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HEALTHCARE ASSOCIATED INFECTIONS (G BEARMAN AND D MORGAN, SECTION EDITORS)

Hospital-Acquired Infections Under Pay-for-Performance Systems: an Administrative Perspective on Management and Change

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Abstract

Purpose of Review The purpose of this review is to explore the impact of hospital-acquired infection on payment under pay-for-performance systems, and provide perspective on the role of administrators in infection prevention.

Recent Findings Hospital-acquired infections continue to pose a serious threat to patient safety and to the fiscal viability of healthcare facilities under pay-for-performance systems. There is mixed evidence that use of pay-for-performance systems leads to prevention of hospital-acquired conditions. Use of evidence-based guidelines has been shown to reduce hospital-acquired infections.

Summary Increasing use of pay-for-performance (PFP) systems results in potential loss of reimbursement for healthcare organizations that fail to prevent hospital-acquired infections (HAI). Healthcare administrators must work with front-line providers and infection control staff to establish and maintain evidence-based infection prevention policy. Additionally, infection control policy should be regularly updated to reflect best practices, and proper change management techniques should be employed in order to mobilize and empower staff to increase their ability to prevent hospital-acquired infections.

Keywords Hospital-acquired infection · Change management · Pay for performance · Healthcare administration · Healthcare management · Alternative payment models · Hospital-acquired condition · CMS · Medicare reimbursement · Medicaid reimbursement · Hospital reimbursement · Nosocomial condition · CLABSI · Kotter method · Kotter change management · Preventing hospital infection · Infection prevention · Hospital management · Organizational change · CMS payment · Infection prevention program · Horizontal vs vertical intervention · Horizontal infection control · Vertical infection control

Introduction

The implementation of pay-for-performance (PFP) systems in healthcare means opportunity and challenge for administrators and clinicians seeking to improve healthcare delivery. In many systems, the prevention of hospital-acquired infections (HAI) is an increasing focus of research and resources, not only to prevent adverse patient outcomes but to avoid financial penalization under new PFP systems. This article discusses the current PFP environment, the importance of hospital infection prevention (HIP) programs, the five most common HAIs, use of vertical and horizontal interventions, and the role of administration in establishing and maintaining evidence-based policies to optimize clinical care and financial performance in an inpatient setting. Finally, we will provide an example of a new infection prevention technology with corresponding sample change implementation plan following the Kotter Change Management Model [1•].

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Background

Hospital-acquired infections (HAI) represent a public health issue across the continuum of care, and are a particularly costly problem in an inpatient hospital setting. Studies estimate an incidence of approximately 440,000 HAIs per year in an adult inpatient population with an associated annual cost of $9.8 billion [2••]. Out of all patients hospitalized on any given day, roughly 1 in 25 will contract a hospital-acquired infection [3•]. The problem is pervasive, and research suggests the majority of these infections are preventable. Hospital administrators play a pivotal role in reducing HAIs given their managerial responsibilities to allocate resources and establish goals for their facilities. In an increasingly complex healthcare environment, it is important for hospital administrators to work closely with clinicians and epidemiologists to ensure the implementation of current evidence-based guidelines and to maintain strong infection control programming.

Pay-for-Performance in Healthcare

Pay-for-performance programs use financial consequences to incentivize or deter behaviors of healthcare providers and facilities. The PFP system links each payment to the performance of a healthcare facility, commonly in comparison to established benchmarks in quality and safety. PFP is on a spectrum of new payment systems known as alternative payment methods (APM). These APMs continue the departure from traditional fee-for-service (FFS), increasingly shifting financial risk to hospitals for each episode of care. The goal of PFP programs, and other APMs such as capitation and bundled payments, is to focus providers on the health outcomes of patients rather than on the rate of services provided. As pointed out by Kondo and his colleagues in their 2016 paper, *Implementation processes and pay for performance in healthcare: a systematic review*, "APMs are intended to motivate high value care and improved patient outcomes whereas FFS primarily promotes higher service volume." [4].

