

Economic burden of healthcare-associated infections: an American perspective

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Annually, approximately 2 million patients suffer with healthcare-associated infections (HAIs) in the USA, and nearly 90,000 are estimated to die. The overall direct cost of HAIs to hospitals ranges from US\$28 billion to 45 billion. While the range is wide, HAIs are clearly expensive. In addition, most HAIs are thought to be preventable; however, published guidelines are not congruent. Important policy changes include mandating hospitals to publically report HAI rates and a federal pay-for-performance measure that will no longer allow Medicare to pay more for patients with HAIs. Further rigorous economic evaluations of specific interventions, as well as on evaluations of the policies, are required.

KEYWORDS: cost • guideline • healthcare-associated infection • nosocomial infection

In the past 20 years, the overall incidence of healthcare-associated infections (HAIs) in the USA has increased by 36% [1]. Annually, in the USA, approximately 2 million patients suffer from a HAI, and an estimated 90,000 of these patients die [2]. This ranks HAI as the fifth leading cause of death in US acute-care hospitals [3]. Four categories of infections account for approximately three-quarters of HAIs in the acute-care hospital setting: surgical-site infections (SSIs), central-line-associated bloodstream infections (CLABSIs), ventilator-associated pneumonia (VAP) and catheter-associated urinary tract infections (CAUTIs). The substantial human suffering and financial burden of these infections is staggering. TABLE 1 presents estimates made by the US Department of Health and Human Services (DHHS) summarizing the burden of these infections [4]. These estimates were made using previous systematic reviews of the literature on the attributable costs of HAIs [5,6], and data reported by the US CDC National Healthcare Safety Network (NHSN) [3]. Using some of these data sources, a health economist at the CDC has recently estimated the annual hospital costs of HAIs in the USA to be between US\$28 billion and 45 billion per year [7].

The wide variation in these cost estimates reflects the range of estimates found in the literature for each type of infection and the assumptions made in the analyses. The variation in methods used in conducting the economic analysis include differences in patient populations studied, variations in study settings, inclusion of multiple drug-resistant infections and the perspective of the economic analysis. Most investigators used only index hospitalization costs. However, a few researchers included outpatient costs and conducted the analysis from broader perspectives [8].

Important concepts to consider when determining the attributable costs of HAIs are adjustment for patients' underlying severity of illness and comorbid conditions, as well as length of stay in the hospital prior to acquiring the infection [9]. Failure to consider and adjust for these factors can result in biased estimates of attributable cost, usually making the infection seem more expensive.

Nonetheless, the costs of HAIs are clearly high and increasing as the number of infections that are caused by multiple drug-resistant organisms (MDROs) increases. More than 70% of the bacteria that cause HAIs are resistant to at least one of the drugs most commonly used to treat them [10,11], and there is strong evidence that the attributable costs, length of stay and mortality are

Table 1. Burden of healthcare-associated infections.

Infection type	Annual infections (n)	Mean hospital cost per infection (US\$)	Mean deaths per year
Surgical-site infection	290,485	25,546	13,088
Ventilator-associated pneumonia	250,205	9,966	35,967
Central-line-associated bloodstream infection	248,678	36,441	30,655
Catheter-associated urinary tract infection	561,677	1006	8205

Adapted from [4].

even greater when an infection is caused by a MDRO [12–18]. One MDRO that has received much attention is methicillin-resistant *Staphylococcus aureus* (MRSA). The increased disease burden of MRSA compared with infections caused by methicillin-susceptible *S. aureus* has been confirmed in two meta-analyses [19,20]. In one study, the increased attributable cost of MRSA versus methicillin-susceptible *S. aureus* was estimated to be on average approximately \$4000 per infection [18]. In addition, another group of researchers recently found that *Clostridium difficile* is occurring almost as frequently in the hospital setting as MRSA, also impacting resource use and inpatient mortality [21]. Researchers have estimated the costs of *C. difficile*-associated diarrhea to be approximately \$4500 per patient [22].

As a result of the persistent nature of this insidious, costly and often preventable problem, HAIs have been identified as one of only a handful of focus areas in Developing Healthy People [20–23]. With the extent of the problem, and knowing that focusing on specific infection types is likely to yield the best results, DHHS has developed an action plan to prevent HAI and has identified SSI, VAP, CLABSI, CAUTI, MRSA and *C. difficile* infections acquired in acute-care hospital settings as their top priority [4].

Economic considerations in preventing HAIs

Despite the high morbidity, mortality and costs associated with HAIs, a large proportion are preventable. For example, 66 intensive-care units (ICUs) in southwestern Pennsylvania, USA, formed a coalition with the goal of decreasing HAI rates [24]. Using a multifaceted approach, these ICUs obtained a 68% decrease in CLABSI rates over a 5-year period. A similar reduction was also found in 103 ICUs in Michigan, USA [25]. In both of these, important components of the multifaceted approach included accurate measurement of the infections using standardized protocols, as well as changing the organizational culture to promote patient safety [26–28]. The cost–benefit ratio associated with implementation of these types of prevention strategies is not clear.

