

RESEARCH LETTERS

The Ability of Intensive Care Units to Maintain Zero Central Line-Associated Bloodstream Infections

Central line-associated bloodstream infections (CLABSIs) are common, costly, and largely preventable and are a target of many recent national initiatives.¹⁻³ One common method of reporting performance is the duration of time without infection,⁴ a simple technique used for motivating sustained improvement. Despite evidence demonstrating reduced infection rates from evidence-based interventions for CLABSIs, the field has not yet defined the attainable duration of time hospitals can go without a CLABSI. Without understanding “best achievable” time without any infection, hospitals may anchor themselves, and public expectations, to suboptimal performance. Such data are required to establish performance benchmarks that represent best practices, create realistic public expectations, motivate internal improvement efforts, and design fair pay-for-performance policies.

The objective of this study was to explore and quantify the ability of intensive care units (ICUs) to sustain zero CLABSIs over time. This study examined data from ICUs that participated in the Michigan Keystone ICU Project (an initiative including the Johns Hopkins University Quality and Safety Research Group's Comprehensive Unit-Based Safety Program and CLABSI Program), which was associated with statewide reduction in CLABSI for up to 36 months.^{5,6}

Methods. Data for CLABSIs were obtained from 80 ICUs in 57 hospitals located predominantly in the state of Michigan. Intensive care units were eligible for this study if they reported 36 continuous months or more of data during and after implementation of the CLABSI intervention (23 of the 103 ICUs included in the original study were excluded because they did not meet this requirement).^{5,6} Up to 4 years of data (March 2004–February 2008) were available at the time of analysis (median, 45 months; interquartile range [IQR]: 42–48 months). Data for the number of central line days and CLABSIs, as defined by the National Nosocomial Infections Surveillance (NNIS) system,¹ were analyzed on a quarterly basis. However, for ease of interpretation, duration of time without an infection is reported in months, using a conservative assumption that any CLABSI occurred in the first month of a quarter.

The primary outcome was the greatest number of consecutive months with zero CLABSIs reported during the

study period for each ICU (the unit of analysis). Follow-up data were available for 36 months. Secondary outcomes were binary indicators for sustaining zero CLABSIs for 12 and 24 consecutive months for each ICU. Two hospital-level factors obtained from the American Hospital Association were included: teaching status and bed size (<200; 200–299; 300–399; and >399 beds).^{5,6}

Proportions of ICUs sustaining zero infections for 12 and 24 months were calculated for the secondary outcomes. Outcome measures were stratified by teaching status and within each teaching status by hospital bed size. We used SAS software, version 9.1 (SAS Institute Inc, Cary, North Carolina) for statistical analysis. The Johns Hopkins Medical School institutional review board approved this study.

Results. Among all 80 ICUs, the mean (SD) and median (IQR) consecutive number of months with zero CLABSIs was 16.5 (10.8) and 15 (6.0–25.5), respectively. Sixty percent of ICUs sustained zero CLABSIs for 12 months or more and 26% for 24 months or more (**Table**).

Within both teaching and nonteaching hospital categories, these outcome measures decreased as hospital bed size increased. Among teaching hospitals with more than 399 beds, 32% of ICUs went 1 year or more without a CLABSI. In general, nonteaching hospitals had a higher number of consecutive months with zero CLABSIs and a greater proportion of ICUs sustaining zero CLABSIs for 12 and 24 months compared with teaching hospitals (**Table**).

Comment. Overall, the majority of ICUs achieved 12 months or more without a reported CLABSI, and more than quarter achieved 24 months or more. These findings suggest that in the setting of a comprehensive initiative focused on reducing CLABSIs, extended periods without infections are possible; even among large teaching hospitals, one-third achieved at least 1 year without a CLABSI. As such, incentives for hospitals to implement and sustain evidence-based infection prevention initiatives appear warranted.

