An Analysis of Patients Treated for Cerebrospinal Fluid Rhinorrhea in the United States from 2002 to 2010

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Abstract

Keywords

- cerebrospinal fluid rhinorrhea
- CSF rhinorrhea
- Nationwide Inpatient Sample
- NIS
- HCUP
- CSF leak repair
- length of stay
- hospital charges
- complications
- skull base surgery

Background The Nationwide Inpatient Sample (NIS) database was used to analyze the demographic features and concomitant diagnoses in patients admitted with cerebrospinal fluid (CSF) rhinorrhea.

Methods We analyzed the NIS database for all hospital admissions of CSF rhinorrhea between 2002 and 2010. Patient demographics, length of stay, hospital charges, concomitant diagnoses, hospital level characteristics, and complications were analyzed for patients undergoing surgical repair (group I) and for those treated without surgical repair (group II).

Results Patients in group I were significantly older, the majority were female (67.5%), and were more likely to be obese (12.9%), have diabetes mellitus (15.7%), and hypertension (41.6%). Lengths of stay were similar between the two groups, but group I patients incurred higher hospital charges ($p < 0.001$). Group I patients were more likely classified as an elective admission (59.8 vs. 38.6%), and were more frequently admitted to a teaching hospital (83.6%) with a large bed size (79.0%). Acute medical complications and concomitant diagnosis of meningitis were similar in both groups.

Conclusion Rates of meningitis did not differ between the two groups. Patients who underwent surgical repair were more likely to be an elective admission and admitted to a teaching hospital. Hospital charges were higher in patients undergoing repair.

Introduction

Cerebrospinal fluid (CSF) rhinorrhea is a condition in which there is a perforation of the skull base that results in com-

munication between the subarachnoid space and surrounding extracranial spaces leading to leakage of CSF.¹ Common sites of the defect include the frontal, ethmoid, and sphenoid sinuses as well as the cribriform plate.^{1,2} Symptoms unique to

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the presence of CSF rhinorrhea include clear, colorless, usually unilateral nasal discharge. Other presenting symptoms are due to the underlying etiology.^{1,3}

Approximately 80% of the cases of CSF rhinorrhea occur following nonsurgical trauma. Iatrogenic and nontraumatic causes are less common.⁴ Regardless of the etiology of CSF rhinorrhea, the drainage may resolve with conservative management. Surgery has also proven to be an effective method of treatment with endoscopic repair having an initial success rate between 85 and 95%.^{2,3}

One of the most common and serious complications in patients with CSF rhinorrhea is meningitis. Rates of meningitis have been estimated between 10 and 36% in these patients and can result in significant morbidity and mortality.^{5,6} In this study, the Nationwide Inpatient Sample (NIS) database, sponsored by the Agency for Healthcare Research and Quality and the Healthcare Cost and Utilization Projection, was used to analyze patient demographics, hospital level characteristics, length of stay, hospital charges, acute medical complications, and concomitant diagnoses in this condition.

Materials and Methods

Data from approximately 7 million hospitalizations each year are contained within the NIS database. It is the largest all-payer database and is representative of a 20% sample of all hospital discharges in the United States. When weighted, the database estimates more than 36 million hospitalizations annually.⁷ Along with other variables, the NIS database provides information on primary and secondary diagnoses and procedures, time to procedure, patient demographics, hospital charges, and length of stay. Institutional review board (IRB) approval was not necessary as per the guidelines of the IRB of Rutgers New Jersey Medical School (Newark, New Jersey) given that no patient identifiers were used in this analysis.

Data were extracted from the NIS database in March, 2015. Patients hospitalized with an index diagnosis of "cerebrospinal fluid rhinorrhea" were obtained using the International Classification of Disease, ninth revision; clinical modification (ICD-9-CM) code 349.81. CSF rhinorrhea repair (group I) was defined by the following procedures: simple suture of dura mater of brain

(02.11), other repair of cerebral meninges (02.12), or other operations on skull, brain, and cerebral meninges (02.99). Patients who had any of these codes present in procedure variables 1 through 15 were stratified to the repair cohort. Patients who did not undergo these procedures were stratified to group II. The clinical classification software (CCS) variable in the NIS database was used to identify patients with meningitis (76). Additionally, patients with concomitant diagnoses of chronic sinusitis (473.0–473.9) and acute sinusitis (461.0–461.9) were included in the analysis. Acute medical complications and surgical complications were evaluated using codes outlined in ▶Table 1. The study population was evaluated for age, race, length of stay, hospital charges, associated conditions, and complications.

