher CLABSI rates than private hospitals (*P*-value<0.01), that ICUs from hospitals with more than 150 beds had an average of 2.07 lower CLABSI rates than those with equal or less than 150 beds (*P*-value<0.01), and that ICUs that participated in both the first and second phases of the collaborative had an average of 1.23 lower CLABSI rates than those that only participated in the second phase (*P*-value<0.01).

Table 3 Association between sociodemographic characteristics and CLABSI rate

N = 83 ICUs	CLABSI Rate		
Variable	Coeff	95% CI	*P*-value
Public hospital	1.29	(0.60, 1.97)	<0.01
>150 hospital beds	−2.07	(−2.78, −1.35)	<0.01
>25 ICU beds	−0.33	(−1.22, 0.56)	0.47
Having participated in Phase 1	−1.23	(−1.94, −0.52)	<0.01

Note: Coeff = coefficient; CI = confidence interval.

*Random-effects Poisson regression analysis.

Limitations

Our project had several limitations. First, the absences of a control group with which to compare the impact of the adoption of the insertion and maintenance bundles on the CLABSI rate. Second, this is a before-and-after analysis rather than a stepped wedge design, which increases our risk of bias and limits our ability to attribute changes seen in CLABSI rates to the Collaborative. Third, participating ICUs were non-randomly selected; we used availability sampling instead, which may have also biased our results. Fourth, we used self-reported data, and did not conduct any audits to verify the accuracy of the data. However, our results are consistent with those of similar projects implemented in developing countries and we believe our proposed interventions are more likely generalizable to other ICUs with similar demographic characteristics in Latin American countries given that this was treated as a quality improvement and not as a research project and that the participation was voluntary. Future studies should use robust quasi-experimental designs to better understand the factors that determine the degree of adoption of best practices as a result of using quality improvement methods.

Lessons learned

To our knowledge, this is the first study to report results from a multi-country, virtual quality improvement collaborative. The results of our study are similar to those of other quality-improvement collaboratives aimed at reducing CLABSI incidence rates in developing countries [27–30]. The highest (albeit lower) baseline CLABSI incidence rates were observed for mixed, surgical, and cardiovascular ICUs, which is consistent with results from the International Nosocomial Infection Control Consortium (INICC) report [5]. ICUs with more than 10 beds, ICUs from private, and ICUs from larger size hospitals (>150 beds) had the lowest baseline CLABSI incidence rates.

Several factors may have contributed to a lower baseline CLABSI incidence rate for the second phase (2.58 episodes per 1000

CL days) of the Collaborative compared with that of the first phase (5.68 episodes per 1000 CL days), including a potential secular trend from 27 (69.2%) of the 39 ICUs that had participated in the first phase of the Collaborative and continued to the second phase. Effects of secular trends on the reduction of HAIs have been documented before [31].

Previous studies have documented education, active engagement of ICU staff and hospital leadership, performance monitoring, and continuous feedback as key success factors to the adoption of evidence-based best practices for CLABSI prevention [14, 32–36]. Some of the key success factors of the Adiós Bacteriemias Collaborative included: (1) convergence of expert organizations and individuals from different countries; (2) leveraging existing local expertise within each country; (3) translation and local-context adaptation of evidence into practice; (4) active leadership involvement and commitment; (5) local capacity building in quality improvement and CLABSI prevention; (6) continuous reporting of processes and outcome measures; (7) availability of an online repository for data reporting, and literature and tools sharing; (8) credibility and trust resulted from the perception of it being an international initiative; and (9) sense of connectedness and belonging to a community that allowed for knowledge development and best-practices sharing across participating hospitals and across countries. As for barriers and challenges to the successful adoption of standards and protocols for infection prevention, previous studies have documented lack of medical supplies, understaffing, inadequate or insufficient training on infection control, inadequate communication and lack of teamwork, work overload, and lack of measurement systems among others [9–11, 17, 37, 38]. Some of the challenges and barriers that were observed to the adoption of the CL bundles during the implementation of the Adiós Bacteriemias Collaborative included: (1) lack of acknowledgment of the problem and resistance to change at the beginning; (2) low quality improvement and technological literacy among participating teams; (3) high variability in adoption of guidelines and protocols for infection prevention across participating ICUs; and (4) lack of or insufficient supplies.

Even though the compliance with the bundles of care improved during the implementation of the Collaborative, cultural change around quality improvement requires consistent and long-lasting actions for their institutionalization and sustainability. We recommend that the participating hospitals continue to actively engage and support health care providers in the implementation of quality improvement efforts to ensure that the results are sustained over time.