There have been a number of published studies in which researchers report on the investigations of the effectiveness of specific infection prevention processes. Much of this evidence has been synthesized in guidelines developed by the CDC, including [29–35]:

- Preventing healthcare-associated pneumonia
- Hand hygiene

- Prevention of intravascular device-related infections
- Isolation precautions: preventing transmission of infectious agents in healthcare settings
- Prevention of CAUTI
- Management of MDROs in healthcare settings

In a previous study, hospital costs of complying with the new hand-hygiene guidelines, namely the use of alcohol rubs, was estimated and the cost of implementation was very inexpensive, ranging from 0 to over \$20,000 per hospital [36]. There have not been formal cost estimates of implementation of the other guidelines. However, the cost–effectiveness of specific products (e.g., antimicrobial impregnated catheters) has been estimated [37,38].

There are controversies regarding recommendations for other important infection prevention, surveillance and control processes, some of which are related to economic considerations. One of the most debated topics in infection control and prevention in the USA is the use of barrier precautions and surveillance cultures (often used in tandem to prevent the spread of MDRO). The Healthcare Infection Control Practices Advisory Committee, who write the CDC guidelines, do not recommend routine cultures, unless prevalence of a drug-resistant organism is high, but they do recommend use of barrier precautions for patients identified as colonized or infected with a MDRO [35]. Conversely, the Society for Healthcare Epidemiology of America (SHEA) recommends surveillance cultures for all high-risk patients upon hospital admission and pre-emptive barrier precautions while culture results are pending [39–41]. In these guidelines, ‘high risk’ is not consistently defined [42]. While the SHEA guideline is controversial, there is a published report of a single institution effectively implementing these processes on all patients admitted into an intensive-care unit [43]. Furthermore, these procedures are the standard of care in many European hospitals [42]. The concerns regarding culturing all patients and needlessly using barrier precautions on patients are related to patient outcomes, as well as cost of care. Researchers recently conducted a systematic review of the literature on barrier precautions for MDRO patients and found that, although barrier precautions are recommended by the CDC, this intervention has unintended consequences, and patients on barrier precautions experience less healthcare-worker contact, changes in systems of care that produce delays, more noninfectious adverse events, increased symptoms of depression and anxiety, as well as decreased satisfaction with care [44]. In another systematic review of evidence on the effectiveness of barrier precautions and surveillance

Table 2. Overview of 20-State mandatory reporting requirements to the National Healthcare Safety Network.

Requirement	State		
Central-line bloodstream infection	CA, CO, CT, DE, IL, MA, MD, NH, NJ, NV, NY, OK, OR, PA, SC, TN, VA, VT, WA, WV		
Catheter-associated urinary tract infection	PA, NV		
Surgical-site infection	CO, MA, NH, NJ, NV, NY, OR, PA, SC, TN, VT		
Ventilator-associated pneumonia	NH, NV, OK, PA, WA		
Year	2007	2008	2009
Chronological list of when States initiated mandatory reporting requirements	CO, NY, SC, VT	CA, CT, DE, IL, TN, MA, MD, OK, PA, VA, WA	NH, NJ, NV, OR, WV

cultures in reducing HAI rates, the evidence base was also found to be lacking [42]. Furthermore, if the patient needs a private room for isolation, there are economic implications for the hospitals. A formal cost–effectiveness analysis of the active surveillance policy with isolation is warranted, and this research should be conducted from multiple perspectives.

It is clear that there is substantial uncertainty in what constitutes the best practice in HAI prevention, as well as the cost–effectiveness of various prevention strategies. This translates into a wide variation in processes implemented at the bedside, as well as variation in policies at the organization and unit level.

Economic consequences of major policy changes related to HAIs remains unknown

The context in which infection prevention, surveillance and control is practiced in the USA is changing. Owing to the magnitude of the HAIs and drug-resistance problems in hospitals, and the increasing demand for healthcare information by public and consumer groups (e.g., the Committee to Reduce Infection Deaths and the Consumers Union), many States now mandate hospitals to publicly disclose data regarding their performance and/or outcomes in relation to these infections. As of 1 June 2009, all but 14 States have instituted some type of legislation or regulation regarding reporting. This new phenomenon began in 2004 with Pennsylvania, Illinois and Florida being the first States to initiate some form of mandatory reporting. It is important to note that State legislation and regulations across the nation are not uniform. As part of these initiatives, 20 States now mandate that hospitals report their data through the NHSN, and the network grew from less than 500 institutions in 2007 to over 2300 institutions in 2009. TABLE 2 outlines some of what 20 States have mandated to be reported to the NHSN on its initiation and the year the State required its hospitals to join.