All statistical analyses were performed using SPSS version 22 (IBM, Armonk, New York, United States). Independent two-tailed *t* test, cross-tabulation, Pearson chi-square, Fisher exact tests were used to analyze associations between variables where indicated. Probability values (*p* value) < 0.05 were considered statistically significant.

Results

We identified 1,541 patients admitted with an index diagnosis of CSF rhinorrhea between 2002 and 2010 using the NIS database. The majority (53.5%) underwent surgical repair (group I) of the CSF leak (▶Table 2).

Group I patients were older (48.3 ± 16.1) compared with group II (44.6 ± 18.0) ($p < 0.001$) (▶Table 2). Overall, the majority of patients who underwent repair were female (67.5%) ($p = 0.004$). Overall, the largest group of patients was white (47.4%) and there were no significant differences in race between the two groups. Repair patients were significantly more likely to be obese (12.9 vs. 7.2%), have diabetes mellitus (15.7 vs. 11.6%) and hypertension (41.6 vs. 32.5%) (▶Table 3). Concomitant diagnosis of chronic sinusitis was seen more commonly among repair patients ($p = 0.010$) (▶Table 2). Overall, patients had an associated diagnosis of meningitis 6.8% of the time. However, no differences in rates of meningitis or acute sinusitis were observed between the cohorts. Length of stay did not differ between group I and

Table 1 ICD-9 diagnosis codes for medical and surgical complications

Variable	ICD-9 code
Medical complications	
Acute cardiac event	410.0–410.9, 411.1, 411.8, 415.0, 420.0, 420.9, 421.0, 421.1, 421.9, 422.0, 422.9, 427.0–427.5, 428.0–428.9
Acute pulmonary edema or failure	518.4, 518.81, 518.82, 518.84
Acute cerebrovascular event	997.00, 997.01, 997.02, 997.09
Acute renal failure	584.5–584.9
Acute hepatic failure	570
Sepsis	995.9, 038.0–038.4, 999.3
Urinary tract infection	559.0, 996.64, 996.31, V13.02

Abbreviation: ICD-9, International Classification of Disease, ninth revision.

Table 2 Characteristics of patients in group I and group II cohort

Characteristics	All Patients (n = 1,541)	Group I (n = 824, 53.5%)	Group II (n = 717, 46.5%)	p Value
Age, y, mean $\pm$ SD	46.6 $\pm$ 17.1	48.3 $\pm$ 16.1	44.6 $\pm$ 18.0	< 0.001 ^a
Age cohorts, y, %				
$\leq$ 40	33.9	30.0	38.4	< 0.001 ^a
41–60	45.0	47.2	42.4	0.065
61–80	19.5	21.1	17.7	0.098
> 80	1.4	1.6	1.1	0.439
Unknown	0.3	0.1	0.4	0.344
Sex (%)				
Male	35.4	32.2	39.1	
Female	64.2	67.5	60.4	
Unknown	0.5	0.4	0.6	
Race (%)				
White	47.4	47.1	47.8	0.565
Black	13.1	14.4	11.6	0.102
Hispanic	9.3	8.6	10.0	0.298
Asian/Pacific Islander	1.2	1.0	1.5	0.306
Other	2.4	2.7	2.1	0.476
Unknown	26.5	26.2	26.9	0.755
Length of stay, d, mean	6.7	6.8	6.6	0.632
Hospital charge, \$, mean	41,808	52,045	30,226	< 0.001 ^a
Payer (%)				
Medicare	19.1	20.1	18.0	0.285
Medicaid	11.5	10.6	12.6	0.220
Private	58.3	60.7	55.6	0.046 ^a
Self-pay	4.2	3.3	5.2	0.064
No charge	0.6	0.0	1.3	0.001 ^a
Other	6.0	5.1	7.1	0.097
Unknown	0.3	0.2	0.3	1.000
Type of admission (%)				
Elective	50.0	59.8	38.6	
Emergency/urgent	39.0	27.1	52.7	
Unknown	11.0	13.1	8.6	
Concomitant diagnoses (%)				
Meningitis	6.8	7.2	6.4	0.563
Chronic sinusitis	10.4	12.3	8.2	0.010 ^a
Acute sinusitis	0.5	0.5	0.6	1.000

Abbreviation: SD, standard deviation.

