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Permalink

https://escholarship.org/uc/item/6q44p3km

Journal

American Journal of Infection Control, 41(2)

ISSN

0196-6553

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Publication Date

2013-02-01

DOI

10.1016/j.ajic.2012.02.017

Peer reviewed

Infection prevention practices in adult intensive care units in a large community hospital system after implementing strategies to reduce health care-associated, methicillin-resistant *Staphylococcus aureus* infections

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Background: A range of strategies and approaches have been developed for preventing health care-associated infections. Understanding the variation in practices among facilities is necessary to improve compliance with existing programs and aid the implementation of new interventions.

Methods: In 2009, HCA Inc administered an electronic survey to measure compliance with evidence-based infection prevention practices as well as identify variation in products or methods, such as use of special approach technology for central vascular catheters and ventilator care. Responding adult intensive care units (ICUs) were those considering participation in a clinical trial to reduce health care-associated infections.

Results: Responses from 99 ICUs in 55 hospitals indicated that many evidenced-based practices were used consistently, including methicillin-resistant *Staphylococcus aureus* (MRSA) screening and use of contact precautions for MRSA-positive patients. Other practices exhibited wide variability including discontinuation of precautions and use of antimicrobial technology or chlorhexidine patches for central vascular catheters. MRSA decolonization was not a predominant practice in ICUs.

Conclusion: In this large, community-based health care system, there was substantial variation in the products and methods to reduce health care-associated infections. Despite system-wide emphasis on basic practices as a precursor to adding special approach technologies, this survey showed that these technologies were commonplace, including in facilities where improvement in basic practices was needed.

Health care-associated infections (HAIs) are an ongoing problem in US health care facilities. For example, infections because of methicillin-resistant *Staphylococcus aureus* (MRSA) are especially prevalent, accounting for 75% of intensive care unit (ICU) *S aureus* infections and 60% of non-ICU *S aureus* infections.[1] This has a tremendous impact on patients, with invasive MRSA causing an estimated 19,000 deaths and 278,000 hospitalizations in 2005.[2] In addition, there are approximately 250,000 catheter-related bloodstream infections because of all microorganisms per year, with 80,000 infections occurring in ICUs.[3] Complications of catheter-related bloodstream infections include prolonged ICU and hospital stays and increased morbidity and mortality with an estimated 30,000 deaths per year.[3,4]

As a result, there has been considerable pressure to reduce HAIs. Common practices include the implementation of strategies aimed at a particular organism, such as MRSA. MRSA prevention strategies range from "active screening"—actively culturing the anterior nares

of patients on admission to ICUs—to the implementation of contact precautions for all MRSA-positive patients[5] and to the use of various topical or systemic antimicrobial agents to "decolonize" MRSA-positive carriers and thereby prevent subsequent MRSA infection. Whereas strategies that specifically target a particular organism like MRSA are widely accepted, many now question whether universal strategies that impact all pathogens may be more effective, such as the use of universal chlorhexidine gluconate (CHG) bathing in place of usual soap and water baths for all patients.[6-8] This is particularly relevant because of rising numbers of other antibiotic-resistant pathogens, such as multidrug-resistant gram-negative bacilli, as well as the limits to hospital resources dedicated to infection control and prevention. In addition, there is the ever-present interest in special products, such as impregnated central lines and antiseptic patches, which promise to help reduce infections but are more costly than traditional products.

Evidence supports all of these approaches, from active screening to decolonization to universal pathogen control, as potential strategies for reducing HAIs. However, there is still a lack of baseline information of current practices. There have been few surveys of infection prevention practices and compliance with recommendations, and these studies have shown a high amount of variation in compliance based on local practices.[9-12] Additional study to understand the variation that exists in current practices will be necessary to both evaluate current recommendations and inform comparative effectiveness studies that will guide future HAI prevention practices. National pressure to adopt a single strategy is mounting, and thus an assessment of current practices would greatly inform the field.

This paper presents a survey of the practices present in subset of ICUs in a large, national hospital system. Most of these ICUs are within community hospitals, which provide the majority of hospital care in the United States.[13] This survey of practices in these ICUs provides valuable insight into the adherence to evidence-based practices as well as the variation in products and processes used. The information from this survey provides a snapshot of current practices that will ultimately guide investigation into the clinical effectiveness of strategies to reduce HAIs because of MRSA or other organisms.