The Center for Medicare and Medicaid Services (CMS) continues to enact payment policies tying reimbursement to quality through three programs affecting payment for inpatient services—the hospital readmissions reduction program, the Value-Based Purchasing (VBP) Program, and the Hospital-Acquired Condition (HAC) Reduction Program. These payment policies further support the strategy of rewarding providers for the quality of care through the use of financial incentives and disincentives. The VBP program adjusts inpatient hospital payments based on performance over a range of different measures related to patient outcomes, processes of care, patient experience, and costs of care. The HAC program reduces reimbursement by 1% for those hospitals with performance falling in the worst 25% of hospitals for identified HAC metrics [5].

Some success in PFP programing has been observed when targeting HAIs. For example, hospitals participating in PFP programs for four or more years have on average 3.13 fewer central line-associated bloodstream infections (CLABSIs) per year compared to those participating for less than 4 years [6]. Waters and colleagues also found that an initial 2008 version of CMS's HAC penalty program resulted in the reduction of CLASBI and catheter-associated urinary tract infection (CAUTI) occurrences, but a similar study that examined this CMS policy on a smaller sample of hospitals did not find comparable results [7•, 8]. This points to inconsistency in PFP's reported effectiveness in producing better outcomes in healthcare. Although more evidence is needed to support the effectiveness of PFP, it is likely that reimbursement methods will continue to include incentives intended to reward high-quality care and penalize hospitals for preventable adverse events.

Introduction to Hospital Infection Prevention Programming

Although limited evidence exists on the influence of PFP on HAIs, the goal of reducing hospital-acquired infections resonates with hospital administrators and clinicians as they seek to manage the costs of healthcare delivery and improve patient outcomes from care. To meet the expectations of safety and quality in a complex and challenging healthcare delivery environment, an adequately-staffed hospital infection prevention program is necessary. A major development in hospital infection prevention was the paradigm shift from HAIs as inevitable consequences of hospitalization to the view that every HAI is potentially preventable [9]. Further, there has been a shift from the descriptive and analytic practice of infection control to the more active and process-driven goal of infection prevention.

Following the development of surveillance and outbreak response systems, hospital infection control programs have significantly expanded in depth and scope over the last 30 years. Critical elements of modern, academic infection prevention programs include advancing the signs of infection prevention, wide-scale implementation of best practices, mandatory public reporting, emergency preparedness, and antimicrobial stewardship [10]. To accomplish these goals, infection prevention programs require adequate staffing, robust information technology, and proper funding. Funding must not only cover all essential elements of infection prevention programs, but should also shield physician epidemiologists from the competing pressure of clinical revenue generation [10]. Last, robust infection prevention programs must be backed by hospital senior leadership so that interventions and process changes are implemented with reliability and accountability.

Introduction to Five HAIs Tracked by CMS

The CMS HAC Reduction Program assigns scores to participating facilities based on established criteria used in reporting hospital quality indicators through Hospital Compare on-line reports. The five HAIs assessed by CMS are CLABSI, CAUTI, Surgical Site Infection (SSI), Methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia, and *Clostridium difficile* Infection (CDIF). These five HAIs are given considerable weight in determining hospital reimbursement under PFP. Additionally, the failure to manage these five HAIs results in preventable costs to the hospital and, most importantly, preventable harm to the patient.

CLABSIs are among the costliest HAIs to treat at approximately $45,814 per case [2••]. CLABSI results in prolonged hospital stays, significant morbidity, and increased risk of mortality [11]. As noted above, CLASBI is also one of the indicators monitored by CMS and, thus, can negatively affect hospital reimbursement for associated services performed during an episode of care.

CAUTIs are the most common HAI, and over 75% of all urinary tract infections detected in a hospital may be traced to the use of a catheter [3•]. Over 13,000 deaths per year are associated with CAUTIs, and the occurrence of these infections is associated with increased costs of care, complications, and length of stay [5]. Estimates of the average attributable costs of CAUTI range from $749 to $832 per case [3•]. On an aggregate national basis, CAUTIs are estimated to contribute $390 million to $450 million annually to US hospital costs [12].

