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Case study

Complications and 30-Day readmission rates after craniotomy/ craniectomy: A single Institutional study of 243 consecutive patients

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ABSTRACT

Early hospital readmission has become a proxy for quality of care and contributes significantly to high health care costs in the United States, with more than \$20 billion health care dollars are spent on 30-day readmission annually. Cranial neurosurgical procedures (i.e., craniotomy, craniectomy) are associated with high readmission rates; however, studies examining readmission after cranial procedures are limited and relatively unknown. The aim of this study is to identify the drivers of 30-day unplanned readmission in consecutive patients undergoing craniotomies and craniectomies. The medical records of 243 consecutive patients undergoing either craniotomy or craniectomy at a major academic institution in 2011 were reviewed. Patient demographics, comorbidities, intra- and post-operative complication rates were collected for each patient. We identified all unplanned readmissions within 30 days of discharge. A total of 10 (4.1%) unplanned 30-day readmissions were identified. The mean \pm SD age was 58.58 ± 15.12 years. The most common indication for surgery was malignancy (63.4%) followed by Chiari malformation (10.3%), epilepsy (5.3%), and skull lesion/deformity (2.9%). The majority of patients presented to the emergency department from home (80%), while 10% were readmitted from a skilled nursing facility and 10% were readmitted from an acute rehabilitation institution. The most common presented symptoms for readmitted patients were fever/presumed infection (40%) and altered mental status (40%), followed by new sensory/motor deficits (30%). This study suggests that infection, altered mental status, and new sensory/motor deficits were the primary complications leading to unplanned 30-day readmission after cranial neurosurgery.

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1. Introduction

Reducing readmission rates has become a significant target for current health care reform in the United States. Unplanned readmissions are costly, resulting in a burden of over \$20 billion annually to US health care systems [1]. Furthermore, high readmission rates negatively impact patient outcomes, and previous studies have found that hospitals with high 30-day readmission have higher post-surgical mortality rates [2–4]. Accordingly, recent health care reform has initiated efforts to reduce 30-day readmission rates and better the overall quality of patient care [5].

Within all surgical specialties, neurosurgical procedures in particular are associated with high rates and costs of readmission [6,7]. Nearly 1 in 6 patients undergoing incision/excision of the central nervous system is readmitted within 30 days of the initial

surgery [7], and cranial neurosurgical readmission costs can approach \$45,000 per stay [8]. Moreover, while other specialties' post-surgical rates of readmission have decreased over the past 10 years, neurosurgical readmission rates remain stagnant despite recent health care reform [6]. In an effort to reduce hospital readmission rates, health care policy has begun to focus on identifying the causes of unplanned 30-day readmissions for all types of procedures [9]. As such, within the field of neurosurgery, the drivers of unplanned readmission after spinal surgery have been previously studied [10–13]. However, only a few studies have examined the causes underlying unplanned 30-day readmission in patients undergoing cranial neurosurgical procedures [2,3,8,9,14,15]. Given cranial procedures' higher readmission rate compared to surgeries of the spine, the primary causes of readmission after cranial surgeries warrant further exploration [7,15].

The aim of this study is to identify the drivers of 30-day unplanned readmission in consecutive patients undergoing craniotomies and craniectomies.

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2. Methods

243 consecutive patients undergoing craniotomy or craniectomy at a major academic institution in 2011 were included in this study. Institutional Review Board (IRB) was obtained prior to the initiation of the study. We identified 10 patients' unplanned readmissions to the major academic institution within 30 days of discharge. Inclusion criteria included patients with [1] available demographics and treatment [2]; who underwent a cranial surgery craniotomy or craniectomy in 2011 [3]; and who had an unplanned readmission within 30 days of discharge.

Patient demographics, comorbidities, intra- and post-operative complication rates were collected for each patient. 10 patients with unplanned post-surgical readmissions within 30 days of discharge were identified. Patient records were reviewed to determine the cause of readmission, primary treatment, and length of hospital stay. For readmitted patients, both discharge locations after primary surgery, readmission locations, and discharge locations after second discharge (home, skilled nursing facility, acute rehabilitation institute) were assessed. Other readmission variables included number of days from discharge to readmission and length of stay (LOS) during readmission. Complications upon readmission included wound dehiscence, wound drainage, CSF leak, fever/presumed infection, pseudomeningocele, altered mental status, new sensory/motor deficits, deep vein thrombosis (DVT), pulmonary embolism (PE), dysphagia, urinary tract infection (UTI), and nausea/vomiting. Treatments during readmission included observation, incision and drainage, re-operation, and intravenous antibiotic administration.

Pertinent patient and surgical variables were also evaluated. Demographic variables included age, sex, race, and marital status. Comorbidities assessed included body mass index (BMI), depression, anxiety, congestive heart failure (CHF), coronary artery disease (CAD), atrial fibrillation, peripheral vascular disease (PVD), hypertension (HTN), myocardial infarction (MI), diabetes, hyperlipidemia (HLD), anemia, PE, DVT, chronic kidney disease (CKD), end-stage renal disease (ESRD), smoker status, and alcohol use.