Despite the enthusiastic support for the public release of performance measures [45] and extensive adoption of quality measurement and reporting, there has been little research examining the effect of public reporting on the delivery of healthcare [46] and even less research examined how this reporting may improve care. The effect of mandating hospitals to publicly report HAI rates is unknown. The intended consequence of these policies is that hospitals increase efforts to decrease infection rates. Alternatively, as noted in other efforts to publicize risk-adjusted outcomes [47], interest may be modest and transient; therefore, limiting the impact and using scarce resources to meet mandatory reporting

requirements, not setting specific infection prevention and control priorities. Initial reports indicate no differences in HAI rates between hospitals in States with mandatory reporting requirements when compared to those without [48]. However, infection preventionists and hospital epidemiologists employed in States with mandatory reporting often discuss the lack of resources and the need to focus only on what is mandated, not what they consider their most pressing local problem. The potential for unintended consequences and resulting opportunity costs related to these policies may be high and need to be evaluated.

Another important federal policy change relates to payment reform. As a first step in reform, and with the goal of motivating hospitals to improve quality, the Centers for Medicare and Medicaid Services (CMS) has stopped paying for select ‘preventable complications’, some of which are HAIs [49]. Specifically, as of 1 October 2008, the CMS no longer allows hospitals to receive additional payments for CAUTI, vascular catheter-associated infections and select SSIs. In addition, the CMS is considering adding VAP, *S. aureus* bloodstream infections, *C. difficile*-associated disease and MRSA HAIs to the list. While it is not clear if this new rule will substantially change Medicare payments to hospitals [50], hospitals are certainly under pressure to decrease costs associated with preventable HAIs.

As part of this payment reform initiative, HAIs will be identified using administrative billing records. Identifying HAIs based on administrative data may be problematic. Previously, researchers have found that International Statistical Classification of Diseases and Related Health Problems (ICD)-9 codes and other hospital administrative databases did not accurately identify patients who had a central vascular catheter inserted [51]. In addition, researchers have found very poor concordance between infections identified using CDC definitions and those identified using administrative data [52,53]. Recognizing this problem, CMS now requires a point-on-admission indicator for all secondary diagnoses. The use of the point-on-admission should allow more accurate detection of HAIs in administrative data; however, this has not been verified using rigorous methods. Therefore, the use of administrative coding for infection surveillance and nonpayment for performance has been questioned.

There are also concerns about whether this policy change was a sufficient financial incentive. Hospital payments will only be reduced for Medicare patients in instances in which the HAIs were the only factor causing a case to be reclassified into a more

expensive diagnostic-related group [54]. Thus, the policy change will affect only a minority of hospital patients and the magnitude of the incentive is relatively small. Identification of the relative and absolute magnitude of an effective hospital incentive is important. The diffusion of these incentives to other payers – whether other payers follow the CMS lead and institute similar payment practices – will also affect the magnitude of the incentive. Last, with mandatory public reporting of these same infections in many states, it will be important to understand the relative impact of reputational versus financial incentives.

In other contexts, including both hospital and outpatient settings, limited research has shown that financial incentives for quality, often known as pay-for-performance, result in modest improvement in quality-of-care measures [55]. The literature, however, is sparse. In a recent systematic review of the literature on pay-for-performance in the hospital setting, only eight published studies were found and most studies had methodological flaws [56]. In addition, it is not clear if any observed improvements are sustainable [57]. Given the wide impact of this policy change and the potential for both positive and negative consequences, there is a need to carefully and rigorously evaluate this policy change.

Expert commentary

Healthcare-associated infections continue to be an important patient safety problem and the financial and social costs are staggering. As a result, the DHHS has identified reducing preventable HAIs nationally as an important component of achieving its mission and vision, with the goal of building a safer, more affordable healthcare system for all Americans. However, how best to achieve this goal is not clear, and further research is required on the comparative effectiveness of specific interventions. The new CMS HAI payment policy scale is one of the largest, most visible pay-for-performance initiatives aimed at improving patient safety in the US healthcare system. Understanding the ramifications of this policy, as well as the State-mandated reporting policies, both for HAI and for safety improvement in general, is critical to improving quality efficiently.

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Five-year view

In the DHHS action plan, 5-year targets have been set to reduce specific hospital HAIs and it is probable that these will be met. Furthermore, with the emphasis the USA is now putting on comparative effectiveness research, there is likely to be more economic evaluations conducted on how best to decrease HAIs [58]. However, so far, most of these efforts have been aimed mainly at HAIs in the hospital. With more healthcare occurring outside of the hospital and an increase in chronic disease, it is probable that there will be more community-acquired infections, many of them related to healthcare. Understanding the true societal costs relating to HAIs occurring both in and out of the hospital will be important.

The new Federal pay-for-performance policies, in which many HAIs will no longer be paid for, should also be evaluated.

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Key issues

- Despite wide ranges in estimates of the economic burden of healthcare-associated infections (HAIs), it is clear that they are costly.
- The majority of HAIs are preventable.
- Rigorous economic evaluation comparing various infection control and prevention strategies is required.
- Mandatory public reporting by hospitals of HAI rates is a major policy change that is sweeping across the USA and needs to be evaluated in terms of cost-effectiveness.

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