State of infection prevention in US hospitals enrolled in the National Health and Safety Network

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Background: This report provides a national cross-sectional snapshot of infection prevention and control programs and clinician compliance with the implementation of processes to prevent health care–associated infections (HAIs) in intensive care units (ICUs).

Methods: All hospitals, except Veterans Affairs hospitals, enrolled in the National Healthcare Safety Network (NHSN) were eligible to participate. Participation involved completing a survey assessing the presence of evidence-based prevention policies and clinician adherence and joining our NHSN research group. Descriptive statistics were computed. Facility characteristics and HAI rates by ICU type were compared between respondents and nonrespondents.

Results: Of the 3,374 eligible hospitals, 975 provided data (29% response rate) on 1,653 ICUs, and there were complete data on the presence of policies in 1,534 ICUs. The average number of infection preventionists (IPs) per 100 beds was 1.2. Certification of IP staff varied across institutions, and the average hours per week devoted to data management and secretarial support were generally low. There was variation in the presence of policies and clinician adherence to these policies. There were no differences in HAI rates between respondents and nonrespondents.

Conclusions: Guidelines for IP staffing in acute care hospitals need to be updated. In future work, we will analyze the associations between HAI rates and infection prevention and control program characteristics, as well as the implementation of and clinician adherence to evidence–based policies.
functions outlined included surveillance of nosocomial infections, proper analysis of infection control data, capacity to detect and control outbreaks, written policies for infection control and prevention, collaboration with employee health programs, ongoing education programs, and adequate resources, including a trained hospital epidemiologist (HE), a certified infection preventionist (IP), and adequate computer and clinical microbiology laboratory support.

Despite these requirements, however, how to best organize infection prevention and control programs to help front-line clinicians deliver effective bedside care remains unclear given the contemporary context of mandatory reporting of HAIs, increased acuity of hospitalized patients, and increased incidence of multidrug-resistant organisms (MDROs) and *Clostridium difficile* infections (CDIs). Moreover, there are controversies surrounding published recommendations for important infection prevention, surveillance, and control processes. Despite high infection rates and the need to implement clinically effective processes, there remain wide gaps in knowledge that call for further study.

To fill some of these gaps, and build on our previous research, we undertook the Prevention of Nosocomial Infections and Cost Effectiveness Refined (P-NICER) study. The aims of this national study were to (1) qualitatively describe infection prevention and control in US hospitals, (2) examine the comparative effectiveness of various strategies used by infection control departments to improve clinician adherence to evidence-based practices and decrease HAIs in ICUs across the nation, and (3) examine the impact of state mandatory reporting on infection prevention processes and HAI rates. This report provides a cross-sectional snapshot of the structure and resources of infection prevention and control programs around the country, as well as clinician compliance with the implementation of processes to prevent device-associated infections. The larger P-NICER study includes all ICUs, but here we report only on adult settings.

**METHODS**

This was a mixed-methods study that included both qualitative and quantitative approaches. The qualitative results, which are reported elsewhere, informed the quantitative approach described here. Specifically, based on the qualitative results, we adapted the survey from our previous research (which was originally adapted from the SENIC study).

All hospitals, except for Veterans Affairs hospitals, were eligible to participate if they were enrolled in the National Healthcare Safety Network (NHSN). We considered opening eligibility to all hospitals nationwide, but decided against this approach because the exclusive use of NHSN hospitals maximized the quality and validity of the data collected. To enroll hospitals while protecting the confidentiality of the participating NHSN hospitals, the CDC e-mailed an invitation letter and posted it on the NHSN website. A modified Dillman technique was used for recruitment in the fall of 2011, with weekly reminder e-mails and a last chance communication. In addition, respondents were entered into lotteries, with $100 incentives to increase participation rates.

We invited the hospitals to complete a Web-based survey and join the P-NICER NHSN research group. By joining the P-NICER research group, hospitals provided the research team with access to data from the NHSN annual survey and up to 6 years (2006-2011) of ICU-level data for the device-associated module (e.g., central line–associated bloodstream infection [CLABSI] rates) and hospital-wide data for the MDRO/CDI module (data not discussed here). Data on various hospital characteristics were collected from the annual NHSN survey and the P-NICER survey, including setting (urban, suburban, rural), medical school affiliation (major, graduate, limited, nonteaching), location (northeast, midwest, south, west, other), ownership (for profit, not for profit/other), and size (captured by the number of patient days, admissions, ICU beds, specialty beds, all other beds). Hospital staffing questions asked about the use of hospitalists (yes, no, don’t know) and use of intensivists (yes, no, don’t know).