While self-reported infection rates were not externally validated, best practices to collect data were used (eg, collection by hospital-based infection-control practitioners, ensuring ICU anonymity, and instruction to use the NNIS definition for CLABSI⁷). The data are from a single state that participated in a focused CLABSI program, and a similar program may be necessary for others to achieve these results. However, the intervention is publicly available (<http://www.onthecuspstophai.org/>) and being implemented across 44 other states.⁸

To our knowledge, this is the first large-scale study to demonstrate the potential of ICUs to prevent CLABSIs

Table. Consecutive Months Without CLABSIs by Organizational Characteristics

Characteristic	No. of Unique Hospitals ^a	ICUs, No. (%)	Consecutive Months With Zero Infections ^b		% of ICUs With Zero Infections	
			Mean (SD)	Median (IQR)	At Least 12 mo	At Least 24 mo
Total	57	80	16.5 (10.8)	15 (6.0-25.5)	60	26
Teaching	33	53 (100)	13.5 (9.7)	12 (6.0-18.0)	51	15
No. of hospital beds						
<200	5	5 (9)	26.4 (8.3)	27.0 (18.0-33.0)	100	60
200-299	9	13 (25)	16.6 (12.0)	12.0 (9.0-18.0)	69	23
300-399	8	10 (19)	13.2 (8.0)	10.5 (9.0-15.0)	50	10
>399	11	25 (47)	9.4 (6.1)	6.0 (6.0-12.0)	32	4
Nonteaching	24	27 (100)	22.3 (10.6)	21 (12.0-36.0)	78	48
No. of hospital beds						
<200	10	10 (37)	28.2 (8.6)	31.5 (18.0-36.0)	100	60
200-299	7	7 (26)	19.3 (9.9)	18.0 (9.0-30.0)	71	43
300-399	5	6 (22)	10.5 (2.5)	9.0 (9-12)	33	0.0
>399	2	4 (15)	30.8 (6.2)	31.5 (25.5-36)	100	100

Abbreviations: CLABSI, central line-associated bloodstream infection; ICU, intensive care unit; IQR, interquartile range.

^aSome hospitals had multiple ICUs contributing data to this project.

^bMaximum possible number of consecutive months without a reported infection = 36. Data were analyzed on a quarterly (ie, 3 months except the last quarter that contained 2 months) basis and converted to months.

for a sustained period. Hospitals should strive to emulate these results and implement similar interventions.⁶ Although this study offers hope that CLABSI is largely preventable, health care lacks the scientific foundation to measure and improve other types of infections. Given the lack of progress in improving patient safety, efforts to measure and prevent health care-associated infections and other types of preventable harm should be a research and policy priority.⁹

Allison Lipitz-Snyderman, PhD
 Dale M. Needham, FCA, MD, PhD
 Elizabeth Colantuoni, PhD
 Christine A. Goeschel, MPA, MPS, ScD, RN
 Jill A. Marsteller, PhD, MPP
 David A. Thompson, DNSc, MS, RN
 Sean M. Berenholtz, MD, MHS
 Lisa H. Lubomski, PhD
 Sam Watson, MSA, MT
 Peter J. Pronovost, MD, PhD

Author Affiliations: Departments of Health Policy and Management (Drs Lipitz-Snyderman, Goeschel, Marsteller, Berenholtz, and Pronovost) and Biostatistics (Dr Colantuoni), Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland; Division of Pulmonary & Critical Care Medicine and Department of Physical Medicine and Rehabilitation (Dr Needham), Quality and Safety Research Group (Drs Goeschel, Marsteller, Thompson, Berenholtz, Lubomski, and Pronovost), and Department of Anesthesiology and Critical Care Medicine (Drs Goeschel, Marsteller, Thompson, Berenholtz, Lubomski, and Pronovost), Johns Hopkins University, Baltimore; Johns Hopkins School of Nursing, Baltimore (Drs Goeschel and Pronovost); and Michigan Health & Hospital Association, Lansing (Mr Watson).

Correspondence: Dr Lipitz-Snyderman, Quality & Safety Research Group, Johns Hopkins University, 1909 Thames St, Second Floor, Baltimore, MD 21231 (alipitz@jhsp .edu).

