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Major article

# Certification in infection control matters: Impact of infection control department characteristics and policies on rates of multidrug-resistant infections

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***Background:*** The study objective is to describe infection control policies aimed at multidrug-resistant organisms (MDRO) in California hospitals and assess the relationship among these policies, structural characteristics, and rates of methicillin-resistant *Staphylococcus aureus* (MRSA) or vancomycin-resistant *Enterococcus* (VRE) bloodstream infections and *Clostridium difficile* infections.

***Methods:*** Data on infection control policies, structural characteristics, and MDRO rates were collected through a 2010 survey of California infection control departments. Bivariate and multivariable Poisson and negative binomial regressions were conducted.

***Results:*** One hundred eighty hospitals provided data (response rate, 54%). Targeted MRSA screening upon admission was reported by the majority of hospitals (87%). The majority of hospitals implemented contact precautions for confirmed MDRO and *C difficile* patients; presumptive isolation/contact precautions for patients with pending screens were less frequently implemented. Few infection control policies were associated with lower MDRO rates. Hospitals with a certified infection control director had significantly lower rates of MRSA bloodstream infections ($P < .05$).

***Conclusion:*** Although most California hospitals are involved in activities to decrease MDRO, there is variation in specific activities utilized with the most focus placed on MRSA. This study highlights the importance of certification and its significant impact on infection rates. Additional research is needed to confirm these findings.



Health care-associated infections (HAI) caused by multidrug-resistant organisms (MDRO) are an important patient safety concern. Multiple studies have shown that MDRO infections are associated with greater patient morbidity and mortality, as well as increased health care costs.[1-4] Methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant *Enterococcus* (VRE) species are 2 MDRO that have presented some of the greatest challenges in the health care setting.[5,6] In fact, surveillance for and reporting of MRSA and other MDRO is currently being mandated or pending legislation in several states, underscoring the importance of these infections. In addition, although not specifically considered MDRO, infections caused by *Clostridium difficile* are associated with the frequent use of antibiotics and also result in significant patient burden.[7,8] Transmission of both MDRO and *C difficile* in hospitals has been attributed in part to inappropriate use of antibiotics and the lack of appropriate infection control measures in hospitals.[9] Infection prevention programs utilize a range of infection control measures to reduce antibiotic resistant infections in the hospital setting including isolation and contact precautions, universal or targeted active surveillance, and antibiotic restriction/stewardship programs.[10] However, there is wide variation in published recommendations on the actual use of these measures.[10-14]

This variation underscores the need to identify effective strategies, but such data are currently scant. Several recent systematic reviews have been conducted to summarize the evidence on the effectiveness of barrier/isolation precautions, active surveillance, and other infection control policies to control transmission of MDRO.[15-18] Although the reviews noted some evidence of effectiveness, all of the authors pointed to the overall poor quality and methodologic flaws of the reviewed studies.[15-18] Based on the lack of quality evidence and lack of data regarding the cost-effectiveness of these measures, many have argued against routine screening of all admissions to the hospital.[19,20]

In addition to gaps in the evidence regarding effective infection control policies directed at MDRO, there is also lack of data on the

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actual implementation of these policies in hospitals. Although several studies have been conducted on the use of different infection control practices in acute care hospitals,[21-23] the extent to which infection control strategies related to MDRO are adopted is not well described. Furthermore, there is paucity of data exploring structural (ie, hospital and infection control department) characteristics that influence MDRO and *C difficile* rates. Therefore, the aims of this study were to (1) describe the use of infection control policies aimed at reducing MDRO and *C difficile* in the State of California and (2) assess the relationship between the presence and/or correct implementation of infection control policies for MDRO, structural characteristics, and rates of BSI caused by MRSA or VRE and infections caused by *C difficile*.

We hypothesized that the presence of and increased compliance with infection control policies and several structural characteristics of the hospital and infection control department (such as teaching status, infection control staffing, and certification) would be associated with decreased rates of MRSA and VRE bloodstream infections (BSI) and *C difficile* infections.

## METHODS

Data for this study are from a large cross-sectional study of California hospitals conducted in the spring of 2010. The aim of this larger study funded by the Blue Shield of California Foundation (grant No. 2490932) was to explore the impact of mandatory reporting on the role of infection preventionists (IPs) and HAI rates. Study procedures were reviewed and approved by the Columbia University Medical Center Institutional Review Board.

