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Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major article

Laboratory-confirmed, health care-associated bloodstream infections in Jordan: A matched cost and length of stay study

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Key Words:

Nosocomial
Bloodstream infections
Risk factors
Health care costs
Charges
Length of stay

Background: No studies have been carried out in Jordan to examine length of stay (LOS) and extra cost associated with health care-associated bloodstream infections (HCABSI). This study aims to estimate the extra LOS and cost associated with HCABSI among adult hospitalized Jordanian patients.

Methods: Five-year data were retrieved from 1 large university-affiliated hospital in Jordan. Matched case-control design was used in this study. Cases were determined based on confirmed positive blood culture after 48 hours of admission. Matching criteria were age (± 5 years), gender, admission diagnosis, and LOS in comparison group equal to the LOS ($\pm 5\%$) before blood culture for the case group.

Results: Of the total 445 infected patients 125 (28.1%) were matched with uninfected patients. The mean LOS after infection for cases was 12.1 days (standard deviation [SD] = 17.2) compared with 8.3 (SD = 7.9) days for the controls ($P = .02$). The total mean inflation-adjusted charges for cases was M (mean) = US \$7,426, SD = \$7,252 compared with M = \$3,274, SD = \$4,209 for controls, $P < .001$. Using multiple regression modeling, LOS after acquiring HCABSI, admission to critical care units, and being infected with HCABSI were significant predictors of patients' total charges.

Conclusion: Figures generated from this can be used to inform health care researchers, policy makers, and professionals about the impact of HCABSI.

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Health care-associated bloodstream infections (BSI) (HCABSI) were reported as the most common site of health care-associated infection in different studies^{1,2} and were associated with substantial risk of mortality.^{3,4} In 2006, BSIs were ranked as the ninth leading cause of death in the United States⁵ and the 10th in 2007.⁶ Recent estimates using a national cluster probability sample suggested that more than 500,000 patients acquire HCABSI annually in the US hospitals, and, of these, 111,427 died.⁷ Recently, the Centers for Disease Control and Prevention (CDC)⁸ reported that, from 2000 to 2007, the rate of hospitalization from BSIs for elderly individuals (65–74 years) increased by 57%, from 6.5 per 1,000 to 10.2 per 1,000. For those aged 75 to 84 years, the corresponding rate increased by 52%; from 11.7 per 1,000 to 17.8 per 1,000.

Studies on HCABSI around the world consistently demonstrate an increased length of stay (LOS) and health care costs.^{3,9,10} In the

United States, one study estimated that HCABSI account for \$3.5 billion in costs and approximately 3.5 million additional hospital days per year.¹¹ Another study by Warren et al¹² estimated that a single episode of central venous catheter-related BSI was associated with increased health care costs ranging from \$3,700 to \$56,167. The CDC¹³ estimates that the cost per infection ranges from \$34,508 to \$56,000. Recently, AL-Rawajfah et al⁹ estimated that mean total charges for patients with HCABSI in the US hospitals were \$85,813 (\$110,183 in 2010 US \$) compared with \$22,821 (\$29,302 in 2010 US \$) for uninfected patients ($P < .001$). AL-Rawajfah et al⁹ estimated that, in 2003, HCABSI potentially cost the US economy nearly \$29 billion (\$37.24 billion in 2010 US \$).

HCABSI are associated with substantial increase of LOS. Numerous reports worldwide have shown excess LOS associated with HCABSI.^{14–17} Studies suggested that the excess LOS associated with HCABSI ranged from two¹⁸ to 7 times longer stays compared with uninfected patients.¹⁹ A recent US national study⁹ suggested that the mean LOS for HCABSI in the US hospitals is 16.0 days compared with 5.4 days for the uninfected patients ($P < .001$). Based on their estimated number of HCABSI in 2003,⁷ AL-Rawajfah

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Supported by the Deanship of Academic Research at Al al-Bayt University.

Conflicts of interest: None to report.

et al⁹ estimated that HCABSIs resulted in approximately 5.7 million additional hospital days in the US hospitals in 2003.

Like any developing country, health care-associated infections are considered a major health issue in Jordan. Khuri-Bulos et al²⁰ conducted a Jordanian study to compare nosocomial infections in a Jordanian university hospital with National Nosocomial Infections Surveillance infection rates in the United States. Findings from the study demonstrated that BSIs rates in Jordan were higher than the 90th percentile of the US rates. The results by Khuri-Bulos et al were supported by another report, which suggested that the incidences of HCABSIs in developing countries are almost 5 times higher than international standards.²¹ Moreover, studies in Middle East countries, including Jordan,^{22,23} Egypt,²⁴ Saudi Arabia,²⁵ Tunisia, Algeria, and Morocco,²⁶ demonstrated minimal compliance with good hand hygiene practices.

Jordan is 89,342 km² in area with a total population of about 6 million.²⁷ The gross per capita income in 2010 was US \$4,505. In 2010, the Ministry of Health budget comprised 7.4% of the total national budget.²⁷ Health care is delivered primarily by governmental, military, private, and university-affiliated hospitals.