Author Contributions: Dr Lipitz-Snyderman had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. *Study concept and design:* Lipitz-Snyderman, Goeschel, Marsteller, Thompson, Berenholtz, and Pronovost. *Acquisition of data:* Berenholtz, Lubomski, Watson, and Pronovost. *Analysis and interpretation of data:* Lipitz-Snyderman, Needham, Colantuoni, Marsteller, and Pronovost. *Drafting of the manuscript:* Lipitz-Snyderman and Pronovost. *Critical revision of the manuscript for important intellectual content:* Needham, Colantuoni, Goeschel, Marsteller, Thompson, Berenholtz, Lubomski, Watson, and Pronovost. *Statistical analysis:* Lipitz-Snyderman, Colantuoni, and Pronovost. *Obtained funding:* Goeschel and Pronovost. *Administrative, technical, and material support:* Goeschel, Thompson, Lubomski, Watson, and Pronovost. *Study supervision:* Needham, Lubomski, and Pronovost.

Financial Disclosure: Dr Pronovost reports receiving grants from the Agency for Healthcare Research and Quality (AHRQ) and National Patient Safety Agency to reduce CLABSIs, speaking honoraria from hospitals and the Leigh Bureau, and royalties from the sale of his book on patient safety. Dr Goeschel reports receiving honoraria for speaking on quality and patient safety nationally and internationally; current contractual support through the AHRQ ACTION network; and grant support through the Robert Wood Johnson Foundation (RWJF). Previous support included grant support from the AHRQ, RWJF, and Society for Cardiovascular Anesthesia Foundation and contracts from the UK National Patient Safety Agency and World Health Organization Patient Safety Programme. Dr Berenholtz has received support from the Michigan

Health & Hospital Association, AHRQ, National Institutes of Health, World Health Organization, and RWJF for work on other studies and has received honoraria and travel expenses from various hospitals and hospital associations for consulting work related to patient safety and quality improvement. Dr Berenholtz has equity ownership in Docusys Inc that is unrelated to this study.

Funding/Support: This study was supported in part by grant 1UC1HS14246 from the AHRQ.

Additional Contributions: The Michigan Health & Hospital Association's Keystone Center and Michigan hospitals partnered in this effort to improve patient safety.

1. O'Grady NP, Alexander M, Dellinger EP, et al; Centers for Disease Control and Prevention. Guidelines for the prevention of intravascular catheter-related infections. *MMWR Recomm Rep.* 2002;51(RR-10):1-29.
2. Centers for Disease Control and Prevention's National Healthcare Safety Network. *First State-Specific Healthcare-Associated Infections Summary Data Report.* Atlanta: GA: Centers for Disease Control and Prevention; 2009.
3. Centers for Medicare and Medicaid Services (CMS), HHS. Medicare Program; hospital inpatient prospective payment systems for acute care hospitals and the long-term care hospital prospective payment system changes and FY2011 rates; provider agreements and supplier approvals; and hospital conditions of participation for rehabilitation and respiratory care services; Medicaid program: accreditation for providers of inpatient psychiatric services: final rules and interim final rule with comment period. *Fed Regist.* 2010;75(157):50041-50681.
4. Institute for Healthcare Improvement. What zero looks like: eliminating hospital-acquired infections. <http://www.ihl.org/IHI/Topics/HealthcareAssociatedInfections/InfectionsGeneral/ImprovementStories/WhatZeroLooksLikeEliminatingHospitalAcquiredInfections.htm>. Accessed August 24, 2010.
5. Pronovost P, Needham D, Berenholtz S, et al. An intervention to decrease catheter-related bloodstream infections in the ICU. *N Engl J Med.* 2006;355(26):2725-2732.
6. Pronovost PJ, Goeschel CA, Colantuoni E, et al. Sustaining reductions in catheter related bloodstream infections in Michigan intensive care units: observational study. *BMJ.* 2010;340:c309.
7. Needham DM, Sinopoli DJ, Dinglas VD, et al. Improving data quality control in quality improvement projects. *Int J Qual Health Care.* 2009;21(2):145-150.
8. Pronovost PJ. Learning accountability for patient outcomes. *JAMA.* 2010;304(2):204-205.
9. andrigan CP, Parry GJ, Bones CB, Hackbarth AD, Goldmann DA, Sharek PJ. Temporal trends in rates of patient harm resulting from medical care. *N Engl J Med.* 2010;363(22):2124-2134 L.

