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Economics of facial fracture reductions in the United States over 12 months

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Abstract – Objective: The face is a complex architectural structure in the body and is a high-risk site for fractures. Hospitalization is necessary for adequate treatment. The objective of this study is to examine hospitalization outcomes associated with reduction in facial fractures in the United States. Methods: The Nationwide Inpatient Sample (NIS) of the health care cost and utilization project for 2008 was used. This database provides weighted estimates of all hospitalizations in the United States, which approximates 39.88 million admissions in the entire United States. Hospital discharges with primary procedure ICD-9-CM codes for reduction in facial fractures were selected. Outcomes examined included hospitalization charges, length of stay, and causes of injuries. All estimates obtained from the sample were projected to national levels. Results: Reduction in facial fractures was performed as primary procedure in 21 244 hospitalizations. The total hospitalization charges were about \$1.06 billion, and total hospitalization days was 93 808. About 80% of all hospitalizations occurred among men. The frequently occurring external causes of injuries leading to hospitalization for reduction in facial fractures include assault (36.5% of all hospitalizations), motor vehicle traffic accidents (16%), falls (15%), and other transportation accidents (3.5%). The frequently performed procedures were open reduction in mandibular fractures (52.2%), open reduction in facial fractures including those of orbital rim or wall (14.7%), closed reduction in mandibular fractures (12.1%), and open reduction in malar and zygomatic fractures (11.8%). Conclusions: National hospitalization outcomes related to reduction in facial fractures indicate an extensive consumption of hospital resources. If hospital emergency room protocols and inpatient protocols relating to the most expensive fractures and longest hospital stays that we have identified can improve, this may lead to improved outcomes and a reduction in hospital charges for facial fractures.

Introduction

Hospitalizations because of fractures of the mandible and maxilla are known to incur a significant burden on the community impacting both finances and lost days from work and school. Previous research has considered the hospital costs of specific facial fracture types (1); however, this study had a sample size of only 12 fractures and authors could only conclude that costs 'vary widely' for managing mandibular fractures. Another study has compared inpatient costs with outpatient costs (2) when managing mandibular fracture and found the most cost effective method to be evaluation at the emergency department followed by elective, delayed care in stable patients cases. However, there is a paucity of knowledge of how fractures of the mandible and maxilla are managed in hospital, the financial burden of this care, and the co-morbidities of patients who require facial fracture reduction. The objective of this study is to provide descriptive data on the characteristics of patients requiring hospitalization for facial fractures

and characteristics associated with facial fracture reduction using a nationwide dataset.

There is much variation in the findings of previous studies that have considered patients hospitalized for facial fractures. This variation may limit the use of those findings in guiding cost effective policy decisions to help reduce the incidence of hospitalizations because of these fractures in the United States. For example, motor vehicle accidents (MVA) as a cause of maxillofacial fractures varied from 5% in a study of Indigenous Australians (3) to 70% in a Canadian study (4) that constitutes a 14 times increased risk of maxillofacial fracture because of MVA between studies. Similarly, accidental falls as a cause of fractures varied from 7% in one study (5) to 26% in another study (6).

Existing research suggests that men tend to be the victims of fractures of the mandible or maxilla more frequently than women (3–5, 7–10). Existing studies also suggest that MVA or assault tends to be the most common causative events (3–5, 7, 8, 10–12), but there is large variation from studies in one country to another.

An objective of our study is to identify populations who are most frequently victims of fractures of the mandible and maxilla. Preventive interventions that target these groups may cause a large reduction in the incidence of fractures of the mandible and maxilla. We hope that this will, subsequently, reduce the financial burden on the health care system in the United States and lead to the more efficient use of those funds.