^aStatistically significant.

group II patients, but hospital charges were significantly higher in the repair cohort (\$52,045 vs. 41,808). Acute medical complications occurred at similar frequency in both groups of patients (► **Table 4**).

Patients who underwent repair were significantly more likely to have private payer status than patients not treated

surgically (60.7 vs. 55.6%; $p = 0.046$). Overall, 50.0% of patients with CSF rhinorrhea were elective admissions, and group I patients were more commonly an elective admission (59.8%) when compared with group II patients (38.6%) ($p < 0.001$) (► **Table 1**). Patients who underwent repair were more likely to be admitted to a teaching hospital

Table 3 Comorbidities in group I and group II cohort

Comorbidities (%)	All patients (n = 1,541)	Group I (n = 824, 53.5%)	Group II (n = 717, 46.5%)	p Value
Alcohol abuse	0.8	1.0	0.7	0.566
Congestive heart failure	2.0	1.9	2.1	0.820
Pulmonary disease	10.9	11.2	10.6	0.756
Coagulopathy	0.4	0.2	0.6	0.425
Diabetes uncomplicated	13.8	15.7	11.6	0.023 ^a
Diabetes complicated	0.8	0.8	0.8	0.988
Hypertension	37.4	41.6	32.5	< 0.001 ^a
Hypothyroidism	8.4	8.6	8.1	0.738
Liver disease	0.5	0.5	0.4	1.000
Fluid/electrolyte	6.5	7.2	5.7	0.266
Obesity	10.4	12.9	7.5	0.001 ^a
Peripheral vascular disorders	0.5	0.4	0.7	0.483
Renal failure	1.8	1.7	1.8	0.851
Weight loss	0.8	0.7	0.8	1.000
Unknown	0.9	0.6	1.3	–

^aStatistically significant.

(83.6%), and a hospital with a large bed size (79.0%) ($p = 0.001$ and 0.002, respectively) relative to patients who did not have surgical management (► **Table 5**).

Discussion

Cerebrospinal fluid (CSF) rhinorrhea most commonly occurs as a result of accidental trauma.^{8,9} Other etiologies include iatrogenic, tumors, spontaneous leaks, and congenital malformations.^{9–11} Proper management aims to reduce the complications of CSF rhinorrhea including meningitis and brain abscess.^{6,10,12} Typically, the cause of the CSF leak greatly impacts the management decisions, as it is generally accepted that CSF rhinorrhea from acute trauma is more like to resolve without intervention when compared with that arising spontaneously or iatrogenically.^{9,13,14} Consensus has largely been

reached regarding the approach to repair and when indicated; endoscopic endonasal repair offers high success rates and low morbidity when compared with open surgical repair.^{15–18} In the present study, we analyzed patient demographics, hospital level characteristics, hospital charges, and length of stay between patient undergoing surgical repair (group I) and those treated without surgical repair (group II).

The majority of patients admitted for a primary diagnosis of CSF rhinorrhea were females. Numerous studies have shown a female preponderance in spontaneous CSF rhinorrhea but not in traumatic or iatrogenic cases.^{1,2,13} Patients who underwent surgical repair had a statistically greater female preponderance. There were no significant differences in the racial makeup of patients in the two main groups. Patients who underwent repair were older (48.3 vs. 44.6 years). Patients who underwent surgical repair were more