SSIs also contribute significantly to morbidity and mortality, and their economic impact is substantial. The costs attributable to SSI are $11,087 to $29,443 per case and these infections make up the largest percentage of total HAI costs at 33.7% per year, in aggregate approximately $3450 million per year [2••, 3•].

Hospital-acquired CDIF infection also has a substantial effect on patient outcomes and hospital costs. CDIF results in significantly prolonged hospital length of stay independent of baseline risk of mortality. Additionally, CDIF cases add approximately $9118–$13,574 of costs per case, can be challenging to treat, and are prone to relapse [13].

The discussion below examines key clinical guidelines, policies, and procedures that administrators and clinicians could implement to reduce incidence of HAIs in their hospitals so as to avoid preventable costs and improve healthcare outcomes for patients.

Central Line-Associated Bloodstream Infection

The prevention of central line-associated infections is backed by high-quality data in favor of a bundled risk reduction approach [14••]. The creation of a central line insertion checklist, which assures standardization in catheter insertion has resulted in significant CLABSI risk reduction [15, 16]. Standardization in catheter maintenance through the use of chlorhexidine-impregnated catheter dressings and the use of alcohol-impregnated port protectors (AIPP) has further reduced the risk of CLABSI [14••, 17].

In addition, the employment of patient bathing with chlorhexidine gluconate results in a therapeutic intervention which decreases patient bacterial bioburden and further decreases the risk of CLABSI. One survey of US hospitals found daily bathing with chlorhexidine-impregnated washcloths significantly reduced the risks of acquisition of MDROs and development of hospital-acquired bloodstream infections [18]. Hospital administration plays an important role in supporting the education, systems, structures, and accountability needed to implement and sustain CLABSI risk reduction mechanisms. In the "Change Implementation" section of this article, an example of one unit's switch from manual disinfection to AIPP illustrates the importance of organized change management in preventing infection.

Catheter-Associated Urinary Tract Infection

Much like CLABSI reduction, minimizing the risk of catheter-associated urinary tract infection requires a standardized approach. Best practices for CAUTI risk reduction are summarized in the Centers for Disease Control (CDC)/Society of Healthcare Epidemiology of America (SHEA) compendium of strategies to prevent healthcare-associated infections in acute care hospitals [14••].

In addition to standardized processes for catheter insertion and maintenance, limiting the unnecessary use of urinary catheters results in a significant reduction in CAUTIs. A key strategy for reducing unnecessary catheter use involves daily charting of catheter use and the use of the electronic medical record to generate automatic 48 or 72 h discontinuation orders that must be formally overridden by the medical team [19]. In addition, the use of biocide impregnated urinary catheters, such as silver-coated or nitrofurazone-impregnated urinary catheters, may further decrease risk of CAUTI [20]. Investments in information technology, along with the development of processes and mechanisms for standardization and reliability in catheter insertion, maintenance, and discontinuation are critical.

Surgical Site Infections

The reduction of surgical site infections requires broad collaboration across the disciplines of infection prevention, surgery, anesthesia, and perioperative nursing. Key interventions include administering antimicrobial prophylaxis according to evidence-based standards and guidelines, not removing hair at the operative site unless the presence of hair will interfere with the operation, using clippers instead of razors when hair removal is necessary, controlling perioperative blood glucose, maintaining perioperative normothermia, optimizing tissue oxygenation by administering supplemental oxygen during and immediately following surgical procedures, using alcohol-containing preoperative skin preparatory agents if no contraindication exists, using impervious plastic wound protectors for gastrointestinal and biliary tract surgery, using a checklist based on the WHO checklist to ensure compliance with best practices for surgical patient safety, and performing surveillance with feedback for SSI and risk factor reduction-related process of care measures [14••].

Health administration plays a key role in partnering with both infection prevention and practitioners in the operating room to support systems and policies that allow for high reliability in risk factor mitigation.