Methods

This retrospective study utilized data from the 2008 Nationwide Inpatient Sample (NIS) that is a component of the Healthcare Cost and Utilization Project (HCUP) (13). This dataset is available for research purposes through Agency for Healthcare Research and Quality (AHRQ), Rockville, MD, USA. NIS is a large, uniform, multistate dataset from 20% stratified sample of US community hospitals containing information with regards to 8 million hospital stays each year. It encompasses data from 1056 hospitals situated across 42 states in USA. The hospitals included in the NIS dataset are drawn from 5162 hospitals (hospital universe) in the entire United States. The NIS sampling strata is based on five hospital characteristics including geographic region (northeast, Midwest, south, and west), control or ownership (government non-federal, private not for profit, and private investor owned), location (rural or urban), teaching status (teaching or non-teaching), and bed size (small, medium, or large). The NIS dataset is designed to be a stratified probability sample of hospitals form the sample frame with sampling probabilities estimated to select 20% of the universe of U.S. community, nonrehabilitation hospitals contained in each stratum (13). Each discharge (hospitalization) in the NIS dataset is assigned a sample weight that can be used to project to 100% of all hospitalizations in the entire United States. This database provides weighted estimates of all hospitalizations in the United States, which approximates 39.88 million admissions in the entire United States.

The NIS is the largest, all-payer health database in the United States. The NIS dataset provides information on close to 100 patient and hospital-related variables including age, gender, race, insurance status, primary diagnosis (reason for hospitalization), presence of co-morbid conditions, external causes of injuries, procedures performed during hospitalization, length of stay in hospital, hospital charges, discharge status, and type of admission (elective or emergency/urgent).

As this is a secondary dataset made available to researchers and policy makers through AHRQ, it does not require institutional review board approval. Upon completing the data user agreement with HCUP, one of the authors obtained the dataset and conducted the analyses. In this study, all patients hospitalized with an ICD-9-CM (International Classification of Diseases, 9th Revision, Clinical Modification) code for facial fracture reduction in the primary procedure field were included. The specific codes from 76.70 through 76.79 were utilized in the current study. The ICD-9-CM codes used to select the hospitalizations are '76.70' (reduction in facial fracture, not otherwise specified), '76.71' (closed reduction in

malar and zygomatic fracture), '76.72' (open reduction in malar and zygomatic fracture), '76.73' (closed reduction in maxillary fracture), '76.74' (open reduction in maxillary fracture), '76.75' (closed reduction in mandibular fracture), '76.76' (open reduction in mandibular fracture), '76.77' (open reduction in alveolar fracture), '76.78' (closed reduction in orbital fracture), and '76.79' (open reduction in orbit rim or wall).

All estimates obtained from the NIS dataset were projected to the national level with the use of a discharge weight variable assigned to each discharge. Simple descriptive statistics (frequencies) were used to summarize the prevalence estimates of facial fracture reduction. Analyses utilized the sas Version 9.2 (SAS Institute, Cary, NC, USA) and sas Callable SUDAAN Version 10.0.1 (Research Triangle Park, NC, USA) software programs. As dictated by the data user agreement with AHRQ, any individual cell counts below or equal to 10 cannot be presented to maintain patient confidentiality. Consequently, in the current study, all estimates that occur ≤ 10 are denoted by 'DS' (discharge status suppressed as per the data user agreement).

Results

In year 2008, a total of 21 244 hospitalizations underwent a facial fracture reduction in the United States as a primary procedure. Characteristics of these hospitalizations are summarized in Tables 1–4. Close to 80% of all hospitalizations occurred among men. Private insurance and Medicaid were the primary payers in 38.2% and 18.1% of hospitalizations, respectively. Uninsured individuals represented 20.8% of hospitalizations. Whites, Blacks, and Hispanics represented 57.3%, 19.8%, and 15.9%, respectively (Table 1). The common co-morbid conditions associated with facial fractures were alcohol abuse (15.4%), hypertension (13.2%), drug abuse (9.6%), chronic pulmonary disease (7.5%), and fluid and electrolyte disorders (6.0%) (Table 2).

Table 1. Characteristics of patients hospitalized for facial fractures $(N = 21 \ 244)$

Characteristic	Response	N (%)	
Gender	Male	16 653 (79.6)	
	Female	4257 (20.4)	
Insurance status	Medicare	2027 (9.6)	
	Medicaid	3819 (18.1)	
	Private	8076 (38.2)	
	Uninsured	4394 (20.8)	
	Others	2792 (13.2)	
Type of admission	Elective	18 279 (86.5)	
	Emergency/Urgent	2852 (13.5)	
Race	White	9637 (57.3)	
	Black	3336 (19.8)	
	Hispanic	2669 (15.9)	
	Asian or pacific islander	226 (1.3)	
	Native American	212 (1.3)	
	Others	738 (4.4)	

Individual cell counts may not add up to the global cell counts because of missing values and also the differences arising from variance computations when using the discharge weight variable.