In Jordan, few studies have been carried out regarding HCABSIs^{20,28} or community-acquired BSIs in adults^{29,30} or HCABSIs in neonates.³¹ However, none of these studies addressed the associated increase of LOS and costs. Therefore, this study aims to examine the extra LOS and costs associated with HCABSIs in adult patients in a large hospital, which provides care for approximately 1 million inhabitants in the north of Jordan.

METHODS

Data source and study design

This study utilized a matched case-control design to estimate the extra LOS and cost associated with HCABSIs independent of the matching factors. The study was based on electronic health records for a 5-year period (05/31/2003 to 07/13/2008). Data were extracted for each patient from admission through discharge. A single large hospital was used for this study because few private or governmental hospitals have electronic health records, which make this study feasible. Ethical approvals were obtained from Al al-Bayt University, as well as the participating hospital.

Sample

Cases consisted of all adult patients (age 18 years and older) who were admitted to the hospital for more than 48 hours, had a positive blood culture after the 48 hours of admission, and no evidence of BSI at the time of admission. The decision of including only adult cases was based on various studies that demonstrated that risk factors and outcomes of HCABSIs among children and infants are different from adult populations.³²⁻³⁴ The confirmed infected patients were matched to a comparison group of uninfected patients (ie, controls). Matching was based on age, gender, primary diagnosis for admission, and LOS in comparison group equal to the LOS ($\pm 5\%$) before blood culture for the cases group. Additionally, all cases were matched with controls the same month of admission. Date of infection was defined by the date when infection was confirmed by blood culture results. Similar matching criteria were used in other studies.^{16,35} Standard definitions proposed by the CDC were used in this study.^{36,37} According to the CDC, laboratory-confirmed HCABSIs is defined as a clinical infection that is associated with isolation of 1 or more microorganisms from blood cultures drawn at least 48 hours after admission with no evidence of infection at the time of admission.^{35,37}

Data analysis procedures: Descriptive and bivariate analyses

SPSS-PC version 16 (SPSS Inc, Chicago, IL) was used to compute frequencies, percentages, means, and their standard deviations (SD) to describe the sample. STATA (version 10.0; STATA Corp, College Station, TX) was used for conditional logistic regression procedures. To estimate extra LOS associated with HCABSIs, we compared the mean LOS after infection for the infected patients with mean LOS for the uninfected patients. We also compared the mean total charges for cases and controls to estimate differences in charges associated with HCABSIs. For multivariate analysis, a multiple regression model was estimated to predict the effect of LOS after blood culture, critical care units (CCU) admission, and infection status on total cost. Assumptions of the multiple regression model were checked to ensure reliability of parameter estimation.

The exchange rate used for converting Jordanian Dinar (JD) to US Dollar (USD) was JD 1 = USD 1.41 on December 31, 2011 (Central Bank of Jordan, 2011). To adjust cost of hospital stay for inflation, we used the consumer price index (CPI) estimates from the Central Bank of Jordan (2011). Because the base year for those estimates was 2006, we used the following formula to change the base year to 2011.

$$CPI_{t,Base=2011} = \frac{CPI_{t,Base=2006}}{CPI_{2011,Base=2006}} \times 100$$

where $t = 2003, 2004 \dots 2011$. The following formula was used to obtain inflation-adjusted cost estimates.

$$Adjusted\ cost_t = \frac{Cost_t}{CPI_{t,Base=2011}} \times 100$$

RESULTS

Description of the sample

During the study period, there were 54,918 adult admissions who met the inclusion criteria. Of the total eligible admissions, there were 445 cases of confirmed HCABSIs. The overall incidence rate during the study period was 8.1 infections per 1,000 adult admissions. Of the total confirmed HCABSIs, 179 (40.2%) were from CCUs, and 153 (34.4%) were from medical units. Of the total infected patients, 251 (56.4%) were male. The mean age for the cases was 56.4 years (SD = 18.1) and, for controls, 56.1 years (SD = 16.1). Of the total number of cases, 318 (71.5%) died in the hospital. Of the total deaths among cases, 36.2% were 60 years of age or older. All of the controls were discharged alive from the hospital. The mean total LOS for cases was 27.7 days (SD = 37.6) compared with 8.3 (SD = 7.9) for controls. On average, cases were hospitalized for 15.1 days (SD = 27.6) before acquiring infection and stayed an additional 12.7 days (SD = 16.7) after the first positive blood culture.

Results of LOS and charges

To estimate extra LOS and charges associated with HCABSIs, we were able to match 28.1% ($n = 125$) of cases to controls. Matching was based on age, gender, admission diagnosis, admission unit, admission month, and LOS ($\pm 5\%$) before infection. The matching was perfect for gender, admission month, and LOS. Of the total 125 pairs, 92.8% were perfectly matched on age. The remaining cases (9 pairs; 7.2%) fell in adjacent age groups. For these 9 pairs, the difference in age ranged between 2 and 12 years (M [mean] = 7.89, SD = 3.69).

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