METHODS

Setting

HCA Inc is one of the largest health care systems in the United States. HCA-affiliated facilities (collectively referred to as HCA) currently include 166 hospitals, 116 outpatient surgery and endoscopy centers, and over 400 physician practices in 23 states and England. HCA facilities provide nearly 5% of major hospital services in the United States. These facilities range from academic health centers and tertiary-referral hospitals to general community and critical access hospitals and serve a highly diverse patient population.[14] There are approximately 1.5 million adult admissions to all HCA hospitals annually, with nearly 250,000 patients (15%) admitted to adult ICUs.

Evidence-based practice bundles from the Society for Healthcare Epidemiology of America compendium[15] and Institute for Healthcare Improvement 5 Million lives campaign[16] as well as an internally developed program,[17] referred to as the MRSA "ABCs," had been implemented in all HCA facilities prior to the survey. The MRSA "ABCs" were implemented in 2007 and involved active MRSA surveillance of high-risk patients, use of barrier precautions, promotion of hand hygiene and disinfection, recruitment of executive champions, and patient empowerment.[17]

Survey methods

An electronic survey of adult ICUs was administered to assess the consistency of practices surrounding the prevention of HAIs. The survey was requested of hospitals that indicated interest in participating in a clinical trial to reduce HAIs because of MRSA, excluding those facilities that did not have an ICU, were specialty care/psychiatric facilities, or were dedicated children's hospitals (n = 13). In addition, those ICUs in which routine CHG bathing was standard practice for more than one third of patients were excluded from the survey as an initial screen because this intervention was in direct conflict with the proposed clinical trial. Whereas this threshold would include mixed medical/surgical populations where CHG bathing for cardiovascular surgery is the standard of care, a total of 35 hospitals did not participate because of pre-established use of CHG cloths in the ICU.

This survey was designed with several parts: (1) hospital and ICU characteristics, including type, number of admissions, and average length of stay; (2) self-assessment of average compliance with basic infection prevention processes; (3) MRSA prevention strategies in use, including screening, isolation, and decolonization; (4) environmental cleaning practices; and (5) use of special approach technology for prevention of central line and ventilator-associated infections.

Survey questions were sent in September 2009 to infection preventionists and ICU nursing directors, who jointly responded for each adult ICU location using an electronic SurveyMonkey based tool (SurveyMonkey, Palo Alto, CA). Survey results were downloaded into Microsoft Excel (Microsoft Corp, Redmond, WA) for tabulation after validating responses for nonstandard and free text responses.

RESULTS

Respondent hospital and ICU characteristics

Survey responses were obtained from 99 adult ICUs in 55 hospitals. The majority of these hospitals were community based; 5% were major medical teaching hospitals. Hospitals were located across 16 states with an average licensed bed size of 288 (range, 67-875; median, 257) and an average daily census of 163 (range, 13-537; median, 157). Average annual admission was 12,023 (range, 1,459-37,478; median, 12,005). Bed size and geographic distribution are presented in Table 1. The geographic distribution reflects both the wide geographic range as well as a large number of HCA facilities in Florida and Texas. Classification of the 99 adult ICUs are presented in Table 1. Annual admissions for these ICUs averaged 1,695 (range, 161-4,689; median, 1,299).

Self-assessment of compliance with infection prevention practices

The median self-reported compliance rate across ICUs for basic infection control practices was 90% (range, 50%-100%) for hand hygiene, 90% for central line-associated bloodstream infections (CLABSI) practice bundles (range, 30%-100%), and 90% for ventilator bundles (range, 30%-100%). Compliance less than 80% was reported in 22% (22) of ICUs for hand hygiene, 15% (15) of ICUs for CLABSI practice bundles, and 16% (16) of ICUs for ventilator bundles. Validation of compliance was not performed.

Patient bathing occurred daily in 98% of ICUs, with 7.9% using CHG bathing products. Oral care of ventilated patients occurred once daily in 18% of ICUs, twice daily in 5%, every 4 hours in 22% and every 2 hours in 35%. Of all ICUs, 6.5% used CHG-based oral care; the others used a variety of other oral care products that did not include CHG.