The Adiós Bacteriemias Collaborative was successful in improving adherence to evidence-based best practices for CL insertion and maintenance and in reducing the incidence of CLABSI. Our study demonstrated that adaptations to the traditional BTS model, such as virtual collaboratives, allow for the incorporation of quality improvement methods to promote the adoption and local-context adaptation of best practices and produce similar results than collaboratives that involve face-to-face interaction. Virtual collaboratives represent a good alternative to bring quality improvement methods and evidence-based best practices at a lower cost to developing countries and to promote knowledge sharing between and across teams from different settings.

In conclusion, evidence-based interventions and a multi-country, virtual Collaborative were associated with a significant reduction in the rate of CLABSI in Latin American ICUs. These findings may be applicable for the mitigation of CLABSI across Latin American ICUs with similar characteristics.

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Chile: Hospital Regional Antofagasta

Colombia: Centro Médico IMBANACO, Clínica Bautista, Clínica Cardio VID, Clínica Medilaser SA, Fundación Santa Fé de Bogotá, Hospital Pablo Tobón Uribe, Hospital Universitario Departamental de Nariño, Servicios Especiales de Salud Hospital de Caldas

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References

1. Rosenthal VD, Rodrigues C, Álvarez-Moreno C *et al*. Effectiveness of a multidimensional approach for prevention of ventilator-associated pneumonia in adult intensive care units from 14 developing countries of four continents: findings of the International Nosocomial Infection Control Consortium. *Crit Care Med* 2012;**40**:3121–8. Available from: http://www.ncbi.nlm.nih.gov/pubmed/22975890.
2. The Joint Commission. Preventing central line—associated bloodstream infections: a global challenge, a global perspective. *Curr Surg Ther* 11/e. 2012;136. Available from: http://www.jointcommission.org/assets/1/18/clabsi_monograph.pdf%0A. http://www.jointcommission.org/assets/1/18/CLABSI_Monograph.pdf.
3. Crnich CJ, Maki DG. The role of intravascular devices in sepsis. *Curr Infect Dis Rep* 2001;**3**:496–506.
4. Rosenthal VD, Al-Abdely HM, El-Kholy AA *et al*. International Nosocomial Infection Control Consortium report, data summary of 50 countries for 2010–2015: device-associated module. *Am J Infect Control* 2016;**44**:1495–1504.
5. Rosenthal VD, Maki DG, Mehta Y *et al*. International Nosocomial Infection Control Consortiu (INICC) report, data summary of 43 countries for 2007–2012. Device-associated module. *Am J Infect Control* 2014;**42**:942–56. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0196655314008566.
6. Flodgren G, Conterno LO, Mayhew A *et al*. Interventions to improve professional adherence to guidelines for prevention of device-related infections. *Cochrane Database Syst Rev* 2013.
7. Su D, Hu B, Rosenthal VD *et al*. Impact of the International Nosocomial Infection Control Consortium (INICC) Multidimensional Hand Hygiene Approach in five intensive care units in three cities of China. *Public Health* 2015.