Infection prevention and control program characteristics assessed in the P-NICER survey included department to which infection prevention and control reports (medicine, nursing, other); use of electronic surveillance systems (yes, no) and if present, commercially available system or custom developed; and presence of feedback mechanism of HAI rates to senior management, physicians, and nursing units (yes, no, don’t know for each item). Detailed staffing data were elicited, including presence of a physician HE (yes, no), number of IP full-time equivalents per 100 beds, proportion of IPs with certification (none, some, all), and hours of data management and secretarial support per week. The percentage of total IP hours spent in various locations (inpatient wards, office, other) and percentage of IP time spent on various activities (surveillance, teaching, other) were assessed as well.

The adult ICUs were defined based on NHSN definitions as burns, medical, medical cardiac, medical/surgical, neurologic, neurosurgical, respiratory, surgical, surgical cardiothoracic, and trauma. The P-NICER survey inquired about the implementation of evidence-based infection prevention policies, and clinician adherence to these policies, for the prevention of device-associated HAIs for the largest ICU of each type. For CLABSI prevention, these policies included the use of an insertion checklist and 5 individual recommended evidence-based processes (i.e., monitoring hand hygiene at insertion, using maximal barrier precautions for insertion, applying chlorhexidine at the insertion site, selecting an optimal catheter site, and checking the line daily for necessity). Ventilator-associated pneumonia (VAP) prevention involved the use of a ventilator bundle checklist and the 5 processes included on most checklists (i.e., raising the head of the bed to 30-45 degrees, providing a daily sedation vacation and assessment of readiness to extubate, administering medications to prevent stomach ulcers, providing deep venous thrombosis prophylaxis, and using chlorhexidine for mouth care).

For prevention of catheter-associated urinary tract infections (CAUTIs), 4 processes were assessed: using a urinary catheter reminder or stop order, allowing nurse-initiated urinary catheter discontinuation, using portable bladder ultrasound to measure postvoid residual volume, and, for men, using condom catheters. Based on previous research showing that clinician adherence to these policies needs to be consistently high to impact HAI rates, we dichotomized these variables into those that achieved >95% adherence the last time the policy was monitored versus other (lower compliance, no monitoring, or don’t know).

Descriptive statistics for the hospital and infection prevention and control program characteristics were computed using Stata version 11 (StataCorp, College Station, TX). Cross-tabulations with the χ² or Fisher’s exact test, as appropriate, were used to examine the presence of the different evidence-based policies overall and by ICU type. In these analyses, only those ICUs with complete policy data were included. Owing to small cell sizes, clinician adherence was examined only in the medical, medical cardiac, medical/surgical, surgical, and surgical cardiothoracic ICUs. To assess the generalizability of our sample to the nation at large, the CDC compared our respondents (those who completed the P-NICER survey and/or joined our NHSN research group) with nonrespondents (nonparticipants in both the P-NICER survey and the NHSN research group) on the facility characteristics from the NHSN.
annual survey and the CLABSI rates by ICU type for the fourth quarter of 2011. All research procedures were approved by Columbia University Medical Center and RAND Corporation Institutional Review Boards.

RESULTS

Of the 3,374 eligible hospitals, 975 provided data (29% response rate) on 1,653 ICUs, and there were complete data on the presence of policies in 1,534 ICUs. Table 1 summarizes the characteristics of these facilities. The hospitals are located in all settings across the nation with the largest proportions being rural (42%), in the South (36%), nonteaching (66%), and not for profit (75%). The hospitals have an average of 52,578 annual patient-days with 11,377 admissions, 32 ICU beds, 12 specialty beds, and 182 other beds. Most of the facilities use hospitalists (n = 817; 84%) and almost one-half use intensivists (n = 480; 49%).