Table 2. Presence of co-morbid conditions

Co-morbid condition	N (%)		
AIDS	63 (0.3)		
Alcohol abuse	3287 (15.4)		
Deficiency anemias	578 (2.7)		
Rheumatoid arthritis/collagen vascular diseases	94 (0.4)		
Chronic blood loss anemia	73 (0.3)		
Congestive heart failure	191 (0.9)		
Chronic pulmonary disease	1586 (7.5)		
Coagulopathy	224 (1.1)		
Depression	825 (3.9)		
Diabetes, uncomplicated	839 (3.9)		
Diabetes with chronic complications	87 (0.4)		
Drug abuse	2034 (9.6)		
Hypertension	2809 (13.2)		
Hypothyroidism	360 (1.7)		
Liver disease	242 (1.1)		
Lymphoma	15 (0.1)		
Fluid and electrolyte disorders	1278 (6.0)		
Metastatic cancer	25 (0.1)		
Neurological disorders	704 (3.3)		
Obesity	388 (1.8)		
Paralysis	109 (0.5)		
Peripheral vascular disorders	153 (0.7)		
Psychoses	890 (4.2)		
Pulmonary circulation disorders	79 (0.4)		
Renal failure	148 (0.7)		
Solid tumor without metastasis	34 (0.2)		
Valvular disease	229 (1.1)		
Weight loss	294 (1.4)		

Table 3. Causes of facial fracture

Etiology	N (%)
Cut and/or pierce	88 (0.4)
Fall	3182 (15.0)
Fire	DS
Firearm	264 (1.2)
Machinery	67 (0.3)
MVT	3345 (15.7)
Pedalcycle	452 (2.1)
Pedest	34 (0.2)
Transportation	748 (3.5)
Nature	DS
Overext	DS
Poison	26 (0.1)
Struck	7763 (36.5)
Suffocate	24 (0.1)

DS = Discharge Information Suppressed as individual cell count is ≤ 10 (as per Agency for Healthcare Research and Quality data user agreement).

Among the 14 different causes of facial fractures reported in this study, the most common causes were assault (36.5%), motor vehicle accident (15.7%), and accidental falls (15.0%) (Table 3).

The hospitalization charges and length of stay associated with different types of facial fracture reduction are described in Table 4. The total number of days in hospital for all admissions associated with reduction in facial fractures was 93 808. The different types of facial fractures reported in the current study were mandibular, malar and zygoma, maxillary, alveolar, and other unspecified fractures. Open reduction in mandibular fracture was the most frequent (ICD-9-CM code of 76.76) method of management and represented 52.2% and incurred a mean hospital cost of \$49 892. Closed reduction in the mandible (ICD-9-CM code of 76.75) was the next most frequent (12.1%), and the mean cost was \$26 035. Open reduction in the malar and zygoma (ICD-9-CM code of 76.72) represented 11.8%, and closed reduction represented for 0.2%.

The most expensive management was associated with open reduction in maxillary fractures (ICD-9-CM 76.74), which incurred a mean cost of \$88 442 for a nationwide total of \$130 628 834. This type of fracture reduction was also associated with the longest mean hospital stay (7.84 days) and the largest total number of hospital days (46 053 days).

Discussion

To our knowledge, this is the first study reviewing hospitalization outcomes and resource use involved with the management of facial fractures using a nationally representative database. The study focuses on three measures: causes of facial fractures, hospitalization charges associated with each fracture reduction method, and length of stay. The results of our study indicate that a large use of resources is involved in the management of facial fractures in hospitals. The total hospitalization charges for facial fracture reduction in the United States were \$1.06 billion in 2008.

Fractures that required open reduction in the mandible represented 52.2% of all hospitalizations because of facial fractures. In fact, these fractures accounted for more than half of all hospitalization charges and more than half of hospitalization days associated with facial fractures. Existing research shows that the mandible is the most commonly fractured facial bone and the zygoma is the second most common (14). Our study confirms these findings and also shows that mandibular fractures requiring reduction accounted for 64.3% of all fracture reductions.