Table 1
Respondent hospital and ICU characteristics

	Number of facilities	Percent of facilities
Total hospitals responding	55	
Hospital bed size		
6-24	0	0
25-49	0	0
50-99	4	7
100-199	14	25
200-299	15	27
300-399	12	22
400-499	5	9
500+	5	9
Hospital geographic region (AHA)*		
Mid-Atlantic/NE	1	2
S Atlantic	28	51
E North Central	0	0
E South Central	4	7
W North Central	5	9
W South Central	12	22
Mountain	3	5
Pacific	2	4
Total ICUs responding	99	
ICU classification		
Medical/surgical	70	71
Medical cardiac	10	10
Cardiothoracic surgery	15	15
Other (Neurosurgery, trauma and respiratory)	4	4

AHA, American Hospital Association.
*AHA-defined regions: New England: CT, MA, ME, NH, RI, VT; Mid-Atlantic: NJ, NY, PA; South Atlantic/associated territories: DC, DE, FL, GA, MD, NC, SC, VA, WV, Puerto Rico, Virgin Islands; East North Central: IL, IN, MI, OH, WI; East South Central: AL, KY, MS, TN; West North Central: IA, KS, MN, MO, ND, NE, SD; West South Central: AR, LA, OK, TX; Mountain: AZ, CO, ID, MT, NM, NV, UT, WY; Pacific/associated territories: AK, CA, HI, OR, WA, American Samoa, Guam, Marshall Islands, Northern Mariana Islands. All states within a given region may not be represented in data.

Table 2
MRSA isolation precautions and use of antimicrobial products in adult ICUs

Practices	% Performing practice
MRSA contact precautions practice	
Active surveillance screening on admission to ICU	100
Contact precautions if MRSA	99
Private room whenever possible	94
Cohort patients with same MDRO	34
Glove use	100
Gloves to enter room	86
Gloves only if patient contact anticipated	14
Gown use	100
Gown to enter	76
Gown only if patient contact anticipated	24
Masks used for all MRSA+ patients	29
Masks used in patients with respiratory symptoms	32
Use of disposable patient care equipment	87
Have a policy for discontinuing precautions	68
Use of antimicrobial products	
Antimicrobial CVC dressings	
Biopatch CHG dressing	34
3M Tegaderm with CHG	15
Algidex (silver) dressing	32
Total use of antimicrobial CVC dressing	81
Antimicrobial CVC	
CHG-silver coated CVC	44
Minocycline/rifampin CVC	7
Silver/platinum CVC	10
Antimicrobial heparin coated CVC	8
Total use of antimicrobial CVCs	69
Use of both antimicrobial catheter and CVC dressing	20

MRSA prevention strategies

Compliance with contact precaution practices for MRSA is provided in Table 2. Active surveillance for MRSA colonization occurred for 100% of ICU direct admissions or transfers because of implementation of the HCA MRSA "ABC" initiative. Nares screens for active surveillance were taken within 24 hours of admission. The prevalence of MRSA in adult ICUs averaged 22% (range, 6.9%-43.9%) based on analysis of microbiology testing for colonization and infection.

Body sites screened for MRSA were predominantly bilateral nares (85%) or unilateral nares (15%). Other sites also assessed for MRSA colonization included wounds (12%), axilla (2%), and groin (1%). In addition to nares screen at ICU admission, 3% of ICUs routinely repeated screens for patients with at least a 14-day stay. Nares are the most common site to detect MRSA carriage. Screening other body sites and repeat screening are recommended for enhanced control efforts where colonized patients would not be identified by nares testing alone.[18]

Contact precautions are enhanced strategies intended to prevent transmission of infectious agents, which are spread by direct or indirect contact with the patient or the patient's environment. Recommendations for health care personnel caring for patients on contact precautions are to wear a gown and gloves for all interactions that may involve contact with the patient or potentially contaminated areas in the patient's environment.[5] As reported in Table 2, 86% of responding ICUs standardized the wearing of gloves upon entry to the patient's room, and 76% standardized the wearing of gowns upon room entry. The remainder permitted barrier protection selection based on anticipated contact with the patient or their immediate environment. Masks are not recommended as a routine prevention strategy to prevent transmission[5] but are recommended for splash-generating procedures, respiratory exposure, and to prevent transmission from heavily colonized sources such as burns. Approximately one third of facilities implemented routine mask use as a standard of practice to minimize exposure of health care personnel in ICUs based on MRSA-positive status, patient symptoms, and tasks performed (Table 2). Although private rooms are preferred, cohorting MRSA-colonized patients is acceptable.[5,13] Discontinuing contact precautions remains an unresolved issue,[5,19] and 68% reported having a policy for discontinuing contact precautions.

