Sources of Variation in Hospital-Level Infection Rates After Coronary Artery Bypass Grafting: An Analysis of The Society of Thoracic Surgeons Adult Heart Surgery Database

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Background. **Patients undergoing coronary artery bypass grafting (CABG) are at risk for a variety of infections. Investigators have focused on predictors of these adverse sequelae, but less attention has been focused on characterizing hospital-level variability in these outcomes.**

Methods. **Between July 2011 and December 2013, The Society of Thoracic Surgeons Adult Cardiac Surgery Database shows 365,686 patients underwent isolated CABG in 1,084 hospitals. Hospital-acquired infections (HAIs) were defined as pneumonia, sepsis/septicemia, deep sternal wound infection/mediastinitis, vein harvest/cannulation site infection, or thoracotomy infection. Hospitals were ranked by their HAI rate as low (≤10th percentile), medium (10th to 90th percentile), and high (>90th percentile). Differences in perioperative factors and composite morbidity and mortality end points across these groups were determined using the Wilcoxon rank sum and χ^2 tests.**

Results. **HAIs occurred among 3.97% of patients overall, but rates varied across hospital groups (low: <0.84%, medium: 0.84% to 8.41%, high: >8.41%). Pneumonia (2.98%) was the most common HAI, followed by sepsis/septicemia (0.84%). Patients at high-rate hospitals more often smoked, had diabetes, chronic lung disease, New York Heart Association Functional Classification III to IV, and received blood products ($p < 0.001$); however, they less often were prescribed the appropriate antibiotics ($p < 0.001$). Major morbidity and mortality occurred among 12.3% of patients, although this varied by hospital group (low: 8.6%, medium: 12.3%, high: 17.9%; $p < 0.001$).**

Conclusions. **Substantial hospital-level variation exists in postoperative HAIs among patients undergoing CABG, driven predominantly by pneumonia. Given the relatively small absolute differences in comorbidities across hospital groups, our findings suggest factors other than case mix may explain the observed variation in HAI rates.**

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Hospital-acquired infections (HAIs), including sepsis, pneumonia, and sternal wound or harvest site infections, occur in up to 5% of patients undergoing coronary artery bypass grafting (CABG) [1]. Patients with HAIs are at increased risk of subsequent morbidity, death, and resource utilization [1–5]. Fowler and colleagues [4] reported a more than fivefold increased risk of death among patients when major infections occurred after cardiac operations (17.3% vs 3.0%) [4]. LaPar and associates found a greater incremental cost associated with pneumonia ($50,025) and deep sternal wound infection ($56,003) after isolated CABG, even after adjusting for baseline preoperative risk [2].

Few articles have characterized hospital-level variability in HAI rates. Rogers and colleagues [6] analyzed a cohort of Medicare beneficiaries who underwent CABG between 2003 and 2006. Using administrative data, the authors reported wide variability in infection rates across hospitals, especially among women. More recently, Shih

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and colleagues [1] identified significant variability in the observed rates of HAIs across hospitals participating in the Michigan Society of Thoracic and Cardiovascular Surgeons Quality Collaborative. They reported an overall HAI rate of 5.1%, which varied between 0.9% and 19.1% across hospitals. Although this cohort consisted of 20,896 patients, only 33 hospitals were involved in their study.

A more thorough characterization, including a nationally representative cohort, would improve our overall understanding of the epidemiology of HAIs in this setting. In this descriptive study, we characterized the hospital-level variability in HAI rates across hospitals participating in The Society of Thoracic Surgeons Adult (STS) Cardiac Surgery Database (ACSD).

Material and Methods

This study was approved by the Duke University Health System Institutional Review Board, which declared it to be research not involving human subjects [7].

The STS ACSD

We included 365,686 patients undergoing isolated CABG between July 2011 and December 2013 at 1,084 hospitals participating in the STS ACSD. The STS believes that current hospitals participating in the STS ACSD represent more than 90% of hospitals providing adult cardiac operations in the United States.

