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## Cost comparison and safety of emergency department conscious sedation for the removal of ear foreign bodies



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## ABSTRACT

**Objectives:** The purpose of this study is to investigate the relative cost and safety of ear foreign body (FB) removal via conscious sedation in the emergency department.

**Methods:** A retrospective review of patients presenting from 2000 to 2015 to the emergency department at Mayo Clinic, Rochester, Minnesota was performed. 63 patients requiring sedation for ear foreign body removal were identified. Descriptive data, safety data, and costs were obtained for the study.

**Results:** There were no appreciable differences in patient safety outcomes and otologic outcomes in patients who received sedation in the emergency department or anesthesia in the operating room for FB removal. Cost analysis demonstrated increased cost associated with operating room utilization versus conscious sedation in the emergency department, with the greatest cost increase being in patients evaluated first in the emergency department and then sent to the operating room.

**Conclusions:** Ear foreign body removal in the emergency department shows a similar safety profile to removal in the operating room, but at a markedly lower cost. Emergency department conscious sedation should be considered a viable option in appropriately selected patients with this common problem given these results.

### 1. Introduction

Foreign bodies (FB) within the external auditory canal (EAC) are a common indication for otolaryngology consultation. Common reasons for otolaryngologists' involvement include proximity to the tympanic membrane (TM), size of the FB, and objects with irregular shapes which require technical skills and instrumentation not consistently available to emergency departments or their providers [1].

Once consulted by the Emergency Department (ED), the otolaryngologist must consider multiple factors when considering the best approach to each patient. Often these patients are children or have developmental delay, frequently requiring either chemical or physical restraint to safely remove the FB while reducing the risk of complications such as ear canal lacerations, bleeding, or TM perforation. If the decision is made to use sedation to facilitate FB removal, the next step is to decide whether sedation should take place in the ED or the operating room (OR). While this decision is frequently multifactorial, one important consideration is the cost of providing procedural sedation in the OR, which may be more costly and resource-intensive than the same procedures in other clinical settings [2].

Pediatric conscious sedation in the ED has been evaluated in multiple studies and is generally regarded as safe [3]. Adverse events have been associated with out-of-hospital settings, inadequate monitoring, medication errors, and lack of standardized recovery protocol [4–6]. However, the cost and safety profile for ear FB removal under ED conscious sedation has not been evaluated and compared to OR removal. The objective of this study is to determine whether conscious sedation in the ED for EAC FB removal provides a similar safety profile to OR removal but at lower cost. We hypothesized that this would be the case, which would suggest greater cost effectiveness for ED conscious sedation.

### 2. Material and methods

Saint Marys Hospital Campus, Rochester, Minnesota emergency department records from January 1st, 2000 to May 1st, 2015 were reviewed to identify all patients diagnosed with ICD-9 code “931”, i.e. “foreign body in ear.” Mayo Clinic Institutional Review Board (IRB) approval was granted prior to the review. In accordance with the Minnesota Research Authorization Statute and the Mayo Clinic

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Institutional Review Board guidelines, we excluded patients who had denied research authorization for use of their medical records in research. From this list, patients who received conscious sedation in the ED or were taken to OR for FB removal were identified.

We performed a standard retrospective chart review and utilized RedCap software for data collection [7]. Foreign body data collected included: date of FB removal, date of birth, gender, FB type, laterality of FB, whether the patient was discharged with antibiotics, complications (examples: tympanic membrane perforation, canal bleeding, ossicular disruption, etc.), the specialty of the provider removing the FB (ENT vs ED), and whether the patient received follow-up ENT care. Sedation data collected included: sedating medication used, length of sedation, where sedation occurred (ED vs OR), type and route of sedation medication used, oxygenation data (lowest SpO<sub>2</sub>, SpO<sub>2</sub> < 90%), and whether there were any complications during the sedation (invasive airway manipulation [oral airway insertion, intubation, etc.], resuscitation medication administration, or any provider note regarding complication).