Methicillin-Resistant *Staphylococcus aureus*

Strategies to decrease the risk of hospital-acquired MRSA infections are broad and diverse and are not neatly categorized into simple technical interventions or safety checklists. As summarized in the CDC/SHEA compendium of strategies to prevent healthcare-associated infections, key interventions include conducting a MRSA risk assessment, implementation of a MRSA monitoring program, compliance with hand hygiene, the use contact precautions for MRSA-colonized and MRSA-infected patients, cleaning and disinfection of equipment and the environment, implementing a laboratory-based alert system for MRSA-colonized or MRSA-infected patients on admission or transfer, and providing MRSA data and outcome measures to key stakeholders, including senior leadership, physicians, nursing staff, and others. Active surveillance through microbial screening and isolation of patients is also a component of some MRSA infection prevention programs [14••].

Recently, the added value of isolating patients with endemic MRSA and VRE infection or colonization has become increasingly controversial, with some US healthcare systems reporting ongoing MRSA reduction without the use of contact precautions [21, 22]. Healthcare administration plays a vital role in securing the vital resources and promoting policies and mechanisms for MRSA reduction strategies that answer to both legal/regulatory mandates and local need.

Clostridium difficile Infection

Much like MRSA risk reduction, minimizing *C. difficile* infections requires a broad, multifaceted approach. No one single intervention fully minimizes the risk of hospital-acquired *C. difficile* infection. Key interventions include developing a CDIF surveillance and reporting system, antimicrobial stewardship, the use of contact precautions for suspected or in infected *C. difficile* patients, the use of single occupancy rooms, heightened daily and terminal cleaning of the inanimate environment including an assessment mechanism for the adequacy of cleaning, the implementation of a laboratory-based alert system to provide immediate notification to infection prevention and control and clinical personnel about newly diagnosed CDI patients, promoting and assessing adequate hand hygiene, and educating healthcare professionals, environmental service personnel, and hospital administration about CDIF [14••].

Much like with other elements of infection prevention, in collaboration with the hospital infection prevention program, healthcare administration plays a vital role in securing the vital resources and promoting policies and mechanisms for maximizing *C. difficile* reduction efforts.

Horizontal vs Vertical Interventions

Healthcare systems that focus resources on a single pathogen as a sole approach to infection control are inherently flawed. The new paradigm for infection prevention seeks multi-potent interventions aimed at reducing risk from all pathogens transmitted through the same mechanism contact [23]. The classic example of a vertical intervention strategy is active detection in isolation of MRSA for infection prevention. Horizontal infection prevention programs are characterized by interventions such as hand hygiene, chlorhexidine bathing, central line insertion bundles, ventilator bundle, and safety checklists which have broad risk reduction impact on most hospital-acquired pathogens transmitted by contact [24]. Recently, advances in textiles and other technologies show promise for environmental bioburden reduction-consistent with a horizontal infection prevention platform. Patients in ICU rooms with copper alloy surfaces had a significantly lower rate of incident HAI and/or colonization with MRSA or VRE than did patients treated in standard rooms [25]. The deployment of UVC-light "touchless" disinfecting robots may further decrease bioburden and infection risk [26].

Change Implementation

Implementing one or several strategies to reduce the incidence of HAIs necessarily involves implementing new policies and procedures and, thus, organizational change. It is well understood that change can be difficult not only because of its cost but also because of the inertia that builds up within organizations and also the need to obtain buy-in from managers and front-line staff. In this section, we discuss a model for implementing change developed by Harvard Business School professor John B. Kotter, PhD., and how it might be applied to implement HAI reduction guidelines and policies.