### *Recruitment and enrollment*

All nonspecialty acute care facilities in California were eligible to participate in this study (N = 331). Participants were recruited by the Association for Professionals in Infection Control and Epidemiology, Inc (APIC), and the Columbia University School of Nursing research staff during an 8-week period from April to June 2010. A modified Dillman technique was used including electronic and print invitation letters.[24] Invitations were sent directly to the hospital infection prevention and control department, and the director or coordinator from each hospital was asked to complete this Web-based survey. As an incentive to participate, 8 weekly lotteries to win an APIC textbook were offered to participants who completed the survey.

### *Conceptual framework and data elements*

The conceptual framework used in this study was based on the quality of care definition developed by Donabedian.[25] It is defined as being composed of the structures, processes, and outcomes of care (Fig 1). One of the aims of this study was to assess the association among the structures, processes, and outcomes of care.

### *Structures of care*

The structures of care characteristics of interest in this study were hospital characteristics such as bed size, teaching status, setting (urban/suburban/rural), and participation in quality improvement initiatives (California Hospital Assessment and Reporting Task Force [CHART], Institute for Healthcare Improvement's (IHI) Five Million Lives Campaign, California Healthcare-Associated Infections Prevention Initiative (CHAIPI), and others). Structures of care examined also included infection control department characteristics such as IP staffing defined as the number of full-time equivalent (FTE) IPs per 100 beds, presence of a full-time and part-time physician hospital epidemiologist, total infection control staffing hours, number of IPs, proportion of IPs certified in infection control, and use of electronic surveillance systems for tracking of HAI. Respondents were also asked whether the infection control director was certified in infection control and a member of APIC or the Society for Healthcare Epidemiology of America (SHEA).

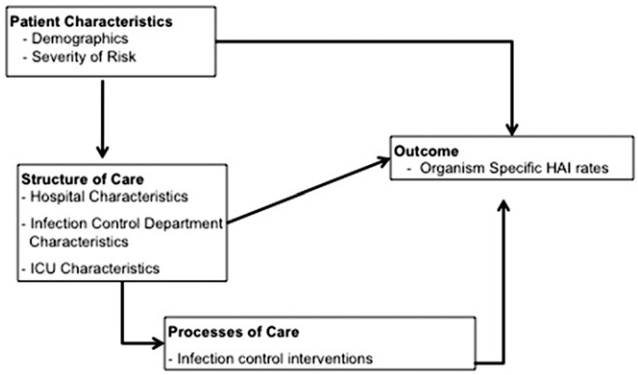


**Fig 1.** Conceptual framework based on Donabedian's definition of quality of care.

### *Processes of care*

The processes of care examined were infection control policies aimed at each of the specific organisms: (1) screening all new patients upon admission, (2) screening select patients upon admission, (3) screening all patients after admission, (4) implementing presumptive isolation/contact precautions pending results of a screen, (5) implementing contact precautions for patients with positive screens, and (6) conducting surveillance of microbiology results for new cases. Data on these policies were collected for MRSA, VRE, and *C difficile* separately. Although admission screening for *C difficile* is not a recommended practice, we wanted to investigate how prevalent this practice was in US hospitals. Respondents who indicated the presence of written infection policies for MRSA were asked about compliance with these policies. Specifically, the IPs were asked to report the proportion of time that the specific policy was correctly implemented, and the response choice available to the participants were as follows: "all of the time (95%-100%)," "usually (75%-94%)," "sometimes (25%-74%)," rarely/never (less than 25%)," "don't know," and "no monitoring." We did not collect data on how compliance with policies was assessed in the study hospitals. Questions on compliance with policies were only asked for MRSA policies to reduce respondent burden. In addition, respondents were also asked about the method used to collect MRSA surveillance cultures including standard culture, polymerase chain reaction (PCR)/other rapid diagnostic test, or MRSA selective agar. Finally, participants were asked whether the hospital promoted the use of soap and water after caring for patients with *C difficile*-associated diarrhea and whether the hospital had a policy in place regarding antibiotic restriction.

