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Hospital cost of pediatric patients with complicated acute sinusitis☆

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ABSTRACT

Objective: Review costs for pediatric patients with complicated acute sinusitis.
Methods: A retrospective case series of patients in a pediatric hospital was created to determine hospital costs using a standardized activity-based accounting system for inpatient treatment between November 2010 and December 2014. Children less than 18 years of age who were admitted for complicated acute sinusitis were included in the study. Demographics, length of stay, type of complication and cost of care were determined for these patients.
Results: The study included 64 patients with a mean age of 10 years. Orbital cellulitis (orbital/preseptal/postseptal cellulitis) accounted for 32.8% of patients, intracranial complications (epidural/subdural abscess, cavernous sinus thrombosis) for 29.7%, orbital abscesses (subperiosteal/intraorbital abscesses) for 25.0%, potts puffy tumor for 7.8%, and other (including facial abscess and dacryocystitis) for 4.7%. The average length of stay was 5.7 days. The mean cost per patient was $20,748. Inpatient floor costs (31%) and operating room costs (18%) were the two greatest expenditures. The major drivers in variation of cost between types of complications included pediatric intensive care unit stays and pharmacy costs.
Conclusion: Although complicated acute sinusitis in the pediatric population is rare, this study demonstrates a significant financial impact on the health care system. Identifying ways to reduce unnecessary costs for these visits would improve the value of care for these patients.

1. Background

Rhinosinusitis is one of the most common disease processes in the pediatric population and affects an estimated 5–7% of patients who present with upper respiratory infection symptoms [1,2]. An acute episode of sinusitis can cause orbital and/or intracranial complications in 5–10% of these patients by either direct extension or hematogenous spread [3]. Orbital complications are more common and present from an extension of ethmoid sinus disease [4]. Five classes of orbital complications have been described by Chandler: Preseptal cellulitis, orbital cellulitis, subperiosteal abscess, orbital abscess and cavernous sinus thrombosis [5]. Intracranial complications include meningitis and epidural or subdural abscesses. Currently, healthcare costs associated with these extra sinus complications are unknown.

With the widespread prevalence of acute sinusitis in the pediatric population, orbital and intracranial complications can create a burden on healthcare costs. Inpatient stays, imaging, other diagnostic tests, and medical and surgical intervention all contribute to the total costs. Total resource utilization for these complex conditions is unknown. However, the changing landscape of healthcare delivery is transitioning to a value-based system and bundled payments are becoming more common. Understanding how and where resources are used for specific disease processes is imperative.

There have not been any studies to date that have focused on pediatric patients with complicated acute sinusitis and the total hospital cost broken down in categories to determine where most of the expense lies. The purpose of this study is to identify the major hospital expenses at a tertiary children's hospital for complicated acute pediatric sinusitis. Determining the major sources of resource utilization for these encounters could identify strategies to reduce unnecessary costs and improve care delivery in the future.

2. Methods

This study was approved by the Institutional Review Boards at the University of Utah and Intermountain Healthcare. Intermountain

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Healthcare (Intermountain) is a not-for-profit, integrated health care system that includes 22 hospitals ranging from tertiary care referral centers to community and rural hospitals in the Intermountain West. Primary Children's Hospital is the tertiary children's hospital within Intermountain. Intermountain houses the Enterprise Data Warehouse (EDW), a comprehensive database that contains administrative, financial and clinical information. The financial data in the EDW are beneficial in that hospital costs, and not simply charges, are recorded. *Charge* data depend on payment agreements between hospitals and third-party payers without correlation to the actual cost of the operation. Alternatively, *cost* data represent a more accurate assessment of resources actually utilized. We have previously used this database to evaluate variation in adenotonsillectomy costs and complications among hospitals and surgeons within a tertiary children's hospital [6] and across the Intermountain system [7].

A retrospective chart review was performed on 724 patients between the ages 1–18 years between November 2010 and December 2014 with one of the following ICD-9 codes: 473.0–473.9 (chronic rhinosinusitis), 461.0 (maxillary acute sinusitis), 461.1 (frontal), 461.2 (ethmoidal), 461.3 (sphenoidal) or 461.9 (acute sinusitis NOS) and had an otolaryngology consultation. The chart review yielded 64 patients who had a complication secondary to their sinus disease that required an inpatient admission. The standardized activity-based accounting system within Intermountain was used to determine the hospital costs (not charges) related to each hospital encounter. Costs were broken down into categories including: (1) Pediatric Intensive Care Unit (PICU), (2) Inpatient floor, (3) Operating Room (OR), (4) Imaging, (5), Laboratory, (6) Pharmacy, and (7) Other. Professional fees for any inpatient medical consultations and follow-up, surgical intervention, and anesthesia care were not included. In addition, the length of hospital stay was measured.