Previous research shows that zygomatic bone fracture is the most prevalent non-mandibular facial fracture and that an open surgical procedure is the most common method of management (15). Our study concurs, demonstrating that open reduction in the malar and zygoma is the most frequent management needed for nonmandibular facial fractures.

The current study demonstrates that the most costly type of fracture to manage was open reduction in a maxillary fracture that cost \$88 442 each and accounted for 7.0% of all facial fractures. This fracture type was also associated with the longest mean hospital stay of 7.84 days. It is important to recognize that although our dataset captures charges associated with the hospitalizations, it does not provide information on other costs such as prescription medications, outpatient care, postdischarge care, or other miscellaneous costs involved with managing fractures of the mandible and maxilla in a hospital setting in the United States. Subsequently, the indirect costs associated with seeking care and days lost in work because of hospitalization may involve substantial additional costs to the patient.

			Hospitalization Charges (\$)		Length of Stay (Days)	
ICD-9-CM Procedure Code	Type of Facial Fracture Reduction	N (%)	Mean	Standard error	Mean	Standard error
76.70	Reduction in facial fracture, not otherwise specified	34 (0.2)	\$65 131	1810	5.82	0.24
76.71	Closed reduction in malar and zygomatic fracture	48 (0.2)	\$34 136	2233	3.98	0.34
76.72	Open reduction in malar and zygomatic fracture	2499 (11.8)	\$56 661	4699	4.90	0.34
76.73	Closed reduction in maxillary fracture	202 (1.0)	\$32 696	3736	3.61	0.46
76.74	Open reduction in maxillary fracture	1477 (7.0)	\$88 442	7851	7.84	0.72
76.75	Closed reduction of mandibular fracture	2578 (12.1)	\$26 035	2046	2.53	0.13
76.76	Open reduction in mandibular fracture	11 097 (52.2)	\$49 892	3914	4.15	0.21
76.77	Open reduction in alveolar fracture	130 (0.6)	\$45 171	6074	3.72	0.52
76.78	Other closed reduction in facial fracture	52 (0.2)	\$32 351	3233	2.89	0.26
76.79	Other open reduction in facial fracture	3127 (14.7)	\$54 091	3872	5.00	0.34

Table 4. Hospitalization charges and length of stay associated with types of facial fracture reduction

Previous studies have found alcohol to be involved in many incidents of facial fractures (14, 16), and one study found the percentage to be 87% (16). Our study found that 15.4% of facial fractures had a co-morbidity of alcohol abuse. Hypertension (13.2%) and drug abuse (9.6%) were also shown to be important co-morbidities. A Canadian study of 181 patients with mandibular fractures previously demonstrated that about a quarter of these fractures involved the use of alcohol or illegal drugs (11). Presenting education about negotiating and preventing violence as part of detoxification programs for drug and alcohol abuse may reduce the number of hospitalizations because of facial fractures.

In previous studies in developed nations, assaults vary from 28% in a German study (6) to 74% in an Australian study (3). Our study of a developed country, which is the largest study we are aware of, indicates that the main cause of facial fracture is assault and is associated with 36.5% of hospitalizations because of facial fracture. A very contrasting study result was discovered among the Armed Forces in Pakistan, which showed an incidence of jaw fractures from assault of only 4% (17). More research is needed to identify the specific factors that caused this remarkably low incidence, but it may be possible to extrapolate that a structured and disciplined lifestyle (like that in the Armed Forces) may reduce the incidence of jaw fractures because of assault.

Previous research has also shown that, in studies conducted in developing countries, motor vehicle accident (MVA) is the most common cause of jaw fracture (8, 12, 18, 19), whereas, in developed countries, assault is the most common cause and MVA is the second most common (5, 10–12, 20). Our study confirms this pattern for a developed country that the main cause of jaw fracture is assault (36.5%) and the next most common cause is MVA (15.7%).

Accidental falls is the third most common cause of facial fractures and accounts for 15.0% of cases. Various studies of developed nations have shown that accidental falls have been an important cause of facial fracture, but less important than MVA (6, 11, 20). Our study shows that accidental falls (15.0%) have become almost as important as MVA (15.7%) as a cause of facial fractures. There could be one of two causes for this: first, because our study is so large, it provides the first clear description of the causes of hospitalizations

because of jaw fractures; second, because motor vehicle safety campaigns have been effective in reducing MVA's in the United States.