### *Outcomes of care*

The outcomes of care assessed were rates of health care-associated MRSA BSI, VRE BSI, and *C difficile* infections for the first quarter of 2010 (MRSA and VRE BSI rates per 1,000 central line-days and *C difficile* infection rate per 1,000 inpatient-days). In addition to entering the rates, respondents were allowed to select the following answer choices: "don't monitor," "prefer not to answer," and "no hospital level data." Because California hospitals were mandated to report BSI and *C difficile* rates to the National

Healthcare Safety Network (NHSN) and were therefore using NHSN definitions, we asked hospitals to provide these infection data based on NHSN definitions.

### *Statistical analysis*

Data analysis was conducted using Stata Version 11.1 (Stata Corporation, College Station, TX). Descriptive analyses included frequencies, percentages, medians, and interquartile ranges. The 3 sets of dependent variables explored in this study were health care-associated MRSA BSI, VRE BSI, and *C difficile* infection rates. The independent variables included the structures and processes of care variables described previously; the unit of analysis was the hospital. We used negative binomial regression to examine predictors of MRSA BSI rates because the variance of this outcome measure was greater than its mean indicating over-dispersion,[26,27] and an examination of the dispersion parameter $\alpha$ in the likelihood ratio $\chi^2$ test showed that the dispersion parameter differed significantly from zero, providing further evidence of over-dispersion.[27] Poisson regressions were conducted to examine predictors of VRE BSI and *C difficile* rates as the assumption of mean equal to variance was met. Expected incidence rate ratios (IRR) were calculated for all models. These IRR were calculated by exponentiating the raw coefficients in the Poisson or negative binomial models. For each variable in the model, the IRR is the estimated rate ratio comparing those with and without that characteristic, controlling for other variables in that model.

To test the hypothesis that increased intensity of infection control policies is associated with decreased infection rates, we first explored whether simply having a policy in place was associated with lower rates. Next, we explored the association between full compliance with policies defined as $\geq$95% of the time (vs other) and infection rates. For all the analysis, we first conducted bivariate regressions to identify predictors of MRSA BSI, VRE BSI, and *C difficile* infection rates. Multivariable regressions were only conducted for MRSA BSI because we lacked a sufficient sample to identify independent predictors of VRE BSI and *C difficile* rates. Those variables with *P* values $<.2$ in bivariate analysis were entered into a multivariable model to assess the independent predictors of MRSA BSI rates. Potential confounding variables were added one by one into the models, and, if the coefficient of a covariate changed by $>$10%, the variable was considered a confounder and entered into the final model.

## RESULTS

### *Hospital demographics*

In total, 203 out of 331 hospitals completed the overall survey for a response rate of 61%. Of those, 180 completed questions in the MDRO section of the survey (response rate, 54%). Not all hospitals provided MRSA BSI rates, but, among the 91 hospitals that did provide rates, the mean was 0.43 MRSA BSI per 1,000 central line-days (median, 0; range, 0-8), and the mean VRE BSI rate was 0.21 VRE BSI per 1,000 central line-days (median, 0; range, 0-3.2). Finally, the *C difficile* rate provided by 105 hospitals was 0.50 *C difficile* infections per 1,000 inpatient-days (median, 0.41; range, 0-2.3). Table 1 provides the demographic data for study hospitals. Less than half of the hospitals reported the presence of a hospital epidemiologist (n = 96, 44.8%), with a full-time hospital epidemiologist reported by only 6 hospitals (3.4%). Half of hospitals reported that the director in charge of the infection control department was certified in infection control (n = 89, 51.2%); in the majority of the cases, the infection control director was a member of APIC or SHEA. The median IP staffing ratio in the study sample was 0.53 IP FTE per 100 beds (interquartile range, 0.35-0.87).

**Table 1**
Hospital demographic data: N = 180

| | N | % |
|---|---|---|
| Teaching | 48 | 26.8 |
| Presence of hospital epidemiologist | | |
| Any | 96 | 44.8 |
| Full-time | 6 | 3.4 |
| Participation in CHAIPI | 36 | 20.0 |
| Participation in CHART | 105 | 58.3 |
| Participation in IHI | 99 | 55.0 |
| Participation in other initiative | 58 | 32.2 |
| Participation in any initiative | 150 | 83.3 |
| Infection control director certified in infection control (n = 174) | 89 | 51.2 |
| Infection control director member of SHEA/APIC (n = 175) | 157 | 89.7 |
| Electronic surveillance system (n = 179) | 53 | 29.6 |

| | Median | Interquartile range |
|---|---|---|
| Hospital bed size | 173 | 100-340 |
| Infection control director hours | 40 | 25-50 |
| No. of hospital epidemiologists* | 2 | 1-2 |
| Hospital epidemiologist hours | 4 | 1-8 |
| No. of infection preventionists | 1 | 0-2 |
| Total infection preventionist hours | 52 | 40-81 |
| Proportion of infection preventionists certified in infection control | 0.25 | 0-1 |
| No. of FTE infection preventionists per 100 beds | 0.53 | 0.35-0.87 |
| Total infection control hours (infection preventionist + director) | 94.5 | 80-137 |