Kotter Change Management Model

In 1998, Kotter published a short article previewing his book, *Leading Change*. Since then, the Kotter Change Management Model has been used successfully in healthcare to manage organizational change efforts. From improving nursing hand-offs [27] to adopting new electronic health records [28], the Kotter model provides a flexible and practical tool to organize and implement new policies and procedures. The eight stages of Kotter's Change Management Model, the descriptions of the stages, and

Table 1 Kotter Organizational Change Management Model as Applied to CLASBI Reduction Initiative at VCU Health System

Stage	Description	Example
Establish a Sense of Urgency	Define the problem (severity, scope, frequency, etc.) and outline consequences of delayed action. Ensure that the change is seen as less risky than the current system.	The rate of CLABSI in the intensive care units (ICU) is 4% per device day, 2 times higher than in other similar facilities where AIPP is used. Each patient in our care is at risk of CLABSI. Switching to AIPP will present less risk to our patients than our current caps.
Create a Guiding Coalition	Enlist a group of employees with the right combination of experience, leadership, skills, and credibility to drive the change and influence others.	Form a guiding coalition with ICU Nurse Managers, the Hospital Epidemiologist, the CNO, and an experienced member of the nursing staff.
Develop a Clear Shared Vision	Form clear, evidence-based solution. Solution must have a roadmap of steps with a measurable goal.	"We will significantly reduce patient risk of CLABSI on our units by using AIPP on all lines. This adoption of AIPP on each unit will lead to use of AIPP hospital-wide."
Communicate the Vision	Communicate the change convincingly, thoroughly, and frequently. Ensure that multiple means of communication are used (verbal and written in different forms). Listen carefully to feedback, and address concerns openly and honestly.	At monthly Champions in Infection Prevention Meetings (CHIPs), where all units are represented by 1–2 nurses empowered as infection prevention liaisons, the new policy is introduced. It is also communicated in email to all team members, and in laminated signs posted in appropriate areas.
Empower Action	Ensure that existing processes and procedures support the change. Ensure that all resources and materials to conduct the change are available. Identify potential barriers to action and remove these barriers. Empower each team member to contribute to the change, and create fail-safes to guard against mistakes during the learning process.	CHIPs nurse representatives enact an implementation plan with their respective units. CHIPs develop educational plans and reporting mechanisms for units, based on infection control implementation plan. Staff are encouraged to raise concerns and identify issues, and CHIPs leaders are tasked with identifying potential barriers.
Create Short-Term Wins	Create benchmark goals during all phases of change implementation, and reward their completion. Broadcast successes and recognize team members as early benchmarks are met.	Weekly assessment of AIPP is conducted, and feedback is provided. The first week with full compliance of AIPP use on any unit results in staff rewards (such as gift cards provided for each staff member). At the end of the first month, CHIPs leaders are recognized at an operations meeting with hospital leadership.
Build on Gains and Consolidate	Continue to examine successes, identify improvements, and mitigate concerns. Continue to communicate progress and celebrate small wins.	Hospital units with greatest improvement in AIPP use are recognized and share experience with other unit managers. Barriers to compliance are identified in weekly team huddles, and then shared with CHIPs leaders. Target is set for > 90% with AIPP use.
Institutionalize the Change	Ensure that the change is institutionalized in policy, procedure, and organizational culture. Pass importance of change on to new team members and leadership, and incorporate change into orientation, training, peer-review, and performance review.	Hospital policy for the maintenance of CVCs reflects the use of AIPP. Unit to unit compliance with use of alcohol-based disinfecting CVC Caps is reported at the monthly infection prevention committee as a standing agenda item, results are shared with highest level of hospital leadership.

a case example regarding CLABSI reduction at an acute-care hospital are provided in Table 1 of this article.

Conclusion

The adoption of pay-for-performance systems brings new challenges to healthcare administrators as financial risks continue to shift from insurer and patient, to provider and facility. In the past 5 years, the HAIs discussed in this paper have continued to present a threat to patient safety, and to organizational survival in an increasingly competitive healthcare market. Evidence-based infection control guidelines continue to evolve, and these changes bring opportunities for healthcare administrators to partner with clinical experts in change management. Hospital administration must collaborate with content experts in infection prevention and epidemiology so as to allow for the development of an adequately supported infection prevention program with resources, evidence-based policies, and platforms that are methodically implemented to scale with accountability.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