Patients were divided by type of complication into those who had an (1) orbital related cellulitis (preseptal, postseptal, orbital cellulitis), (2) orbital abscess (subperiosteal, orbital), (3) intracranial complication (epidural abscess, subdural abscess, cavernous sinus thrombosis), (4) potts puffy tumor, or (5) other (facial abscess, dacryocysitis). Hospital costs and length of stay were compared between the 5 groups of patients. Statistical analysis was completed using the Fisher's exact test or chi-square test with a statistical significant set at $p < 0.05$.

3. Results

A total of 64 patients with a complication associated with acute sinusitis were included in the cohort from the reviewed 724 patients who had a diagnosis of acute sinusitis (8.8%). None of the 64 patients had any immunological disease, cystic fibrosis, Kartagener disease or primary ciliary dyskinesia that could have predisposed them to a higher risk of complication from an episode of acute sinusitis or created a higher cost burden from their hospital stay. The mean age was 10 ± 5 years. Orbital cellulitis (orbital/preseptal/postseptal cellulitis) accounted for 21 (32.8%) patients, orbital abscesses (subperiosteal, intraorbital abscesses) accounted for 16 (25%), potts puffy for 5 (7.8%), intracranial complications (epidural/subdural abscess, cavernous sinus thrombosis) for 19 (29.7%) and other (including facial abscess and dacryocystitis) for 3 (4.7%). The average length of stay was 5.7 ± 5.1 days (range 1–28 days). The mean length of stay for the orbital cellulitis group was 2.6 ± 1.2 days while the stay for the intracranial complication group was 10.1 ± 6.9 days (Table 1). The mean cost per patient was \$20,748 ± \$23,549 (range \$2181–\$116,925). Across the entire cohort, the inpatient floor accounted for the highest percentage of total costs, followed by the OR (Fig. 1). Within each complication group, the greatest expenditure varied (Fig. 2). The inpatient floor costs were not included in each individual group analysis as the length of stay directly influenced the cost accounted by the inpatient floor category. Separating that from the other categories of expenditure aided in identifying the other contributors that played a role in the management of these patients. Also, within each group, the calculations disregarded the 12.9% of "other" expenditures that included phlebotomy costs, anesthesia medications, post-anesthesia care, etc. from which the emergency department had the greatest percentage at 2.2% of the total cost for all of the patients.

4. Discussion

The unique cost-accounting database at Intermountain healthcare enables analysis of hospital costs for children admitted to a tertiary pediatric hospital for complicated acute sinusitis. We demonstrate that each clinical encounter has a substantial expense with an average cost of just over \$20,000 per hospital admission. This is most likely an underrepresentation, as the data only reflects the costs to the hospital, not the charges, which are usually several magnitudes greater. Including the physician professional fees and potential lost family income during these illnesses would substantially increase this number. Our goal was to better understand what contributes to these costs, so that targets to reduce unnecessary expenses could be identified.

The largest expenditure category was the inpatient floor costs and these costs directly correlate with the length of stay. Dugar et al. found that the average length of stay for all patients with acute sinusitis admitted to the hospital was 4.2 days [8]. Other studies have suggested that the average length of stay increases to an average of 5.8 days in patients with severe orbital complications and 10–21 days in patients with Potts puffy tumor [2,9]. Despite our study showing shorter length of stays, there still was a large burden of cost from these inpatient stays. Admittedly, the severity of each patient's illness varies significantly. Intracranial complications can be more critical and require more intensive care which likely reflects the increased length of stay and expenditure found in these patients. Across the cohort, decreasing the length of stay by one day could reduce costs per encounter by \$4453 (p-value <0.0001) (Fig. 3). Currently, quality measures for health systems and providers include 30-day readmission rates. Whether concerns over increased readmissions lead to unnecessary length of stays is unknown. Developing care process models or standardized discharge criteria for children with complicated acute sinusitis could lead to shorter admissions without sacrificing care quality.

Operating room costs were the second most expensive cost overall and was either first or second highest within each complication group. Given its high burden of cost, further scrutiny

Table 1
Average length of stay for each complication group.

	Number of patients, *N* (% of total)	Mean total cost (\$)	Average length of stay (days)
Orbital cellulitis	21 (32.8%)	5954	2.6
Orbital abscess	16 (25.0%)	13,380	4.6
Intracranial complication	19 (29.7%)	46,167	10.1
Potts puffy tumor	5 (7.8%)	22,135	6.8
Other	3 (4.7%)	7694	3.3