Clinical Neurology and Neurosurgery 138 (2015) 99–103

Contents lists available at ScienceDirect

Clinical Neurology and Neurosurgery

journal homepage: www.elsevier.com/locate/clineuro

Incidence, hospital costs and in-hospital mortality rates of epidural hematoma in the United States

Shyamal C. Bir, Tanmoy Kumar Maiti, Sudheer Ambekar, Anil Nanda*

Department of Neurosurgery, LSU Health-Shreveport, 1501 Kings Highway, Shreveport, LA 71130-3932, USA

ARTICLE INFO

Article history:
Received 12 December 2014
Received in revised form 22 July 2015
Accepted 24 July 2015
Available online 17 August 2015

Keywords:
Epidural hematoma
National in-patient sample
Hospital cost
In-hospital mortality

ABSTRACT

Objective: This study provides the first United States (US) national data regarding frequency, cost and mortality rate of epidural hematoma (EDH) and determines the factors affecting the morbidity and deaths in the patients with EDH undergoing surgical evacuation.
Methods: A retrospective analysis was performed by searching the Nationwide Inpatient Sample (NIS) from 2003 to 2010, the largest all payer database of non-federal community hospitals in the US. All cases of EDH were indentified using ICD-9 codes.
Results: A total of 5189 admissions were identified in the NIS database, and incidence was highest in the second decade (33.4%). The median length of stay in the hospital was about 4 days in each year (2003–2010) without significant difference. The percent of discharge disposition other than home was about 2–3% in the entire cohort, with the highest in 2009 (3%). The average cost per admission increased significantly (80%) from $45,850 in 2003 to $82,800 in 2010. The inhospital mortality and complication rate was 3.5% and 2.9%, respectively. Factors affecting in-hospital mortality rate were age (≤18 yr vs. >18 yr, $P<0.001$), insurance type (medicare vs. private insurance, $P<0.001$), co-morbidities (high vs. low, $P<0.001$), hospital volume (high vs. low volume, $P<0.001$), physician's case volumes (high vs. low volume, $P<0.02$), hospital type (teaching vs. non-teaching, $P<0.01$) and hospital region (South vs. others, $P<0.02$). Similarly, factors affecting adverse outcome at discharge were age (≤18 yr vs. >18 yr, $P<0.001$), female gender ($P<0.001$), median income (fourth quartile vs. other, $P<0.001$), ethnicity (African–American vs. non-African–American, $P<0.02$), insurance type (medicare vs. private insurance, $P<0.001$), co-morbidities (high vs. low, $P<0.001$), hospital case volume (4th quartile volume vs. other, $P<0.001$), physician's case volume (4th quartile volume vs. other, $P<0.0001$), hospital type (teaching vs. non-teaching, hospital bed size (small vs. large, $P<0.001$), hospital region (Northeast vs. others, $P<0.001$) and hospital location (urban vs. rural, $P<0.001$).
Conclusion: Nationally, there has been no significant change in the frequency of EDH. However, its cost is increasing rapidly.

Published by Elsevier B.V.

1. Introduction

Epidural hematoma (EDH) is characterized by the acute onset of traumatic hemorrhage into potential space between the dura mater and skull following head injury. About 85% of the epidural cases are caused by skull fracture with rupture of the middle meningeal artery or its branches [5]. It is more common in male patients and usually occurs in the younger population because of the adherence of dura in the inner surface of the skull in the elder population [4]. Epidural hematoma is a neurosurgical emergency that requires immediate operative management [5]. Despite advancement in neurosurgical management and increasing health care costs within the US, EDH remains a major cause of significant morbidity and mortality. Research evidence suggested that in most case series, the mortality rate for the surgical patients with epidural hematoma was between 12 and 30% [2,3,6]. In addition, the mortality rate is higher (27–70%) in comatose patients undergoing neurosurgical management [2,6,10]. The outcome of these series was largely from single institution series of small patient volume [2,3,6]. The NIS, the largest inpatient database, provides the data to identify and analyze the national trends in health care use, quality and cost [6]. As of now, there is no available data in the literature about hospital cost, or the incidence of inpatient mortality for the patients with EDH in the US. In this study, we have analyzed the data of all EDH from 2001 to 2010 recorded in international Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM).

* Corresponding author.
E-mail address: ananda@lsuhsc.edu (A. Nanda).

http://dx.doi.org/10.1016/j.clineuro.2015.07.021
0303-8467/Published by Elsevier B.V.

2. Methods

2.1. Data source

Data was collected from the NIS database from 2003 to 2010. The NIS database is the largest source of inpatient care data in the US and contains data on 5–8 million hospital admissions from about 1000 hospitals in 45 states. It is provided by the Healthcare Cost and Utilization Project, sponsored by the Agency for Health care Research and Quality (AHRQ, Rockville,). The NIS database is a 20% stratified sample of nonfederal community hospitals and includes about 85% of all hospital discharges in the US.