*APIC*, Association of Professionals in Infection Control and Epidemiology, Inc; *CHAIPI*, California Healthcare-Associated Infections Prevention Initiative; *CHART*, California Hospital Assessment and Reporting Taskforce; *FTE*, full-time equivalents; *IHI*, Institute for Healthcare Improvement; *SHEA*, Society for Healthcare Epidemiology of America.
*Either full-time or part-time.

### *Adoption of MDRO infection control policies*

Table 2 presents data on the adoption of infection control policies aimed at MDRO in California hospitals. The vast majority of hospitals reported that a surveillance culture (n = 174, 97.2%) was collected at admission for any MDRO; the specific populations cultured included transfers from nursing homes (n = 140, 77.8%), readmissions within 30 days (n = 136, 75.6%), intensive care unit patients (n = 131, 72.8%), dialysis patients (n = 114, 63.3%), and all admissions excluding labor and delivery (n = 36, 20%). Less than one-third of hospitals reported screening all patients for MRSA upon admission (n = 52, 29.4%); however, the use of targeted screening for MRSA upon admission was reported more frequently (n = 151, 87.3%). Few hospitals reported targeted screening upon admission for VRE and *C difficile* (6.7% and 3.9%, respectively). The most frequently screened groups for MRSA included readmissions within 30 days (89.4%), transfers from nursing homes (96.0%), intensive care unit patients (86.8%), dialysis patients (76.8%), and patients with specific medical conditions (55.0%). The vast majority of hospitals reported policies to implement contact precautions for patients positive for MRSA (n = 166, 93.3%), VRE (n = 117, 65%), and *C difficile* (n = 151, 83.9%). The presence of policies for presumptive isolation/contact precautions for patients with pending screens was less frequently reported. Only one-third of hospitals had a policy regarding antibiotic restriction (n = 64, 36.4%) including the use of preapprovals, stop orders, or use of formularies.

The most frequently used method for MRSA surveillance was standard culture (36.7%), MRSA selective agar (32.2%), and PCR (23.9%). The reported compliance with MRSA infection control

**Table 2**
MDRO infection control policies in California hospitals: N = 180

| | N | % |
|---|---|---|
| Collection of surveillance culture on hospital admission for any group of patients | 174 | 97.2 |
| Screen all patients for MRSA upon admission | 52 | 29.4 |
| Target new admissions for MRSA screening | 151 | 87.3 |
| Screen all patients for MRSA periodically after admission | 5 | 2.8 |
| Screen select patients for MRSA periodically after admission | 22 | 12.6 |
| Implement presumptive isolation/contact precautions pending a MRSA screen | 61 | 34.3 |
| Implement contact precautions for patients with positive MRSA cultures | 166 | 93.3 |
| Perform surveillance of microbiology results for new cases of MRSA | 130 | 73.0 |
| Screen all new patients for VRE upon admission | 1 | 0.6 |
| Screen select patients for VRE upon admission | 12 | 6.7 |
| Screen all patients for VRE periodically after ICU admission | 1 | 0.6 |
| Screen select patients for VRE periodically after ICU admission | 2 | 1.1 |
| Implement presumptive isolation/contact precautions pending a VRE screen | 21 | 11.7 |
| Implement contact precautions for patients with positive VRE cultures | 117 | 65.0 |
| Surveillance of microbiology results for new VRE cases | 95 | 52.8 |
| Screen all new cases for *C difficile* upon admission | 1 | 0.6 |
| Screen select patients for *C difficile* upon admission | 7 | 3.9 |
| Screen all patients for *C difficile* periodically after admission | 0 | 0 |
| Screen select patients periodically for *C difficile* after admission | 2 | 1.1 |
| Implement presumptive isolation/contact precautions pending *C difficile* screen | 84 | 46.7 |
| Implement contact precautions for patients with positive test | 151 | 83.9 |
| Conduct surveillance of microbiology results for new *C difficile* cases | 119 | 66.1 |
| Promote use of soap/ water after caring for *C difficile* patient | 136 | 75.6 |
| Policy regarding antibiotic restriction | 64 | 36.4 |

