

National Trends and Outcomes of Transjugular Intrahepatic Portosystemic Shunt Creation Using the Nationwide Inpatient Sample

Premal S. Trivedi, MD, MSE, Paul J. Rochon, MD, Janette D. Durham, MD, MBA, and Robert K. Ryu, MD

ABSTRACT

Purpose: To elucidate trends in transjugular intrahepatic portosystemic shunt (TIPS) use and outcomes over the course of a decade, including predictors of inpatient mortality and extended length of hospital stay.

Materials and Methods: The Nationwide Inpatient Sample was interrogated for the most recent 10 years available: 2003–2012. TIPS procedures and associated diagnoses were identified via International Classification of Diseases (version 9) codes, with the latter categorized into primary diagnoses in a hierarchy of disease severity. Linear regression analysis was used to determine trends of TIPS use and outcomes over time. Independent predictors of mortality and extended length of stay were determined by logistic regression.

Results: A total of 55,145 TIPS procedures were captured during the study period. Annual procedural volume did not change significantly (5,979 in 2003, 5,880 in 2012). The majority of TIPSs were created for ascites and/or varices (84%). Inpatient mortality (12.5% in 2003, 10.6% in 2012; $P < .05$) decreased but varied considerably by diagnosis (from 3.7% to 59.3%), with a disparity between bleeding and nonbleeding varices (18.7% vs 3.8%; $P < .01$). Multivariate predictors of mortality ($P < .001$ for all) included primary diagnoses (bleeding varices, hepatorenal and abdominal compartment syndromes), patient characteristics (age > 80 y, black race), and sequelae of advanced cirrhosis (comorbid hepatocellular carcinoma, spontaneous bacterial peritonitis, encephalopathy, and coagulopathy).

Conclusions: National TIPS inpatient mortality has decreased since 2003 while procedural volume has not changed. Postprocedural outcome is a function of patient demographic and socioeconomic factors and associated diagnoses. Independent predictors of poor outcome identified in this large national population study may aid clinicians in better assessing preprocedural risk.

ABBREVIATIONS

BCS = Budd–Chiari syndrome, eLOS = extended length of stay, HRS = hepatorenal syndrome, ICD-9 = International Classification of Diseases, version 9, NIS = Nationwide Inpatient Sample, TIPS = transjugular intrahepatic portosystemic shunt

Transjugular intrahepatic portosystemic shunt (TIPS) creation plays an important role in treatment of patients with chronic liver disease and portal hypertension. Since

the procedure first entered the clinical domain in 1988 (1), thousands of patients worldwide have been treated with TIPS creation (2). National procedural volume and outcomes are not known. Published TIPS data largely emanate from academic centers and reflect a selected patient population, typically with defined inclusion and exclusion criteria. Current TIPS literature therefore may not fully encapsulate practice patterns or outcomes within the larger community of interventionalists treating a broader patient population.

We sought to evaluate national trends in TIPS use and postprocedural outcomes within a representative non-selected national cohort. The major objectives of the study were to determine (i) whether procedural volume has increased, (ii) whether diagnoses have changed,

From the Department of Radiology, University of Colorado Denver Anschutz Medical Center, Mail Stop 8200, AO1, Room 2414, 12631 E. 17th Ave., Aurora, CO 80045. Received September 8, 2015; final revision received December 10, 2015; accepted December 12, 2015. Address correspondence to P.S.T.; E-mail: premalstrivedi@gmail.com

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(iii) if inpatient mortality has improved, and (iv) whether there are predictors of poor outcome.

MATERIALS AND METHODS

Data Source

The Nationwide Inpatient Sample (NIS) is the largest inpatient database in the United States and is a 20% stratified sample originating from all hospitals participating in the Healthcare Cost and Utilization Project, which encompasses more than 95% of the US population. The deidentified administrative discharge dataset is available publicly for purchase from the Agency for Healthcare Research and Quality and contains no patient-level identifiers. Its use for the present study did not meet criteria for human subjects research per institutional review board guidelines and did not undergo review.