In accordance with current recommendations against routine decolonization,[5,19] only 5% of surveyed ICUs regularly decolonized all MRSA-positive patients. Forty percent of ICUs performed targeted decolonization, mostly in MRSA-positive patients prior to cardiovascular surgery in accordance with current recommendations.[5,19,20] When presurgical decolonization was performed, it mainly consisted of mupirocin in cardiovascular surgery patients and was observed with high compliance (range, 80%-100%). Variation in the consistency of decolonization among patients within a single ICU was dependent on the unit-based ICU surgical population (ie, dedicated surgical cardiothoracic ICU or a mixed unit where a subportion of patient were surgical cardiothoracic). In addition, for ICU patients undergoing a surgical procedure, 45% of surgical ICUs routinely gave CHG preoperative baths to 80% to 100% of surgical patients, and 21% of surgical ICUs gave CHG preoperative baths to 10% to 50% of surgical patients.

Although 65% of protocols for MRSA-positive patient were initiated by physician preference, there was variation in decolonization regimens used and duration of therapy because of the patient population in a particular ICU. When decolonization was performed, the most common regimen was mupirocin alone for 3 to 7 days (regimen reported by 43% of ICUs). CHG bathing for 1 to 10 days plus mupirocin for 3 to 7 days was the regimen reported by 35% of ICUs. Finally, CHG bathing for 10 days plus 10 days mupirocin plus oral antibiotics was the regimen reported by 5% of ICUs.

Environmental cleaning

The majority of surveyed adult ICUs (90%) routinely used a quaternary ammonium-based product for terminal cleaning at discharge. Diluted bleach and phenolic-based disinfectants were utilized by the remainder. In addition, 32 (32%) of ICUs reported special practices for isolation precaution rooms at terminal cleaning. Among these, 91% reported changing privacy curtains, and 71% discarded unused disposable supplies.

Use of special products and technology

For skin antisepsis prior to central line insertion, 88 (90%) ICUs used a CHG plus alcohol product $\geq$ 90% of the time, 6 (6%) primarily used CHG plus alcohol 70% to 80% of the time, and 5 (4%) routinely used an antiseptic other than a CHG base. Antiseptic solutions were available in prepackaged vendor kits or individually picked supplies.

The use of special approach technologies are reported in Table 2. Most ICUs (81%) used an antimicrobial dressing, and 69% reported use of an antimicrobial impregnated central line. One in 5 ICUs (20%) used both. The percent purchase volume of antimicrobial-impregnated central venous catheters (CVCs) increased from 67% in 2005 to 79% in 2009 for HCA company wide. Of note, peripherally inserted central catheters with impregnated antimicrobial agents were not available at the time of this survey.

Use of antimicrobial products was substantial even in ICUs that reported needing improvement in basic practices (Table 3). Among ICUs reporting less than 80% compliance with hand hygiene, 77% (17) routinely used antimicrobial CVC dressings, and 59% (13) routinely used antimicrobial catheters. Similarly, among ICUs reporting less than 80% compliance with CLABSI bundles, 80% (12) routinely used antimicrobial CVC dressings, and 73% (11) routinely used antimicrobial catheters. Use of special products did not appear to be different among groups reporting high versus low compliance with basic practices.

DISCUSSION

Evidenced-based protocols have been shown to reduce HAIs, resulting in an elimination of as many of 65% to 70% of cases of CLABSIs and catheter-associated urinary tract infections (CAUTIs), and up to 55% of cases of VAPs and SSIs.[21] Consequently, there have been increased demands for evidence-based infection control practices to both improve patient care and meet external pressures from state requirements and the Centers for Medicare and Medicaid Services,[22] yet there are few data regarding how well these programs have been incorporated into local workflows or the variety that exists among various facilities. To understand better these issues, we surveyed 55 hospitals regarding the use of previously established infection control programs in the ICU. We found that there was variability in infection prevention and control measures and that the use of special approaches and technologies was not always subsequent to the full implementation of basic evidence-based practices.