Intraoperative variables of the initial cranial surgery were evaluated and included surgical indication, tumor pathology, and anatomical location of the craniotomy or craniectomy. Primary indications for surgery were characterized as tumor, Chiari malformation, epilepsy, or skull lesion/deformity. Tumor pathologies included primary glioblastoma, meningioma, metastases, and oligoastrocytoma. Anatomic locations of craniotomy/craniectomy included suboccipital, right frontal, left frontal, and right temporal. Other surgical variables assessed included intraoperative use of microdissection, cortical mapping, electromyogram (EMG), or echography as well as whether the patient was awakened during the procedure. Operative time, estimated blood loss (EBL), number of packed red blood cell units (PRBC), and drain placement were also evaluated.

Post-operative variables included hospital LOS, intensive care unit (ICU) admission, and ICU LOS. Post-operative complications assessed included delirium, urinary tract infection (UTI), fever, presumed infection, wound infection, HTN, hypotension, hematoma, MI, PE, DVT, hydrocephalus, pneumocephalus, stroke, sepsis, weakness, motor deficits, sensory deficits, aphasia/dysarthria, urinary retention, discharge with Foley, and 30-day readmission rate.

Parametric data were expressed as means \pm standard deviation (SD). Nominal data were expressed as median [interquartile range]. Statistical analysis was performed using JMP[®], Version 12. SAS Institute Inc., Cary, NC, 1989–2007.

3. Results

In 2011, 10 (4.1%) of the 243 patients who underwent either a craniotomy or a craniectomy had an unplanned readmission

within 30 days of discharge. Within the larger cohort, the mean \pm SD age was 58.58 ± 15.12 years, Table 1. The number of males was 51.9% and the patients' races included Caucasian (79.4%), African American (14.4%), Asian (1.5%), and other (4.7%), Table 1. 45.3% of patients were married, Table 1. Of readmitted patients, 40.0% were male and patients' races included Caucasian (80.0%), African American (10.0%), and Asian (10.0%), Table 1. Readmitted patients' marital statuses included married (40.0%), single (30.0%), divorced (10.0%), and widowed (20.0%), Table 1.

The mean \pm SD BMI was 25.8 ± 7.1 kg/m² for the total cohort and 30.3 ± 7.3 kg/m² for the readmitted cohort, Table 2. For the total cohort, the most common patient comorbidities included HTN (25.9%), alcohol use (21.1%), HLD (18.9%), current tobacco use (14.1%), and depression (10.7%), Table 2. Other comorbidities included anxiety (9.9%), CHF (0.8%), CAD (5.4%), atrial fibrillation (2.1%), PVD (2.5%), history of MI (1.6%), diabetes (7.4%), anemia (1.6%), PE (2.1%), DVT (2.9%), CKD (0.8%), and ESRD (0.4%), Table 2. Of readmitted patients, the most common comorbidities were HTN (50.0%), current tobacco use (30.0%), depression (20.0%), CAD (20.0%), DVT (20.0%), anxiety (10.0%), and HLD (10.0%).

The most common indication for surgery was tumor (63.4%), followed by Chiari malformation (10.3%), epilepsy (5.3%), and skull lesion/deformity (2.9%), Table 3. Other indications included intracranial cyst removal, cavernoma, and craniotomy for intracranial lesion biopsy. Tumor pathologies included primary glioblastoma (14.0%), meningioma (11.5%), metastases (4.1%), and oligoastrocytoma (3.7%). Suboccipital craniotomies/craniectomies were most common (21.9%) followed by right frontal (18.1%), left frontal (14.8%), and right temporal (7.8%), Table 3. Microdissection was the most common intraoperative variable and employed in 79.4% of surgeries, followed by awake procedures (13.4%), cortical mapping (16.5%), EMG (9.5%), and echography (1.6%), Table 3. The mean \pm SD operative time was 190.6 ± 91.6 min, Table 3. The mean \pm SD EBL and # PRBC was 235.4 ± 231.9 mL and 0.11 ± 0.47 units, respectively, Table 3. A drain was placed in 19.3% of surgeries, Table 3.

The mean \pm SD hospital LOS was 5.5 ± 6.3 days, Table 4. Postoperatively, 86.4% of patients were admitted to the ICU and the mean \pm SD ICU LOS was 1.5 ± 1.9 days, Table 4. The most common post-operative complications included motor deficits (14.0%), weakness (9.5%), aphasia/dysarthria (7.4%), and presumed infection (6.6%). Other postoperative complications include delirium (2.5%), UTI (2.5%), fever (2.9%), wound infection (4.9%), HTN (2.5%), hypoten-

Table 1
Patient demographics.

| Variables | Total cohort n = 243 | Readmitted n = 10 |
|---------------------------|-------------------------|----------------------|
| Age (%) | | |
| >65 years | 29.6 | 20.0 |
| [18 – <65] years | 51.9 | 60.0 |
| <18 years | 18.5 | 20.0 |
| Sex (%) | | |
| Male | 51.9 | 40.0 |
| Female | 48.1 | 60.0 |
| Race (%) | | |
| Caucasian | 79.4 | 80.0 |
| African American | 14.4 | 10.0 |
| Asian | 1.5 | 10.0 |
| Other | 4.7 | 0.0 |
| Marital status (%) | | |
| Married | 45.3 | 40.0 |
| Single | 36.2 | 30.0 |
| Divorced | 5.4 | 10.0 |
| Widowed | 4.5 | 20.0 |
| Other/Unknown | 8.6 | 0.0 |

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