Table 2 presents information on the infection prevention and control programs. The majority of programs report to neither medicine nor nursing. Approximately one-third of the departments (n = 334; 34%) have an electronic surveillance system, the majority of which ranged from 27% for nurse-initiated urinary catheterization to 68% for portable bladder ultrasound. The presence of only 2 of the policies differed significantly by ICU type (P < .05); the use of optimal catheter site selection ranged from 98% in trauma ICUs to 71% in neurologic ICUs, and the use of chlorhexidine for mouth care ranged from 91% for raising the head of the bed). The presence of CAUTI policies was not as frequent (ranging from 27% for nurse-initiated urinary catheterization to 68% for portable bladder ultrasound). The use of optimal catheter site selection ranged from 98% in trauma ICUs to 71% in neurologic ICUs, and the use of chlorhexidine for mouth care ranged from 90% in burn ICUs to 50% in neurologic ICUs.

Overall, adherence to CLABSI prevention policies were widespread (ranging from 87% for checking lines daily to 97% for applying chlorhexidine at catheter insertion sites). This was followed by VAP prevention policies (ranging from 69% for providing chlorhexidine mouth care to 91% for raising the head of the bed). The presence of CAUTI policies was not as frequent (ranging from 27% for nurse-initiated urinary catheterization to 68% for portable bladder ultrasound). The presence of only 2 of the policies differed significantly by ICU type (P < .05); the use of optimal catheter site selection ranged from 98% in trauma ICUs to 71% in neurologic ICUs, and the use of chlorhexidine for mouth care ranged from 90% in burn ICUs to 50% in neurologic ICUs.

Overall, adherence to CLABSI prevention policies ranged from 37% to 71%, adherence to VAP prevention policies ranged from 45% to 55%, and adherence to CAUTI prevention policies was reported infrequently (range, 6%–27%). Table 4 reports on clinician adherence to these policies in medical, medical cardiac, medical/surgical, surgical, and surgical cardiothoracic ICUs. Adherence data are not reported for remaining ICU types owing to small sample sizes. Adherence to only 2 of the CLABSI bundle policies varied significantly by ICU type (P < .05): use of chlorhexidine at the insertion site and optimal catheter site selection. There were no differences in reported adherence to VAP or CAUTI prevention policies by ICU type.

The CDC's comparison of respondent and nonrespondent hospitals found some significant differences in characteristics. Overall, nonrespondents were smaller facilities with fewer patient-days.
The nonrespondents also had a different location profile. The nonrespondents included a higher percent of northeast, 18.8%; midwest, 37.8%; south, 36.4%; west, 20.3%; other, 1.4% versus respondents: northeast, 18.8%; midwest, 21.5%; south, 39.8%; west, 16.0%; other, 1.0%; P < .001. There were no differences between respondents and nonrespondents in medical school affiliation or ownership and, importantly, in the average CLABSI rate for each ICU type.

**DISCUSSION**

This study provides the most comprehensive examination to date of the structures and support of infection prevention and control programs in the US since the SENIC study. We analyzed inpatient infection prevention and control programs and processes in adult ICUs of almost 1000 acute care hospitals across the nation, and evaluated clinician adherence to these processes. We found considerable variation in the organization and structure of infection prevention and control programs across the nation.

In relation to staffing, we found that more than one-third of the hospitals have no certified IPs, and that the mean IP staffing ratio is 1.2 per 100 beds. Originally, the 1985 SENIC study recommended 1 IP per 250 beds. More than a decade ago, a survey of IPs recommended a staffing ratio of 0.8-1.0 IP per 100 hospital beds. We found the average IP staffing ratio exceeded these recommendations, which most likely are outdated owing to the increased complexity and responsibilities of infection prevention in hospitals today. The lack of IP certification is not consistent with the Society for Healthcare Epidemiology of America/Association for Professionals in Infection Control and Epidemiology guidelines. We previously reported that having a certified infection prevention specialist or nurse working with the IP is an important factor in IP staffing and infection control practices. In the current study, we found a double-digit percentage of IPs reporting that they had no assistant nurse or physician to help them perform their work. This finding is concerning, as lack of assistance is likely to result in increased stress, decreased productivity, and higher burnout rates for IPs.
control director was a significant independent predictor of lower MDRO HAI rates. Furthermore, Krein et al found an association between the presence of a certified IP and the use of policies aimed at reducing CLABSI. The lack of an HE in almost 50% of the hospitals is also of concern and not in keeping with current recommendations.