Table 4 Acute medical complications in group I and group II cohort

Acute medical complications (%)	All patients (n = 1,541)	Group I (n = 824, 53.5%)	Group II (n = 717, 46.5%)	p Value
Neurological complications	2.4	2.7	2.1	0.460
Acute cardiac event	2.4	2.5	2.2	0.685
Pulmonary edema or failure	1.0	1.3	0.6	0.192
Acute cerebrovascular event	2.4	2.7	2.1	0.460
Renal failure	0.4	0.4	0.4	1.000
Hepatic failure	0.0	0.0	0.0	–
Sepsis	0.1	0.1	0.1	1.000
Urinary tract infection	2.9	2.4	3.5	0.218
Overall	8.5	9.0	7.9	0.469

Table 5 Hospital level characteristics in group I and group II cohort

	All patients (n = 1,541)	Group I (n = 824, 53.5%)	Group II (n = 717, 46.5%)	p Value
Hospital bed size (%)				
Small	6.9	6.7	7.3	0.656
Medium	17.1	14.3	20.4	0.002 ^a
Large	75.9	79.0	72.4	0.002 ^a
Hospital teaching status (%)				
Teaching hospital	80.5	83.6	77.0	
Nonteaching hospital	19.5	16.4	23.0	
Geographic region (%)				
Northeast	14.8	14.0	15.8	0.320
Midwest	21.2	22.6	19.7	0.164
South	45.9	43.3	49.0	0.027 ^a
West	18.0	20.1	15.6	0.021 ^a
Hospital location				
Rural	2.4	2.3	2.5	
Urban	97.6	97.7	97.5	

^aStatistically significant.

likely to have obesity, diabetes mellitus, and hypertension. Patients who underwent surgical repair (group I) had an associated diagnosis of chronic sinusitis 12.3% of the time compared with 8.2% in group II. However, acute sinusitis was rare in our study population and presented at similar rates in both cohorts.

Length of stay was similar in both groups. However, patients who underwent surgical repair incurred significantly greater hospital charges. Patients who underwent repair were more likely to be an elective admission when compared with patients managed conservatively. In addition, patients surgically repaired were more commonly admitted to a large, teaching hospital. The analysis of complications demonstrated an overall acute medical complication rate of 8.5%. Acute medical complications were similar in both groups; acute cardiac events, acute cerebrovascular events, and urinary tract infections were encountered most frequently.

Regardless of etiology, risk of developing meningitis in unrepaired CSF rhinorrhea has been reported between 10 and 36%.^{5,6} In our study, 6.8% of patients admitted had associated diagnoses of meningitis and no significant difference was found between the two groups. Our study may have underestimated the risk of meningitis due to the short follow-up (limited to the particular hospitalization) and that our study population was limited to those with a primary diagnosis of CSF rhinorrhea, possibly missing patients who presented with meningitis or altered mental status.

A principle limitation of this study is the inability to categorize patients based upon etiology of CSF rhinorrhea, which is inherent to the use of an administrative database such as the NIS. Surrogate indicators for trauma can be

identified but spontaneous and iatrogenic leaks are more difficult to identify in this type of dataset. Given the constraints of the NIS database it is not possible to determine whether patients with an associated diagnosis of meningitis had the diagnoses on admission or developed it while hospitalized. This important limitation does not allow for analysis of the temporal relationship between management and development of meningitis. Additionally, because the ICD-9 procedure codes available for repair of meninges do not specify the approach utilized the authors could not make comparisons between surgical techniques. The NIS records each admission as having a unique identity and as a result does not provide information regarding readmission rates. As a result, we cannot provide information on the long-term success of surgical repair. Additionally, this type of study design can only determine association and not causation. Despite these limitations, this study represents analysis of the characteristics of a large cohort of patients admitted for CSF rhinorrhea managed both surgically and conservatively.

Conclusion

In this analysis, 53.5% of patients admitted for CSF rhinorrhea underwent surgical repair. Patients undergoing surgical repair were more likely to be older, female, and have comorbidities including obesity, diabetes mellitus, and hypertension. While length of stay was similar between the two groups, hospital charges were significantly increased in the repair cohort. Rates of meningitis among those patient undergoing surgical repair were comparable to nonsurgically treated CSF leak.

Financial Disclosures
None.

Conflict of Interest
None.

Note

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