*ICU*, intensive care unit.

policies varied depending on the policy: 83.5% and 81.3% of hospitals reported that the policy to implement contact precautions for patients with positive MRSA cultures and to perform surveillance of microbiology results for new MRSA cases was correctly implemented 95% of the time or more, (n = 86 and 65, respectively). Full compliance with the other infection control policies aimed at MRSA was less frequently reported by the hospitals (data not shown).

### *Predictors of MRSA BSI*

In bivariate analysis, hospitals participating in the IHI campaign and those reporting the presence of an infection control director certified in infection control had significantly lower rates of MRSA BSI (IRR = 0.30 and 0.32, *P* values = .01 and = .02, respectively). The only MRSA infection control policies significantly associated with higher MRSA BSI rates in bivariate analysis was surveillance of microbiology results for new MRSA cases (IRR = 10.02, *P* = .05). Moreover, because of the lack of variation in hospitals reporting the presence of policies for periodic MRSA screening of all patients, we were unable to assess the association between the presence of this policy and MRSA BSI rates.

In the multivariable models presented in Table 3, we assessed the association between each of the infection control policies aimed at MRSA and MRSA BSI rates, controlling for structural characteristics. The adjusted IRR for hospitals that reported the presence of a policy to screen all patients for MRSA upon admission was 10.2 times higher compared with hospitals that did not report this policy (*P* = .01). Conversely, those hospitals with a policy to target new admissions for MRSA screening showed a significantly lower MRSA BSI rates as compared with hospitals that did not report this policy (IRR = 0.03, *P* = .01), controlling for the infection control department characteristics. However, we did not see an association between the remaining MRSA infection control policies and MRSA BSI rates. The presence of an infection control director certified in infection control was a significant predictor of lower MRSA BSI rates in the first 2 models (*P* < .01, respectively). Although the last 2 models were not statistically significant using a *P* value of .05 as a cutoff, there was a trend toward statistical significance (*P* = .06 and .05, respectively). The total number of infection control hours did not have an independent effect on MRSA rates in the multivariable model, and the IP per beds staffing ratio was an independent predictor of MRSA BSI rates in only 1 model (adjusted IRR = 0.13, *P* value = .05). An examination of the association between full compliance (all of the time vs other) with infection control policies related to MRSA and MRSA BSI rates revealed no statistically significant results (results not shown).

### *Predictors of VRE BSI*

Several setting characteristics were significant predictors of lower VRE BSI rates in bivariate analysis (Table 4). Presence of a full-time hospital epidemiologist and total hospital epidemiologist hours were both highly statistically associated with higher VRE BSI rates (IRR = 11.9 and 1.03, *P* values <0.01, respectively). Participation in CHART and in any initiative were associated with lower VRE BSI rates (IRR = 0.29 and 0.22, *P* values = .01 and <0.01, respectively). Only 1 infection control policy, targeted screening of new admissions, approached statistical significance (IRR = 3.31, *P* value = .08). Because very few hospitals reported the presence of the 2 policies for periodic screening, we lacked sufficient power to assess the relationship between these 2 policies and VRE BSI rates.

### *Predictors of C difficile*

In bivariate analyses, hospitals located in rural settings showed a significantly lower *C difficile* rate (IRR = 0.41, *P* value = .05) compared with hospitals located in the urban setting (Table 4). Higher total number of infection control director hours was associated with higher *C difficile* rates (IRR = 1.02, *P* value = .05). None of the infection control policies aimed at *C difficile* were associated with *C difficile* rates.

## DISCUSSION

This study is one of the few to explore the relationship between the presence and implementation of infection control policies, structural characteristics, and rates of MDRO infections in a large group of hospitals in the United States. One of the major strengths of this analysis is a large sample of California hospitals and the use of standard NHSN definitions for health care-associated infections.[28]

This study was conducted more than a year after the institution of mandatory reporting of MRSA and VRE BSI and *C difficile* rates, as well as legislation requiring targeted screening for MRSA[29]; and the majority, but not all, hospitals (87%) reported the presence of a policy to target new admissions for MRSA screening. A survey of Los Angeles County hospitals conducted in 2008 prior to the institution of legislation for MRSA screening showed that 79% of the hospitals reported a policy for targeted screening.[30] Our data demonstrate greater adoption of this policy but indicate a definite lag between implementation of regulations and implementation of policies in the hospitals.

