ADULT CARDIAC SURGERY:
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Penetration, Completeness, and Representativeness of The Society of Thoracic Surgeons Adult Cardiac Surgery Database

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Background. **The Society of Thoracic Surgeons (STS) Adult Cardiac Surgery Database (ACSD) has been successfully linked to the Centers for Medicare and Medicaid (CMS) Medicare database, thereby facilitating comparative effectiveness research and providing information about long-term follow-up and cost. The present study uses this link to determine contemporary completeness, penetration, and representativeness of the STS ACSD.**

Methods. **Using variables common to both STS and CMS databases, STS operations were linked to CMS data for all CMS coronary artery bypass graft (CABG) surgery hospitalizations discharged between 2000 and 2012, inclusive. For each CMS CABG hospitalization, it was determined whether a matching STS record existed.**

Results. **Center-level penetration (number of CMS sites with at least one matched STS participant divided by the total number of CMS CABG sites) increased from 45% in 2000 to 90% in 2012. In 2012, 973 of 1,081 CMS CABG sites (90%) were linked to an STS site.**

Patient-level penetration (number of CMS CABG hospitalizations done at STS sites divided by the total number of CMS CABG hospitalizations) increased from 51% in 2000 to 94% in 2012. In 2012, 71,634 of 76,072 CMS CABG hospitalizations (94%) occurred at an STS site.

Completeness of case inclusion at STS sites (number of CMS CABG cases at STS sites linked to STS records divided by the total number of CMS CABG cases at STS sites) increased from 88% in 2000 to 98% in 2012. In 2012, 69,213 of 70,932 CMS CABG hospitalizations at STS sites (98%) were linked to an STS record.

Conclusions. **Linkage of STS and CMS databases demonstrates high and increasing penetration and completeness of the STS database. Linking STS and CMS data facilitates studying long-term outcomes and costs of cardiothoracic surgery.**

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The Society of Thoracic Surgeons (STS) adult cardiac surgery database (STS ACSD) captures detailed clinical data on adults undergoing cardiac surgical

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procedures performed by STS database participants [1]. An STS database participant is typically a "practice group of cardiothoracic surgeons" or a hospital-based cardiothoracic division or department; uncommonly, an STS database participant is an individual cardiothoracic surgeon. The STS ACSD now encompasses the entire spectrum of adult cardiac surgery, including coronary artery bypass graft (CABG) surgery; surgery of the aortic, mitral, tricuspid, and pulmonary valves; surgery of the thoracic aorta; arrhythmia procedures; and less commonly performed procedures such as pulmonary thromboendarterectomy and removal of tumors of the heart and vena cava.

Data from the STS ACSD are reported back to participants on a quarterly basis in feedback reports. Twice yearly, these feedback reports contain reports of performance on National Quality Forum-endorsed STS metrics and on the various STS composite performance metrics for specific procedures (eg, isolated CABG, isolated aortic valve replacement, aortic valve replacement plus CABG) [2–5]. These performance reports provide numerical point estimates with credible intervals based on a Bayesian hierarchical model, and they also assign participants to a "star rating" category based on the true Bayesian probabilities (eg, 99% for isolated CABG) that the provider is an average, above average, or below average performer. In addition to these regular confidential feedback reports, STS ACSD data are used for quality assessment, performance improvement initiatives, research, public reporting [6–8], and to satisfy regulatory and reimbursement imperatives. Demonstration of high national penetration of STS ACSD and high completeness of data in the STS ACSD are of critical importance when using these data for accountability, reimbursement, quality improvement, and public reporting. Conversely, lack of high national penetration of clinical databases is a commonly used rationale for continued use of claims-based administrative metrics for quality improvement and public reporting.

Evaluation of long-term patient outcomes is also a key goal of the STS. While recognizing the many strengths of the STS National Database, an ongoing limitation has been the lack of longitudinal follow-up information beyond hospital discharge and 30 days after a procedure. Furthermore, the accuracy of information collected after discharge and as long as 30 days after a procedure varies among institutions, and addressing this variability is a major goal of the STS. The Medicare database of the Centers for Medicare and Medicaid Services (CMS) complements the detailed clinical records available in the STS database by providing information about longitudinal long-term outcomes and cost. A prior publication has outlined the methods and initial success of linking the CMS Medicare database to the STS database [1]. Linking these two data sources facilitates comparative effectiveness research and provides information about cost as well as long-term survival, rehospitalizations, and reinterventions. The 2007 STS-CMS link was previously used to examine completeness, penetration, and representativeness of the STS ACSD [1]. The purpose of the present study is to use the STS-CMS link to determine contemporary penetration, completeness, and representativeness of the STS ACSD.

Patients and Methods

Institutional Review Board Approval

This study was approved by the Duke University Health System Institutional Review Board. Because the data used in analysis represent a limited data set (no direct patient identifiers) that was originally collected for nonresearch purposes, and the investigators do not know the identity of individual patients, the analysis of these data was declared by the Duke University Health System Institutional Review Board to be research not involving human subjects [9]. This manuscript was also reviewed and approved by the STS National Database Access and Publications Task Force and the STS National Database Quality Measurement Task Force.

Medicare Database of Centers for Medicare and Medicaid Services

Medicare is health insurance provided by the federal government of the United States of America for the following groups of patients: (1) people aged 65 years or older; (2) people younger than 65 with certain disabilities; and (3) people of any age with end-stage renal disease, defined as "permanent kidney failure requiring dialysis or a kidney transplant." The CMS administrative claims data source for this study is the 100% Medicare inpatient claims file, which contains information on hospitalizations of patients enrolled in fee-for-service Medicare. It includes dates of service and diagnostic codes from the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM). The database contains anonymous patient identifiers that enable follow-up of beneficiaries over time, but does not allow identification of any beneficiary through their Medicare health insurance number. In addition, the 100% Medicare denominator file, which links to the inpatient file, contains information on beneficiary eligibility, demographic characteristics, and date of death.

The STS ACSD was linked to CMS claims files using combinations of nonunique indirect identifiers [1, 9, 10]. Records in the two databases were considered to be the same patient if they matched on a set of indirect identifiers including hospital, date of birth, sex, admission date, and discharge date. The matching algorithm required an exact match on a few of these variables or partial matching on a larger number of variables. In a pilot investigation using claims data for patients with heart failure, almost all (99.9%) CMS records from the same hospital were uniquely identified using date of birth, along with any combination of admission date and discharge date, regardless of patient sex.

The Duke Clinical Research Institute used variables common to both the STS ACSD and the CMS Medicare database to link STS operations to CMS inpatient claims data for all hospitalizations during which a patient underwent CABG surgery, with or without concomitant procedures. These hospitalizations are termed