References

Papers of particular interest, published recently, have been highlighted as:
• Of importance
•• Of major importance

1.• Kotter JP. Leading change. Harvard Business Press; 1996. **Kotter's eight-step model is used to manage change across a wide variety of organizations and industries. The eight steps of change occur in three phases: (a) establishing optimal conditions for change; (b) enabling the organization for change and empowering individuals for change; and (c) implementing and sustaining change. In Table 1, an example plan is given using the Kotter model.**

2.•• Zimlichman E, Henderson D, Tamir O, Franz C, Song P, Yamin CK, et al. Health care–associated infections: a meta-analysis of costs and financial impact on the US health care system. JAMA Intern Med. 2013;173(22):2039–46. **Zimlichman and his colleagues provide an estimation of healthcare costs attributed to hospital-acquired infections in the USA using data from years 1986 through 2013. Major findings include (a) central line-associated bloodstream infections are the most expensive per-case hospital-acquired infections; (b) the total annual cost for the five major infections is approximately $9.8 billion; and (c) surgical site infections contribute the most to total hospital-acquired infection treatment cost at 33.7%.**

3.• Scott RD. The direct medical costs of healthcare-associated infections in US hospitals and the benefits of prevention. **Commissioned by the Centers for Disease Control and Prevention in 2009, Economist R. Douglas Scott reports on the economic impact of treating and preventing hospital-acquired infections in the USA. The overall annual direct medical costs of hospital-acquired infection treatment was estimated at $28.4 to $33.8 billion (using consumer price index for all urban consumers) and $35.7 billion to $45 billion (using consumer price index for inpatient hospital services). The benefits of hospital-acquired infection prevention are estimated at a low to be $5.7 to $6.8 billion (20% of infections preventable, consumer price index for all urban consumers) and at a high to be $25.0 to $31.5 billion (70% of infections preventable, consumer price index for inpatient hospital services).**

4. Kondo KK, Damberg CL, Mendelson A, Motu'apuaka M, Freeman M, O'Neil M, et al. Implementation processes and pay for performance in healthcare: a systematic review. J Gen Intern Med. 2016;31(1):61–9.

5. Centers for Medicare & Medicaid Services. Hospital-Acquired Condition Reduction Program (HACRP).

6. Bastian ND, Kang H, Nembhard HB, Bloschichak A, Griffin PM. The impact of a pay-for-performance program on central line–associated blood stream infections in Pennsylvania. Hosp Top. 2016;94(1):8–14.

7.• Waters TM, Daniels MJ, Bazzoli GJ, Perencevich E, Dunton N, Staggs VS, et al. Effect of Medicare's nonpayment for hospital-acquired conditions: lessons for future policy. JAMA Intern Med. 2015;175(3):347–54. **This reference outlines effects of Medicare's financial penalties for hospital-acquired conditions. For conditions with strong evidence-based guidelines available (including central line-associated bloodstream infections and catheter-associated urinary tract infections) nonpayment is associated with improving trends.**

8. Lee JY, Lee SI, Jo MW. Lessons from healthcare providers' attitudes toward pay-for-performance: what should purchasers consider in designing and implementing a successful program? J Prev Med Public Health. 2012;45(3):137.

9. Gerberding JL. Hospital-onset infections: a patient safety issue. Ann Intern Med. 2002;137(8):665–70.

10. Doll M, Hewlett AL, Bearman G. Infection prevention in the hospital from past to present: evolving roles and shifting priorities. Curr Infect Dis Rep. 2016;18(5):16.

11. Siempos II, Kopterides P, Tsangaris I, Dimopoulou I, Armaganidis AE. Impact of catheter-related bloodstream infections on the mortality of critically ill patients: a meta-analysis. Crit Care Med. 2009;37(7):2283–9.

12. Lobdell KW, Stamou S, Sanchez JA. Hospital-acquired infections. Surg Clin N Am. 2012;92(1):65–77.

13. Forster AJ, Taljaard M, Oake N, Wilson K, Roth V, van Walraven C. The effect of hospital-acquired infection with Clostridium difficile on length of stay in hospital. Can Med Assoc J. 2012;184(1):37–42.