The data also indicate that MRSA remains the main focus of infection control programs because most hospitals reported activities aimed at preventing MRSA infections, whereas less attention

**Table 3**
Predictors of MRSA BSI rate per 1,000 central line-days in multivariable analysis: N = 36

| | Coef | *P* value | IRR* | 95% CI |
|---|---|---|---|---|
| Model 1 | | | | |
| Screen all patients for MRSA upon admission | 2.33 | .01 | 10.23 | 1.62-64.5 |
| Infection control director hours | 0.09 | .07 | 1.09 | 0.99-1.20 |
| Infection control director certified in infection control | −2.01 | <.01 | 0.13 | 0.03-0.58 |
| No. of IP FTE per 100 beds | −3.71 | .05 | 0.02 | 0.001-0.95 |
| Participation in IHI | −0.74 | .27 | 0.48 | 0.13-1.78 |
| Model 2 | | | | |
| Target new admissions for MRSA screening | −3.51 | .01 | 0.03 | 0.01-0.43 |
| Infection control director hours | 0.08 | .18 | 1.08 | 0.96-1.22 |
| Infection control director certified in infection control | −2.29 | <.01 | 0.10 | 0.03-0.39 |
| No. of IP FTE per 100 beds | −2.17 | .09 | 0.11 | 0.01-1.43 |
| Participation in CHART | 0.89 | .34 | 2.43 | 0.39-15.27 |
| Model 3 | | | | |
| Screen select patients for MRSA periodically after admission | −1.07 | .24 | 0.34 | 0.06-2.02 |
| Infection control director hours | 0.05 | .17 | 1.05 | 0.98-1.13 |
| Infection control director certified in infection control | −1.21 | .06 | 0.30 | 0.09-1.03 |
| No. of IP FTE per 100 beds | −1.43 | .27 | 0.24 | 0.02-2.95 |
| Participation in IHI | −0.73 | .26 | 0.48 | 0.14-1.71 |
| Model 4 | | | | |
| Implement presumptive isolation/contact precautions pending a MRSA screen | −0.16 | .84 | 0.85 | 0.18-4.02 |
| Infection control director hours | 0.05 | .21 | 1.05 | 0.97-1.13 |
| Infection control director certified in infection control | −1.35 | .05 | 0.26 | 0.07-1.00 |
| No. of IP FTE per 100 beds | −1.60 | .27 | 0.20 | 0.01-3.25 |
| Participation in IHI | −0.73 | .25 | 0.48 | 0.14-1.67 |

*CHART*, California Hospital Assessment and Reporting Taskforce; *CI*, confidence interval; *Coef*, coefficient; *FTE*, full-time equivalents; *IHI*, Institute for Healthcare Improvement; *IRR*, incidence rate ratio.
*All of the variables entered into the model are shown in the Table.

was placed on surveillance and control of VRE and *C difficile*. These data are consistent with results presented by Peterson et al, who also found that MRSA was the most frequently screened organism, followed by VRE, methicillin-susceptible *S aureus*, and *C difficile*.[31] Because targeted MRSA screening is mandated by the State of California, it appears that infection control departments are potentially reacting to legislation and focusing on fulfilling mandates, which may or may not be in line with the infection control priorities of their hospital. This poses a potential risk that the additional time and resources required to fulfill mandates may prevent IPs from proactively determining the most important infection control priorities in their individual setting and instituting policies aimed at these emerging issues. Additional research is needed to determine the degree to which these types of mandates are aligned with the actual needs of the hospitals and the degree to which they impact infection rates and the role of infection control personnel.

The most frequently reported methods for MRSA surveillance in our sample of hospitals were standard culture or use of MRSA selective agar reported by more than two-thirds of hospitals; PCR was used in almost one-fourth. This differs slightly from what was reported by a national study conducted by the APIC in 2006, in which only 8% reported the use of PCR methods.[21] Although the majority of hospitals were obtaining admission cultures for at least certain high-risk groups, the majority used standard cultures for which results are available only after 1 to 3 days. Importantly, because few hospitals report the use of presumptive isolation or contact precautions for patients with pending results and institute isolation only when culture results are positive, the usefulness of screening at admission is greatly diminished because these patients remain a potential reservoir for transmission.