Implementation of evidence-based practices has been shown to reduce HAIs,[17,18,23-25] and, therefore, consistent use of these basic practices (Table 2) should precede the deployment of technology solutions. This is in agreement with the Society for Healthcare Epidemiology of America Compendium guidance that recommends special approaches and technology only if CLABSI rates remain unacceptably high despite implementation of basic practices.[15] This survey revealed variation in compliance with infection prevention practices. Compliance with active surveillance, hand hygiene, and use of gloves and gowns was consistent; however, there remains

Table 3
Use of antimicrobial special technologies by hospital characteristics and basic practice compliance

	Antimicrobial CVC dressing use, % (n/N)	Antimicrobial catheter use, % (n/N)
Hospital/ICU characteristics		
Hospital bed size		
<200	21 (4/19)	47 (9/19)
200-299	48 (14/29)	62 (18/29)
300+	33 (17/51)	69 (35/51)
Hospital geographic area		
Mid/South Atlantic	22 (12/54)	67 (36/54)
Central	49 (18/37)	70 (26/37)
Mountain/Pacific	63 (5/8)	0 (0/8)
ICU classification		
Medical/surgical	32 (22/68)	56 (38/68)
Medical cardiac	40 (4/10)	80 (8/10)
Cardiothoracic surgery	40 (6/15)	73 (11/15)
Other*	50 (3/6)	83 (5/6)
Compliance with basic practice		
Hand hygiene compliance		
Low (0%-79%)	77 (17/22)	59 (13/22)
High (80%-100%)	88 (68/77)	66 (51/77)
CLABSI bundle compliance		
Low (0%-79%)	80 (12/15)	73 (11/15)
Moderate (80%-90%)	82 (50/61)	61 (37/61)
High (>90%)	100 (23/23)	61 (14/23)

*Neurosurgery ICU, trauma ICU.

room for improvement. The observed variation appeared to be a product of local practices and culture and may have contributed to the high reliance on special approach technologies.

Whereas technology may appear to be a quick solution to the problem of HAIs, it should be considered a special approach and implemented only after assuring consistent, high compliance with basic, evidence-based practices. We found that antimicrobial catheters and CVC dressings were highly used regardless of compliance level with basic practices. Further research would be valuable to understand the reasons behind the use of these antimicrobial products to understand whether guidance is being followed. For example, among ICUs with lower compliance with basic practices, we do not know whether antimicrobial technologies were adopted in lieu of improving basic practices in response to elevated CLABSI rates. Similarly, we do not know whether ICUs with high compliance with basic practices adopted antimicrobial technologies preventatively or in response to elevated rates. Discussion with individual hospitals revealed that local pressure from management—because of reduced reimbursement for HAIs and increased public reporting—drove some facilities to adopt technology before assessing compliance with basic practices. External pressures, from reporting requirements to intense marketing campaigns, in combination with the inherent challenges associated with changing behaviors and culture, has increased the interest in special approach technologies. Accordingly, there is an overall need to emphasize adherence to evidence-based practices and the appropriate use of technology.

The ICUs participating in this survey were encouraged to utilize programs previously shown to be associated with high compliance with basic practices, including guidance from experts in infection prevention, education, ownership and execution by clinicians at the local level, using "bundles" of care, data-driven tools to assess impact and to provide feedback to clinicians, and improvement of the safety culture.[26] Although support for these processes exists in the surveyed ICUs, additional efforts will be necessary to further increase compliance and reduce variation. This will be promoted through the development of reliable processes in combination with effective tools for teamwork and communication to achieve a culture of safety. The goal is for the integration of patient safety

and teamwork with evidenced-based interventions to reduce variation and achieve sustained improvement.

The major limitation of this survey is the self-reported nature of the survey data. Compliance with evidence-based processes was not validated. However, a parallel tracking of hand sanitizer and disposable gown orders—indirect indicators for hand hygiene and barrier precautions, respectively—showed dramatic increases in these process measures related to reported compliance with evidence-based practices.[23] In addition, the use of chlorhexidine bathing and MRSA decolonization may be underestimated because this survey was undertaken by hospitals responding to a request for participation in a trial that required minimal use of these agents. The use of CHG based products is a considered a special approach and was known to be a study exclusion criteria which resulted in a lower practice prevalence.

CONCLUSION

The move toward public reporting mandates and changes in reimbursement, such as value-based purchasing, has dramatically increased hospital and public awareness to around HAI prevention. Rigorous adherence to evidenced-based interventions and appropriate use of technology can significantly impact HAI rates, but compliance with these measures varies greatly among facilities. Therefore, the quest to eliminate HAIs will require the development of effective strategies and action plans that can be implemented at the facility level while taking into account local resources and culture.

Acknowledgment

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