14.•• Yokoe DS, Anderson DJ, Berenholtz SM, Calfee DP, Dubberke ER, Ellingson KD, et al. A compendium of strategies to prevent healthcare-associated infections in acute care hospitals: 2014 updates. Am J Infect Control. 2014;42(8):820–8. **This reference includes a comprehensive set of evidence-based guidelines for prevention and management of hospital-acquired infections in acute healthcare settings. The guidelines are a result of collaboration between experts led by the Society for Healthcare Epidemiology of America (SHEA), the Infectious Diseases Society of America (IDSA), the American Hospital Association (AHA), the Association for Professionals in Infection Control and Epidemiology (APIC), and The Joint Commission.**

15. Berenholtz SM, Pronovost PJ, Lipsett PA, Hobson D, Earsing K, Farley JE, et al. Eliminating catheter-related bloodstream infections in the intensive care unit. Crit Care Med. 2004;32(10):2014–20.

16. Pronovost P, Needham D, Berenholtz S, Sinopoli D, Chu H, Cosgrove S, et al. An intervention to decrease catheter-related bloodstream infections in the ICU. N Engl J Med. 2006;355(26):2725–32.

17. Timsit JF, Schwebel C, Bouadma L, Geffroy A, Garrouste-Orgeas M, Pease S, et al. Chlorhexidine-impregnated sponges and less frequent dressing changes for prevention of catheter-related infections in critically ill adults: a randomized controlled trial. JAMA. 2009;301(12):1231–41.

18. Krein SL, Fowler KE, Ratz D, Meddings J, Saint S. Preventing device-associated infections in US hospitals: national surveys from 2005 to 2013. BMJ Qual Saf. 2015;24(6):385–92.

19. Lo E, Nicolle LE, Coffin SE, Gould C, Maragakis LL, Meddings J, et al. Strategies to prevent catheter-associated urinary tract infections in acute care hospitals: 2014 update. Infect Control Hosp Epidemiol. 2014;35(5):464–79.

20. Lam TB, Omar MI, Fisher E, Gillies K, MacLennan S. Types of indwelling urethral catheters for short-term catheterisation in hospitalised adults. Cochrane Libr. 2014.

21. Morgan DJ, Murthy R, Munoz-Price LS, Barnden M, Camins BC, Johnston BL, et al. Reconsidering contact precautions for endemic methicillin-resistant *Staphylococcus aureus* and vancomycin-resistant enterococcus. Infect Control Hosp Epidemiol. 2015;36(10):1163–72.
22. Morgan DJ, Wenzel RP, Bearman G. Contact precautions for endemic MRSA and VRE: time to retire legal mandates. JAMA. 2017;318(4):329–30.
23. Wenzel RP, Bearman G, Edmond MB. Screening for MRSA: a flawed hospital infection control intervention. Infect Control Hosp Epidemiol. 2008;29(11):1012–8.
24. Wenzel RP, Edmond MB. Infection control: the case for horizontal rather than vertical interventional programs. Int J Infect Dis. 2010;14:S3–5.
25. Salgado CD, Sepkowitz KA, John JF, Cantey JR, Attaway HH, Freeman KD, et al. Copper surfaces reduce the rate of healthcare-acquired infections in the intensive care unit. Infect Control Hosp Epidemiol. 2013;34(5):479–86.
26. Fleming M, Patrick A, Gryskevicz M, Masroor N, Hassmer L, Shimp K, et al. Deployment of a touchless ultraviolet light robot for terminal room disinfection: the importance of audit and feedback. Am J Infect Control. 2018;46(2):241–3.
27. Small A, Gist D, Souza D, Dalton J, Magny-Normilus C, David D. Using Kotter's change model for implementing bedside handoff: a quality improvement project. J Nurs Care Qual. 2016;31(4):304–9.
28. Health Information Technology Research Center (HITRC), healthit.gov