Our finding that on average IPs devote approximately one-half of their time in their offices and working on surveillance is consistent with data from other relatively recent surveys, and higher than the 39% of IP time estimated by a Delphi study published in 2002. Computer support and administrative and data management personnel are key components of the operations of an infection control program. In 2000, Stevenson et al surveyed 77 rural hospitals and found that one-third used software to facilitate surveillance. In a previous survey of 289 hospitals in 2007, 32% of hospitals reported having an electronic surveillance system. Our finding of 34% of hospitals using electronic surveillance systems shows a slow trend of uptake. The low average number of hours devoted to data management was surprising, given the complexity of electronic surveillance systems and the need for useful data reports to provide feedback to bedside clinicians and hospital administration.

Our finding of a high prevalence of CLABSI and VAP prevention policies but a relatively low prevalence of CAUTI prevention policies is consistent with data from surveys of 200 Californian hospitals conducted before and after implementation of mandatory reporting in the state. The relatively low uptake of CAUTI prevention policies is also consistent with that reported by Saint et al in a recently published survey of 78 Michigan hospitals and 392 non-Michigan hospitals. These findings are surprising given that CAUTI is the most frequent HAI and was the first hospital-acquired condition selected for nonpayment. Furthermore, Saint et al found greater reductions in CAUTI rates in the Michigan hospitals, which were more likely than non-Michigan hospitals to have CAUTI prevention policies in place.

Establishing policies does not ensure clinician adherence at the bedside. Previous studies have found that an extremely high rate of clinician adherence to infection prevention policies is needed to lead to a decrease in HAIs. Unfortunately, the hospitals that monitored clinician adherence reported relatively low rates of adherence. Furthermore, we found little time spent on prevention process education and some hospitals without feedback mechanisms. There is a large evidence base supporting the use of audit and feedback interventions to improve professional practice and ultimately improve patient outcomes.

Our study has some strengths and weaknesses. Although the response rate to the P-NICER survey was only moderate, this is the largest survey of acute care hospital infection prevention and control programs reported to date. Both the survey and HAI rate data were self-reported by infection control department personnel; however, given the variability across institutions and use of NHSN definitions, there is no reason to believe that this resulted in systematic bias. Furthermore, there were no differences in CLABSI rates between our respondents and nonrespondents, giving us some confidence in the generalizability of our data. Finally, we previously found high a test-retest reliability of our survey.

Based on our findings, IP staffing in acute care hospitals is not consistent with published guidelines. The Certification Board of Infection Control and Epidemiology has documented the changing role of IPs; however, there has been no subsequent update of staffing guidelines.

The United States has seen vast improvements in CLABSI rates, with impressive progress toward the 5-year targets as set out in the HAI Action Plan. In the present descriptive study, infection prevention and control program characteristics, presence of policies, and clinician adherence were not linked to actual HAI rates. Multivariate analyses are needed, and we will present these associations in future reports. Nonetheless, our present results suggest that the reduction in CLABSI rates may be a result of advances in the ability of infection prevention and control programs to fully implement evidence-based care, such as bundled care policies, to drive down CLABSI and VAP rates.

Evidence-based care bundles were first promoted by the Institute for Healthcare Improvement (IHI), which led the first campaign to save 100,000 lives or more. Campaigns such as this focused clinicians and leadership on infection prevention and resulted in increased investment in infection control and prevention programs. However, focusing on infection prevention uses limited and competing resources and requires an ongoing financial commitment by the institution. We should continue to monitor the trends to ensure continued positive outcomes.

Evidence-based practices related to CAUTI prevention have not been well implemented. The CDC’s CAUTI guidelines were not published until 2009, and, as documented in this study, hospitals across the country are at varying stages of implementing, reinforcing, and measuring the outcomes related to this set of guidelines. Clearly, more focus on CAUTIs is needed, and dissemination and implementation studies to inform how best to improve evidence-based practices should be helpful.

References