8. O'Grady NP, Alexander M, Dellinger EP *et al*. Guidelines for the prevention of intravascular catheter-related infections. *Am J Infect Control* 2002.
9. Lynch P, Rosenthal VD, Borg MA *et al*. Infection control in developing countries. In: Jarvis W (ed). *Bennett and Brachman's Hospital Infections*. Philadelphia, PA: Lippincott Williams & Wilkins, 2007: 255–71.
10. Rosenthal VD. Health-care-associated infections in developing countries. *Lancet* 2011.
11. Fridkin SK, Pear SM, Williamson TH *et al*. The role of understaffing in central venous catheter-associated bloodstream infections. *Infect Control Hosp Epidemiol* 1996.
12. Longmate AG, Ellis KS, Boyle L *et al*. Elimination of central-venous-catheter-related bloodstream infections from the intensive care unit. *BMJ Qual Saf* 2011.
13. Clancy CM. Eliminating central line-associated blood stream infections: progress continues on a national patient safety imperative. *J Nurs Care Qual* 2012.
14. Pronovost P. Interventions to decrease catheter-related bloodstream infections in the ICU: The Keystone Intensive Care Unit Project. *Am J Infect Control* 2008.
15. Pronovost PJ, Goeschel CA, Colantuoni E *et al*. Sustaining reductions in catheter related bloodstream infections in Michigan intensive care units: observational study. *BMJ* 2010.
16. Goeschel CA, Pronovost PJ. Harnessing the potential of health care collaboratives: lessons from the keystone ICU project. *Adv Patient Saf New Dir Altern Approaches* 2008. (Vol 2 Cult Redesign).
17. Sawyer M, Weeks K, Goeschel CA *et al*. Using evidence, rigorous measurement, and collaboration to eliminate central catheter-associated bloodstream infections. *Crit Care Med* 2010.
18. Palomar Martínez M, Alvarez Lerma F, Riera Badía MA *et al*. Prevention of bacteriema related with ICU catheters by multifactorial intervention: a report of the pilot study. *Med Intensiva* 2010.
19. Palomar M, Álvarez-Lerma F, Riera A *et al*. Impact of a national multimodal intervention to prevent catheter-related bloodstream infection in the ICU: The Spanish experience. *Crit Care Med* 2013.
20. Schulman J, Stricof R, Stevens TP *et al*. Statewide NICU central-line-associated bloodstream infection rates decline after bundles and checklists. *Pediatrics* 2011;**127**:436–44. Available from: http://pediatrics.aappublications.org/cgi/doi/10.1542/peds.2010-2873.
21. Seddon ME, Hocking CJ, Mead P *et al*. Aiming for zero: decreasing central line associated bacteraemia in the intensive care unit. *N Z Med J* 2011.
22. *10 IHI Innovations to Improve Health and Health Care*. Cambridge, Massachusetts: Institute for Healthcare Improvement; 2017. Available from: www.ihi.org.
23. Dellinger P, Garland J, Heard SO *et al* CDC Guidelines for Prevention of CLABSI. 2011
24. Gray J, Proudfoot S, Power M *et al*. Target CLAB zero: a national improvement collaborative to reduce central line-associated bacteraemia in New Zealand intensive care units. *N Z Med J* 2015;**128**:13–21.
25. *The Breakthrough Series: IHI's Collaborative Model for Achieving Breakthrough Improvement*. IHI Innovation Series white paper. Boston: Institute for Healthcare Improvement; 2003. Available from: www.IHI.org.
26. Langley, GJ. The Improvement Guide: A Practical Approach to Enhancing Organizational Performance, 1996. Print.
27. Leblebicioglu H, Rosenthal VD, Arikan ÖA *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.
28. Rosenthal VD, Ramachandran B, Villamil-Gómez W *et al*. Impact of a multidimensional infection control strategy on central line-associated bloodstream infection rates in pediatric intensive care units of five developing countries: Findings of the International Nosocomial Infection Control Consortium (INICC). *Infection* 2012.
29. Higuera F, Rosenthal VD, Duarte P *et al*. The effect of process control on the incidence of central venous catheter-associated bloodstream infections and mortality in intensive care units in Mexico. *Crit Care Med* 2005.
30. Higuera F, Rangel-Frausto MS, Rosenthal VD *et al*. Attributable cost and length of stay for patients with central venous catheter—associated bloodstream infection in Mexico City intensive care units a prospective, matched analysis. *Infect Control Hosp Epidemiol* 2007.
31. Bion J, Richardson A, Hibbert P *et al*. Matching Michigan: a 2-year stepped interventional programme to minimise central venous catheter-blood stream infections in intensive care units in England. *BMJ Qual Saf* 2013;**22**:110–23.
32. Valencia Quintero JP, Jimenez Quintana MDM, Manzano Manzano F *et al*. Impact of an educational program on decreasing central line-associated bloodstream infection in a medical intensive care unit in spain. *Intensive Care Med* 2013.
33. Sherertz RJ, Ely EW, Westbrook DM *et al*. Education of physicians-in-training can decrease the risk for vascular catheter infection. *Ann Intern Med* 2000;**132**:641–8.
34. Basinger MA The reduction of central line-associated bloodstream infections in Intensive Care Units through the implementation of the comprehensive unit-based safety program. Reduction of Central Line-associated Bloodstream Infections in Intensive Care Units Through the Implementation of the Comprehensive Unit-based Safety Program. 2014.
35. Barsuk JH, Cohen ER, Feinglass J *et al*. Use of simulation-based education to reduce catheter-related bloodstream infections. *Arch Intern Med* 2009.
36. Ullman AJ, Long DA, Rickard CM. Prevention of central venous catheter infections: a survey of paediatric ICU nurses' knowledge and practice. *Nurse Educ Today* 2014.
37. Jain M, Miller L, Belt D *et al*. Decline in ICU adverse events, nosocomial infections and cost through a quality improvement initiative focusing on teamwork and culture change. *Qual Saf Health Care* 2006.
38. Gershengorn HB, Kocher R, Factor P. Management strategies to effect change in intensive care units: Lessons from the world of business—Part I. Targeting quality improvement initiatives. *Ann Am Thorac Soc* 2014.