In our study, having an infection control director who was certified in infection control was a significant independent predictor of lower MRSA BSI rates. A study conducted by Krein et al reported an association between the presence of a certified IP and use of policies aimed at reducing catheter-related BSI,[31] but, to our knowledge, this is the first study that has demonstrated a potential link between staff certification and lower MDRO rates. It is possible that infection control director certification may directly influence MRSA BSI rates through the adoption of evidence-based practices instituted by a potentially more experienced and knowledgeable director or that certification is an indicator of the overall quality of the organization and a more supportive organizational climate. The impact of certification on quality of care and patient outcomes merits further investigation.

Few infection control policies were shown to be significant predictors of infection rates in our study, which may be due to a lack of statistical power to detect small differences. In this study, we did observe a significant relationship between universal screening policies upon admission (as opposed to no active surveillance screening or targeted screening) and higher rates of MRSA BSI. This is not surprising because expanding surveillance and reporting to other areas is likely to identify additional cases and result in higher reported rates of infections.

One limitation of this study is its cross-sectional nature, which prevents us from determining temporality. Data on the timing of the policies and how long these policies were in place prior to the observation of the infection rates were not collected. An additional weakness is reliance on self-reported data regarding the presence and intensity of infection control processes and infection rates. However, collection of these data through direct observation or review of medical records would be extremely costly in time and resources and would prohibit the use of a large sample. The estimates reported in this study are likely to be, if anything, over-reported. There is a possibility of selection bias in that hospitals with high intensity of infection control processes and low HAI rates may have been more likely to participate in this study. An additional limitation is the lack of data on MDRO rates from all of the participating hospitals. However, when we compared hospitals that provided data with those that did not, there were no significant differences between the 2 groups in terms of location, participation in initiatives, or infection control staffing levels (data not shown). Although there is the possibility of slight variation in definitions of infections across settings, this variation should be minimal because this study includes only California hospitals that are mandated by

**Table 4**
Significant structural predictors of VRE BSI rates and *C difficile* infections in bivariate analysis

| | Coef | *P* value | IRR | 95% CI |
|---|---|---|---|---|
| VRE BSI (n = 91)* | | | | |
| Participation in CHART | −1.26 | .01 | 0.29 | 0.11-0.75 |
| Participation in any initiative | −1.52 | <.01 | 0.22 | 0.09-0.54 |
| Physician hospital epidemiologist hours | 0.03 | <.01 | 1.03 | 1.01-1.06 |
| Presence of a full-time hospital epidemiologist | 2.48 | <.01 | 11.9 | 2.22-63.90 |
| *Clostridium difficile* (n = 105)† | | | | |
| Setting (reference group = urban) | | | | |
| Suburb | −0.33 | .27 | 0.72 | 0.40-1.29 |
| Rural | −0.89 | .05 | 0.41 | 0.17-1.00 |
| Infection control director hours | 0.02 | .05 | 1.02 | 1.00-1.04 |

*CHART*, California Hospital Assessment and Reporting Taskforce; *Coef*, coefficient; *IHI*, Institute for Healthcare Improvement; *IRR*, incidence rate ratios.
*Per 1,000 central line-days.
†Per 1,000 inpatient-days.

law to report their BSI and *C difficile* rates to the NHSN and are therefore using NHSN definitions. Last, this study is restricted to acute care hospitals in California, which may limit the generalizability of these results.

There is still much to be learned about the factors that influence a hospital's adoption of infection control policies and rates of MDRO. This study highlights the importance of infection control certification as an important predictor of HAI rates. It also demonstrates the continued focus placed on MRSA as evidenced by policies instituted by infection control departments, potentially in response to state mandates. Also evident is the use of screening using standard culture techniques without concurrent implementation of contact precautions for potentially infected/colonized patients, which may diminish the utility of these policies. Further research is needed to confirm these findings and to generate quality data on the most effective infection prevention and control policies aimed at MDRO HAI to strengthen the evidence base and facilitate the development of more standardized infection prevention and control guidelines.

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