U.S. Hospital Use of Echocardiography

Insights From the Nationwide Inpatient Sample

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ABSTRACT

BACKGROUND Increased use of echocardiography (echo) raises questions of whether echo is an overused diagnostic procedure in the United States.

OBJECTIVES This study investigated national trends, practice patterns, and patient outcomes associated with inpatient echo use reported in the Nationwide Inpatient Sample (NIS).

METHODS We identified admission diagnoses most commonly associated with echo use and performed multivariate logistic regression within each diagnosis cohort to assess whether echo use was associated with all-cause inpatient mortality. Secondary analysis was performed within our institution to validate use trends identified in the NIS database.

RESULTS Between 2001 and 2011, the absolute volume and incidence of echo steadily increased at average annual rates of 3.41% and 3.04%, respectively. In 2010, the use of echo was associated with lower odds of inpatient mortality among hospitalizations for acute myocardial infarction (adjusted odds ratio [OR]: 0.74; 95% confidence interval [CI]: 0.63 to 0.86; p < 0.001), cardiac dysrhythmia (adjusted OR: 0.72; 95% CI: 0.55 to 0.94; p = 0.02), acute cerebrovascular disease (adjusted OR: 0.36; 95% CI: 0.31 to 0.42; p < 0.001), congestive heart failure (adjusted OR: 0.82; 95% CI: 0.72 to 0.94; p = 0.005), and sepsis (adjusted OR: 0.77; 95% CI: 0.70 to 0.85; p < 0.001). In 2010, these 5 diagnoses accounted for 3.7 million hospital admissions (9% of all hospitalizations); however, echo was reported in only 8% of cases. Secondary analysis of imaging practices at our institution confirmed underuse of echo among patients who died during hospitalization for indications identified in the NIS database.

CONCLUSIONS Despite increasing rates of performance, echo may be underused during critical cardiovascular hospitalizations. (J Am Coll Cardiol 2016;67:502–11) © 2016 by the American College of Cardiology Foundation.

Echocardiography (echo) is the most ubiquitous, versatile, and cost-effective cardiac imaging modality available (1-5). These attributes, in combination with an infinitesimal risk-to-benefit ratio, explain why echo has become a mainstay of the cardiovascular evaluation. Widespread reliance on echo has fostered growing concern for its overuse and has led to the formation of appropriate use criteria (1). Although several studies have demonstrated adherence to these guidelines in clinical practice (2-4), national trends in the use of echo have not been fully described. The closest approximations are from Medicare literature, which

showed that the use of echo (transthoracic echocardiography [TTE] and transesophageal echocardiography [TEE]) increased by 7.7% per year from 1999 to 2004 (5), and it nearly doubled from 1999 to 2008 (6). Reports from the Veterans Healthcare Administration also demonstrated an annual increase in total echo volume of 3.9% from 2000 to 2007, but this finding was primarily driven by population expansion rather than by a change in imaging practices (7). Given the paucity of data, this study was conducted to describe trends, practice patterns, and patient outcomes associated with the use of echo through a comprehensive assessment of hospitalizations

available in the Nationwide Inpatient Sample (NIS) database (8).

METHODS

We first queried the NIS to quantify temporal trends in inpatient echo use between 2001 and 2011. Next we explored the 2010 database to investigate whether echo use was associated with all-cause in-hospital mortality among the diagnoses for which echo is most commonly performed.

DATA SOURCE. The NIS is the largest, publicly available, all-payer inpatient database in the United States (8). Annually, the NIS is composed of discharge-level data from roughly 8 million hospitalizations and approximates a stratified sample of 20% of community hospitals in the United States. The sampling methodology of the NIS permits the application of weighting variables that allow for the calculation of national estimates, which have been validated against other U.S. hospital registries (9). Each hospitalization within the database contains clinical and resource-use information. Patients' diagnoses are documented in parallel, as both International Classification of Disease-9th edition-Clinical Modification (ICD-9-CM) and clinically meaningful clusters of ICD-9-CM's, termed Clinical Classification Software (CCS) codes.