Reducing Heart Failure Readmissions by Teaching Patient-Centered Care to Internal Medicine Residents

Approximately 1 of every 5 Medicare patients is rehospitalized within 30 days of discharge, and heart failure (HF) is the most common reason for these readmissions.¹ Despite advances in the care of patients with HF, 30-day readmission rates have actually increased in recent years.²

We developed and implemented a patient-centered care curriculum for residents on the inpatient general medicine service that focuses on the importance of knowing patients as individuals to achieve safer transitions out of the hospital.³ We hypothesized that this curriculum would reduce 30-day rehospitalizations for patients with HF, since effective daily self-management plays an especially crucial role in avoiding the complications of this condition.

Methods. Patients were admitted for a principal diagnosis of congestive HF to the teaching general medicine ser-

vice at Johns Hopkins Bayview Medical Center between October 18, 2007, and August 31, 2009. In October 2007, the number of patients assigned to 1 of the 4 teaching service teams (each consisting of 1 faculty attending physician, 1 resident, 2 interns, and 2 basic medicine clerkship students) was reduced by half to provide trainees more time with their patients during and after hospitalization.³ The balance of patients were admitted to the hospitalist service. Patient assignment to the intervention vs a standard teaching team was based on a rotating call schedule. A patient-centered, transition-focused curriculum for this intervention team called for 3 components to be implemented for all patients: (1) a medication adherence assessment, (2) telephone call(s) to outpatient provider(s), and (3) a telephone call to each patient after discharge to assess the patient's experience of the care transition and his or her understanding of the hospital stay and plans for follow-up. Trainees were encouraged to consider how each patient's psychosocial circumstances affect medical care. In addition, the intervention team visited selected patients at home or in a nursing facility after discharge to better appreciate the patient's perspective of the transition in care.

Administrative records provided information on patient demographics, principal diagnosis, and 30-day readmissions. Team assignment was ascertained using an electronic database. The Social Security Death Index⁴ was used to identify patients who died within 30 days of discharge. This study was approved by the institutional review board at Johns Hopkins University School of Medicine.

A retrospective, quasi-experimental study design and time-to-event analysis was used to assess the primary outcome of death or readmission for HF within 30 days of hospital discharge. Kaplan-Meier survival curves were constructed to describe the probability of survival without readmission for HF during the 30-day follow-up period. The log-rank test for equality of survivor functions was used to compare survival curves. Statistical significance was set at $P \leq .05$.

Results. During the study period, HF was the principal diagnosis for 52 of 972 patients (5.3%) admitted to the intervention team and 323 of 5361 (6.0%) admitted to the 3 standard inpatient teaching teams. The mean age of patients admitted for HF to the standard teams was 71.5 years; 58% were women; and 72% were white and 26% black. There were no significant differences in these characteristics of the patients with HF admitted to the intervention team.

The rate of death or rehospitalization for HF within 30 days was 14% on the 3 standard teams (45 of 323 patients) and 4% on the intervention team (2 of 52 patients) ($P = .04$). The rate of death or rehospitalization for any diagnosis within 30 days was 32% on the standard teams (104 of 323) and 25% on the intervention team (13 of 52) ($P = .34$). The probability of survival 30 days without readmission for HF was higher for the intervention team ($P = .046$) (**Figure**). No patient admitted with a principal diagnosis of HF to the intervention team was readmitted for HF within 30 days of discharge for the last 17 months of the study period. Before implementation