Study Variables

The primary outcome for this analysis was the postoperative development of an HAI, defined as presence of any one of the following: pneumonia, sepsis or septicemia, harvest or cannulation site infection, deep sternal wound infection, or thoracotomy or parasternal site infection.

Rates of overall HAIs were compared across hospitals, and three categories of HAI hospitals were defined according to percentile cutoffs: low rate ($\leq$10th percentile), medium rate (10th and 90th percentile), and high rate (>90th percentile). We computed the rates of major in-hospital morbidity (stroke, reoperation, renal failure, and prolonged ventilation) or death associated with the three categories of HAI hospitals.

Statistical Analysis

Continuous variables are presented as median (interquartile range: 25th, 75th) and categoric variables as counts and percentages. Continuous variables were compared using the Wilcoxon rank sum test, and categoric variables were compared using the Pearson χ^2 test. Given the influence that pneumonia has on a center's HAI rate, we conducted a sensitivity analysis using a modified definition of HAI excluding pneumonia and estimated the degree of concordance, defined as the percentage of hospitals/patients remaining in the same infection category (low, medium, or high), between definitions. Statistical analyses were performed using SAS 9.3 software (SAS Institute Inc, Cary, NC) and R 2.15.2 software (R Foundation for Statistical Computing, Vienna, Austria). The two-tailed tests were considered significant at a p value of less than 0.05.

Results

The overall rate of HAI was 3.97% and varied significantly across hospitals (Fig 1). The HAI rate was less than 0.84% in the low-rate hospitals, 0.84% to 8.41% in the medium-rate hospitals, and >8.41% in the high-rate hospitals.

Differences in case mix and processes of care among the 365,686 patients from the three categories of HAI hospitals are reported in Table 1. Overall, the average age was

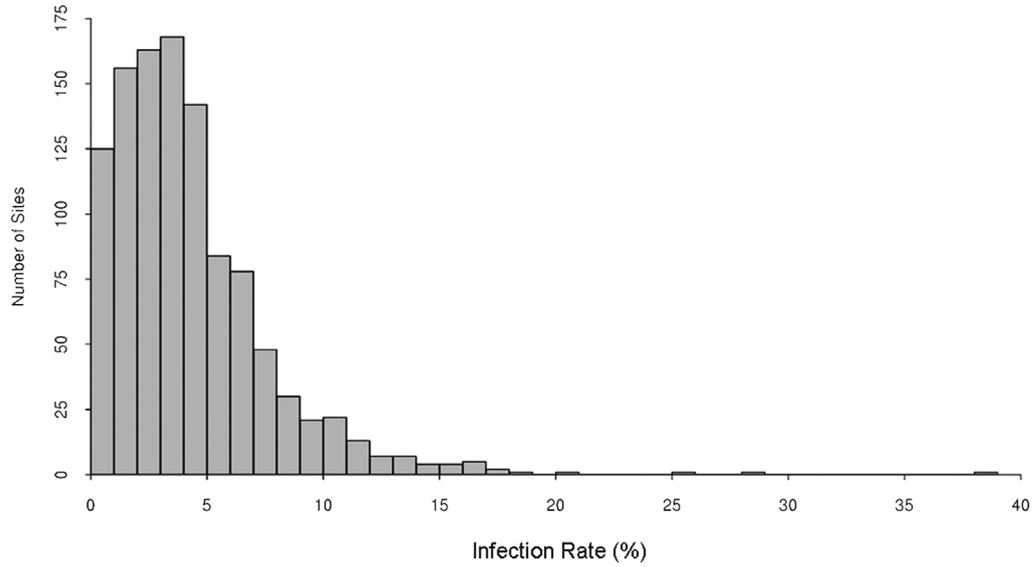

Fig 1. Histogram of overall rate of hospital-acquired infections (HAIs) among 1,084 participating hospitals. HAIs were defined as pneumonia, sepsis/septicemia, deep sternal wound infection/mediastinitis, vein harvest/cannulation infection, or thoracotomy infection.