The ED and OR patients were not matched by treatment year; therefore, changes in unit costs over time that were unrelated to inflation could still bias any cost comparison after inflation adjustment. In order to avoid this potential effect, we examined all possible FB removal patients, regardless of age, within a shorter time frame. Service line level billing data from 2013 to 2014 was used to identify patients in the hospital outpatient or ED setting with an ICD-9 diagnosis code of foreign body in ear (931), a CPT4 (Current Procedure Terminology, v. 4) code indicating foreign body removal from external auditory canal (69200 or 69205), and codes for drugs or anesthesia. Medical record review confirmed a final list of 21 patients whose experience in the ED (8), the ED and operating room (7), or the operating room without referral from the ED (6) was determined to fall within standard practice. We examined all of the services provided to the patients and selected a common representative subset of services and associated quantities for each of the three different treatment location groups. Because the adults included in our sample had developmental delay, we elected to not separate them from the pediatric group, as the services for both were the same. We used the Mayo Clinic Rochester Cost Data Warehouse methodology to create 2014 standardized costs by applying Medicare reimbursement to professional services, multiplying service line hospital charges by Medicare cost report cost-to-charge ratios, and adjusting for inflation with the Gross Domestic Product (GDP) implicit price deflator [8].

JMP software created by SAS Institute Inc.® (Cary, NC) was used for all statistical calculations, including *t* tests, which were applied to compare continuous variables between patients who had their sedation in the ED versus the OR.

### 3. Results

A total of 495 Emergency Department patients diagnosed with ear foreign body were identified within the timespan of the study. Of these 495 patients, 63 needed sedation to have the FB removed. 32 patients received conscious sedation in the ED, and 31 were taken to the OR for management after assessment in the ED. The median age was 5.3 years (range 2.2–46.8 years) in both groups. There was no difference in ages between the OR group and ED group (5.2 versus 5.3 years respectively, *p* = 0.46). The cohort was a majority male (67%). The four most common types of FB are displayed in Table 1. The locations of the FBs are as follows: 42 in the right EAC, 19 in the left, and 2 bilateral.

Of the 32 patients who received conscious sedation in the ED, the types of medication used during the sedation are outlined in Table 2. Complications related to sedation were infrequent, with 1/32 patients requiring assisted mask ventilation and 1/32 developing post sedation vomiting. Eight otologic complications were recorded: 2 tympanic membrane perforations and 6 canal lacerations. The lowest SpO<sub>2</sub> recorded during the ED sedations was 91% with an average SpO<sub>2</sub> of 96%.

**Table 1**  
Type of EAC foreign body.

	Ear (n = 63)
Rock	17
Bead	11
Popcorn	10
Bean	4
Other misc.	21

**Table 2**  
Type of conscious sedation medication administered in the emergency department.

	Number (%)
IM Ketamine	14 (44)
IV Ketamine	11 (34)
Intranasal Midazolam	9 (28)
Oral Midazolam	3 (9)
IV Midazolam	5 (16)
Propofol	3 (9)
IV Fentanyl	2 (6)

IV: Intravenous; IM: Intramuscular.

The average length of sedation was 26.2 min (range 15–46, interquartile range, 20.3 min).

Of the 31 patients who went to the OR, the lowest SpO<sub>2</sub> recorded was 86% with an average SpO<sub>2</sub> of 97%. There were no anesthetic complications noted in the OR group. Recorded otologic complications included 2 tympanic membrane perforations, 1 canal laceration, and 1 ossicular disruption. The average length of sedation was 27.2 min (range 12–63, interquartile range, 14 min).

Topical otic antibiotics were given after FB removal in 24/31 patients taken to the OR and in 23/32 patients from the ED; these proportions were not different (*Z* = 0.50; *p* = 0.62). In the patients that were not given antibiotics after the FB removal, there were no instances of infection after FB removal. For patients with otologic complications, analysis of the type of FB demonstrated two popcorn kernels, four beads, two rocks, one earring backing, and one piece of black rubber from a children's playground.

Standardized costs of the representative services for the three treatment locations are shown in Table 3. The major difference between the costs is due to the hospital facility fees for ED, OR and recovery room. The second driver of the cost difference is the provision of anesthesia in the OR, with both hospital and professional components. The cost of microsurgery in the OR is mostly offset by the costs of injections, IVs, and respiratory services in the ED. The total standardized costs of the representative services indicate that a patient referred directly to the OR, without being evaluated in the ED, can be expected to have a standardized cost 2.2 times greater than a patient who receives treatment in the ED alone, while a patient referred to the OR from the ED can be expected to have a 2.6 times greater standardized cost.

### 4. Discussion

Foreign bodies of the ear are a frequently encountered problem for both emergency medicine practitioners as well as otolaryngologists. Most ear FBs can be removed from the EAC without the need for otolaryngology consult or sedation. Common reasons for the use of conscious sedation include young patient age or developmental delay leading to inability to stay still during the procedure, and pain, secondary to the sensitivity of the medial portion of the EAC. In our study, out of 495 patients presenting with ear FB, 63 required sedation for removal representing a 12% sedation rate. This percentage falls in line with previously reported sedation rates ranging from 6% to 30%

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