As mentioned earlier, existing research has shown that men tend to have more jaw fractures than women (3-5, 7-10). Our study confirmed this finding with 79.6% of facial fracture reductions occurring in men.

Findings from the current study may have several policy implications: Education programs in the areas of drug and alcohol abuse, anger management, and negotiation that targets men may help reduce the incidence of facial fractures in the United States. Previous research has found that when facial fractures are the result of assault, men tend to be assaulted by an unknown attacker, whereas women tend to be assaulted by a known attacker (16). This knowledge should also be considered when developing an education program.

According to the racial profile of the patients hospitalized for facial fracture identified in our study, a relatively higher percentage of blacks (19.8%) was shown in comparison with the 12.6% of Black or African Americans identified in the 2010 Census (21). Our study also shows 1.3% of Asian or Pacific Islanders and 1.3% of Native Americans, which are slightly higher than the percentages identified in the 2010 Census - 0.2% and 0.9%, respectively. The percentage of Hispanic in our study (15.9%) was close to the 2010 Census (16.3%), while the racial percentage of White in our study (57.3%)is significantly lower than the overall percentage of whites (72.4%) stated in the 2010 Census. These findings indicate that the Black or African American population may be a potential group at which intervention measures for facial fracture need to be identified and aimed. It is important to recognize that in 20% sample of the NIS database, certain racial groups may be over represented. However, the weighting variable assigned to each hospitalization is specifically designed to minimize this issue. The estimates presented in the current study are representative of all hospitalizations for each of the race/ ethnic group only in the states that volunteered to provide this information. It should be noted that five states (Georgia, Illinois, Minnesota, Ohio, and West Virginia) did not volunteer to provide information on race variable, and consequently, we are unable to provide a truly nationally representative estimates for the race/ethnicity variable.

The insurance type of each victim of facial fracture was also identified in our study. A 2009 Gallup pole indicates that 16% of Americans do not have health insurance (22). However, our study shows that 20.8% of patients with facial fractures were uninsured, and 38.2% had private insurance. This indicates that the uninsured were relatively nor likely to present to a hospital with a facial fracture.

This may warrant private insurers financing preventive educational programs for their male members, which may save significant hospital costs by reducing the number of facial fractures among their members. Federally funded educational campaigns targeting those uninsured male members of the community may also help to reduce hospitalizations because of facial fractures.

The current study has identified several factors that tend to be more frequently associated with facial fracture reduction in addition to gender and insurance: Those who abuse drugs and alcohol are affected more frequently, the mandible is more frequently affected than bones of the maxilla, and assault is responsible for more facial fractures than the second and third most frequent causes combined.

The study has several limitations, and the results should be interpreted keeping these in mind. As mentioned in the methods section, we identified external causes of injuries using ICD-9-CM codes in the diagnoses fields. It may be possible that certain hospitals do not code these injuries or the coding practices may vary between hospitals. Consequently, our estimates may be biased. The retrospective nature of the dataset precludes us from overcoming this limitation. The hospital charge information we presented in the current study refers to the charges levied by the hospitals on the patients. This does not include profession fee. Unfortunately, the details regarding the break up for individual procedure charges and other charges are not available in the dataset. As mentioned in the methods section, we selected hospitalizations with only the principal procedure code for facial fracture fixations. We intentionally did not include secondary procedures as it would be difficult to attribute all charge data to facial fracture fixations. As a result, the total charges we presented for facial fracture fixations may be an underestimate of the true charges involved for all procedures.

Conclusions

The nationwide hospitalizations related to reduction in facial fractures consume a large amount of hospital resources that are reflected in total hospital charges of over 1 billion dollars. Our study has identified those groups in the population who are hospitalized more frequently for facial fractures, those types of fractures incurring the highest hospital charges and requiring the longest hospital stay, and the most common co-morbid conditions. Knowledge of this information can be used to develop preventive programs that target the groups we have indentified. If hospital emergency room protocols and inpatient protocols relating to the most expensive fractures and longest hospital stays that we have identified can improve, this may lead to improved outcomes and a reduction in hospital charges for facial fractures.

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