Study Population

TIPS procedures were retrospectively extracted from the NIS by their corresponding International Classification of Diseases, version 9 (ICD-9), code, 39.1, for the most recent 10 years available: 2003–2012. No demographic or clinical exclusion criteria were applied. A total of 55,145 TIPS procedures were identified during the study period. Of those, 4,280 (7.8%) did not have a relevant listed diagnosis and were therefore excluded from further analysis, leaving 50,868 in the study group.

Patient demographic characteristics of age, sex, race, and ZIP code income quartile were evaluated (Table 1). ZIP code income quartile, an indirect indicator of economic status, codifies the median household income within the patient's residence ZIP code into four national quartiles, the absolute income ranges for which are updated annually. Hospital characteristics of bed size category, teaching status, and location were evaluated. Hospital location is defined as urban or rural, with the designation determined by the Core Based Statistical Area. Hospital bed size reflects the number of short-term acute-care beds and is adjusted for rural versus urban location. The designation of teaching hospital implies that the hospital has an American Medical Association–approved residency program, is a member of the Council of Teaching Hospitals, or has a ratio of full-time equivalent interns and residents to beds of 0.25 or higher.

Underlying clinical diagnoses were identified by searching the database diagnosis fields for the ICD-9 codes corresponding to the following: gastrointestinal bleeding, bleeding esophageal varices, nonbleeding esophageal varices, ascites, abdominal compartment syndrome, hepatorenal syndrome (HRS), Budd–Chiari syndrome (BCS), portal vein thrombosis, portal hypertension, and hydrothorax. To better ascertain trends over time and the individual contribution of each diagnosis toward inpatient mortality, the following hierarchy of clinical

severity was used to assign procedures to a primary diagnosis when more than one pertinent diagnosis code was present: bleeding esophageal varices, gastrointestinal bleeding, HRS, abdominal compartment syndrome, BCS, nonbleeding esophageal varices, hepatic hydrothorax, ascites, portal vein thrombosis, and finally portal hypertension. This hierarchic allocation was developed via author consensus before outcomes analysis was performed.

Pertinent comorbidities among those recorded in the database and the following additional codiagnoses were evaluated: hepatocellular carcinoma (ICD-9 code 155.0), encephalopathy (ICD-9 code 572.2), and spontaneous bacterial peritonitis (ICD-9 code 567.23; Table 2).

Outcome Analysis

Primary outcomes of inpatient mortality and length of stay are reported in the database. Extended length of stay (eLOS) was defined to further evaluate the outlier group requiring greater than 2 standard deviations longer than the median length of stay, which equated to at least 20 days of hospitalization. Variables impacting mortality and eLOS were identified, including those of patient demographics, hospital characteristics, primary diagnosis, and comorbidities.

Statistical Analysis

All statistical analysis was performed with SAS (version 9; SAS, Cary, North Carolina) and STATA (version 11; StataCorp, College Station, Texas) software packages. Trends over time were evaluated by a generalized linear regression model. Categorical variables were compared by Wilcoxon rank-sum test. Multivariate models to identify independent clinical predictors of death and eLOS were developed by backward selection of univariate predictors meeting the threshold of $P < .10$. Results were considered statistically significant if they met the P value threshold of $< .05$.

RESULTS

Study Population

Median age within the TIPS population was 55 years, with 89% of cases in patients between 40 and 80 years of age (Table 1). Men constituted the majority of the TIPS population (65% overall), with the exception of BCS and portal vein thrombosis groups, which were composed of 58% and 52% women, respectively. Racial distribution of patients was similar across primary diagnoses, with white patients accounting for 71% of the TIPS population overall, and Hispanic patients, the second major racial subgroup, accounting for 17%.

There was a negative correlation between average income within patient residential ZIP code and TIPS creation overall (27.6% within the lowest income quartile, 21.8% within the highest income quartile; $P < .001$), primarily because of considerable discrepancy in income

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