TEMPORAL TRENDS IN ECHO USE. The Healthcare Cost and Utilization Project online NIS registry (HCUPnet) (10) was queried by the ICD-9-CM for echo (procedure code 88.72). This provided national estimates of hospitalizations in which echo was performed from 2001 through 2011. The ICD-9-CM 88.72 is used for coding of all forms of echo. Therefore the database cannot differentiate admissions in which TTE examinations or other forms of echo such as TEE were performed. However, this limitation is likely to be insignificant given that the approximate ratio of TTE use to TEE use is close to 100:1 (6), as well as the clinical insight that few patients receive TEE without first undergoing TTE.

STUDY POPULATION. The 2010 NIS was used to evaluate for an association between echo use and diagnosis specific all-cause hospital mortality. The dataset was first confined to admission diagnoses associated with the greatest proportion of echo use (representing one-half of all estimated inpatient echo studies in 2010) (10). This included acute myocardial infarction (AMI), cardiac dysrhythmia, acute cerebrovascular disease, congestive heart failure (CHF), coronary

artery disease (CAD), sepsis, valvular disease, and nonspecific chest pain (CCS diagnoses codes: 2, 96, 100, 102, 101, 106, 108, and 109). We subsequently applied 3 criteria to the sample: 1) non-emergency department admissions were excluded to control for confounding hospital-to-hospital transfers; 2) hospitalizations lasting <24 h were excluded to counter bias created by critically ill patients in whom a fatal outcome occurred without sufficient lead time to obtain an echo examination if clinically indicated; and 3) neonatal patients were excluded. The final sample included an estimated 3,651,503 hospitalizations and contained 31% of all estimated inpatient echo examinations performed in 2010. State-specific rates of inpatient echo use were derived by dividing estimated statewide echo volume by the corresponding volume of estimated hospitalizations, as recorded in the 2010 NIS.

PATIENT-RELATED AND HOSPITAL CHARACTERISTICS. To assess for association between echo performance and diagnosis-specific hospital mortality rates, we stratified the sample by primary CCS diagnosis code (admission diagnosis). Available independent variables for analyses included the patient's age, race, sex, insurance status, number of comorbidities, median household income by zip code, illness severity score, and admission day (weekend vs. weekday). Information on race was categorized as white, black, Hispanic, and other (Asian, Pacific Islander, Native American, and unknown). Insurance status was classified based on the expected primary payer and included Medicare, Medicaid, private insurance, and other insurance types, including patients who were uninsured. The number of comorbid conditions was a sum of all listed diagnoses. Median household income per patient's zip code was divided into income quartiles defined as follows: 1) $1 to $40,999; 2) $41,000 to $50,999; 3) $51,000 to 66,999; and 4) ≥$67,000. Illness severity was based on All Patient Refined–Diagnosis Related Group (APR-DRG) severity score, a validated clinically coherent set of illness severity and risk of mortality subclasses that adjust for the interactions between a patient's primary diagnosis, comorbidities, age, and procedures occurring during hospitalization, defined as: 1) minor; 2) moderate; 3) major; and 4) extreme (11).

HOSPITALIZATION OUTCOME. The primary endpoint was in-hospital mortality and was analyzed using multivariate regression, as described later.

ABBREVIATIONS AND ACRONYMS

AMI = acute myocardial infarction

APR-DRG = All Patient Refined–Diagnosis Related Group Severity Score

CAD = coronary artery disease

CCS = Clinical Classification Software

CHF = congestive heart failure

echo = echocardiography

ICD-9-CM = International Classification of Disease-9th edition-Clinical Modification

NIS = Nationwide Inpatient Sample

OR = odds ratio

TEE = transesophageal echocardiography

TTE = transthoracic echocardiography