2.2. Defining the study sample

The data was obtained for traumatic EDH from 2003 to 2010 from NIS by using the ICD-9-CM (International Classification of Diseases, Ninth Revision, Clinical Modification) diagnosis and treatment codes. All admissions with primary diagnosis code of 852.40–852.46 or 852.49–852.56 and 852.59, were included in the study. We did not include the non-traumatic EDH (ICD-9 code: 432.0) data in this article. The primary adverse endpoints were in-hospital death or discharge to facilities other than home/self-care.

2.3. Patient and hospital characteristics

Patient age, gender, race, admission source, admission type, primary payer, time of craniotomy and household income for zip code were extracted directly from NIS and included in the analysis. Patients were categorized into two groups, with or without complications. Complications were obtained from the NIS database depending on the ICD-9-CM diagnosis codes: postoperative hematoma and hemorrhage (998.1, 998.11–998.13), neurologica (997.00–997.02, 997.09), thromboembolic complications including deep vein thrombosis and pulmonary embolus (415, 415.1, 415.11, 415.12, 415.19, 451, 451.0–451.2, 451.8, 415.9, 453, 453.0–453.4, 453.8, 453.9), pulmonary excluding embolus (518.81–518.84, 997.3), cardiac (997.1, 410) and urinary and renal (584, 997.5). The modified Charlson co-morbidity index was used to classify co-morbidities, categorizing them as low (0 or 1) or high ($\geq$2) for analysis. Missing values in the database were not taken into consideration for analysis. Hospital cost was calculated using the variable total charges in the NIS database.

Region of the hospital, teaching status, hospital location, hospital size by bed numbers, hospital physicians and volumes were included for analysis. Annual hospital volume was extracted using the individual hospital identifier, and each hospital was classified into quartiles according to the volume of the patients. Mortality and discharge disposition were compared between hospitals and physicians with high or low volumes.

2.4. Outcome variables

The primary outcomes were in-hospital mortality (death), discharge disposition (discharge to facilities other than home/self care) and complications. Discharge disposition to home was considered as routine disposition, but discharges to all other places (transfer to skilled nursing facility, intermediate care facility, home health care, or against medical advice and died) were categorized as other than routine disposition.

2.5. Statistical analysis

Statistical analysis was performed using commercially available software, SPSS version 21.0 (SPSS, IBM Corp., Armonk, NY). We used discharge weights to analyze the national estimate. The Chi-square and Pearson's correlation were used to evaluate the categorical variables. Binary logistic regression analysis was used for the multivariate analysis to generate odds ratio and confidence interval. Missing values were omitted during the analysis. A P value <0.05 was considered as significant.

3. Results

The NIS database contained 5189 admission records for epidural hematoma between 2003 and 2010. Forty-eight percent of the patients were under 18 years old and 49% of the patients were 19–69 years old. About three-fifths (61.6%) of the patients were Caucasians. Three fourths (76.6%) of the patients were admitted from the emergency department, and routine admission was only 11.1%. Thirty-five percent of the patients were admitted on a weekend. Private insurance was the major payer (49.1%) for these patients, whereas medicare paid only for 2.3% of the patients. Craniotomy on the first day of admission was about 80% (Fig. 1 and Table 1).

3.1. Postoperative complications

Hemorrhage and hematoma were observed in 0.54% of the patients, and neurological complications were found in 0.36% of the patients. Thrombotic complications (deep vein thrombosis and pulmonary embolism) were revealed in 0.36% of the patients, and pulmonary complications excluding embolism were observed in 0.28% of the patients. Cardiac and urinary system complications were observed in 0.28% and 0.9% patients respectively. Low (0–1) co-morbidities were found in 98.6% patients and high ($\geq$2) co-morbidities were observed in 1.4% patients. Median stay in the hospital was 4 days. The median total admission charge was $41,128.00 (Fig. 2 and Table 1).

3.2. Patient's characteristics and outcome at discharge

Younger patients ($\leq$18years) showed a high rate of adverse outcome and in-hospital mortality compared to older patients ($P<0.001$). Gender and ethnicity did not show any significant difference in mortality rate, but these factors were significant predictors of adverse disposition. Medicare insurance had a significantly higher rate of adverse disposition ($P<0.001$) and in-hospital mortality rate ($P<0.001$) than private insurance. There was no significant difference in outcome in respect to day of admission (weekend vs. weekday) and primary procedure on the first day of admission. The patients with low median household income had a significantly higher rate of adverse disposition than the patients with high median household income. Patients with low co-morbidities had significantly lower adverse disposition and mortality rate compared to patients with higher co-morbidities (Tables 1 and 2).

3.3. Hospital and surgeon characteristics and outcome

Teaching status of the hospital, bed size (small vs. large) and location (urban vs. rural) had significant bearing on adverse disposition. Although teaching status of the hospital had significant effect on in-hospital mortality, bed size and location of the hospital had no significant effect on in-hospital mortality. Patients admitted in the hospitals with high case volume had significantly lower adverse disposition and mortality rate compared to low case volume hospitals. Patients admitted in rural hospitals had significantly higher adverse disposition compared to urban hospitals, but there was no significant difference in mortality rate between these two groups. Patients admitted in the South had significantly low