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Assault by Battery: Battery-Related Injury in the Head and Neck

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Objectives/Hypothesis: To estimate nationwide incidence of emergency department (ED) visits for battery-related injury (BRI) occurring in the head and neck, and analyze demographic and anatomic-specific trends.

Methods: The National Electronic Injury Surveillance System (NEISS) was searched for BRI in the head and neck, with analysis for incidence, anatomic site, age and gender, and specific diagnoses.

Results: There were an estimated 18,803 head and neck BRI ED visits from 2003 to 2012. A total of 65.8% of patients were male. A total of 92.8% of patients were treated/examined and then released, and 4.7% of patients were admitted. A plurality (34.2%) of patients had BRI related to nose injures, and this represented the youngest cohort (median: 3 years old). The vast majority of ear and nose diagnoses were "foreign bodies"; two-thirds of mouth injuries were related to burns, whereas lacerations predominated in the face and head. Nearly half of ED visits involved patients between 2 and 5 years of age. A total of 45.2% of cases involving patients $\geq$ 65 years of age were related to hearing aid batteries as foreign bodies.

Conclusion: BRI in the head and neck results in a significant amount of ED visits. Mechanisms of injury vary by age and anatomic location, but a considerable male predilection exists. Whereas pediatric patients are primarily affected, particularly patients between 2 to 5 years of age, injuries do occur among adults. Importantly, the prevalence of dislodged hearing-aid batteries in the elderly necessitates comprehensive patient education to increase awareness and counseling regarding this complication. Awareness of demographic and anatomic-specific trends reported in this analysis may be an invaluable adjunct for history-taking and clinical examination.

Key Words: Battery-related injury, batteries, foreign bodies, chemical burns, thermal burns, National Electronic Injury Surveillance System.

Level of Evidence: 4.

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INTRODUCTION

Technological innovations facilitating an increased use of electronics have expanded the availability of batteries. Furthermore, increasingly sophisticated designs involving smaller batteries have introduced new challenges impacting the mechanisms by which battery-related injury (BRI) may occur. Although fears of young children ingesting batteries have been documented,[1–3] there has been little discourse regarding how other populations may be affected. Additionally, BRI may be caused by mechanisms other than ingestion.

Our therapeutic repertoire for diagnosing BRI has evolved concomitant with advances in noninvasive endoscopic approaches and breakthroughs in the availability of comprehensive imaging. Nonetheless, the current health-care climate necessitates identification of cost-effective practices. The first step in this process is defining the extent to which an issue comes up in everyday medical practice. Our objectives were to use a nationwide database to estimate the incidence of emergency department (ED) visits for BRI, focusing on this matter from an otolaryngologist's perspective. Beyond estimating incidence, we were interested in delineating the demographics and specific head and neck diagnoses with which patients present. Familiarity of BRI patterns by age, anatomic location, and diagnosis may be invaluable in supplementing history-taking and clinical decision making. Although BRI has been studied from a pediatric perspective with an emphasis on pediatric ingestion, we were interested in performing a succinct examination covering anatomy relevant to the practicing otolaryngologist for *all* BRI causes, and were also interested in delineating the extent to which nonpediatric populations are affected.

MATERIALS AND METHODS

United States Consumer Product Safety Commission. National Electronic Injury Surveillance System. http://www.cpsc.gov/en/Research–Statistics/NEISS-Injury-Data/. Accessed January 25, 2014. The National Electronic Injury Surveillance System (NEISS) was accessed from the Consumer Product Safety Commission's Web site and used for the collection of

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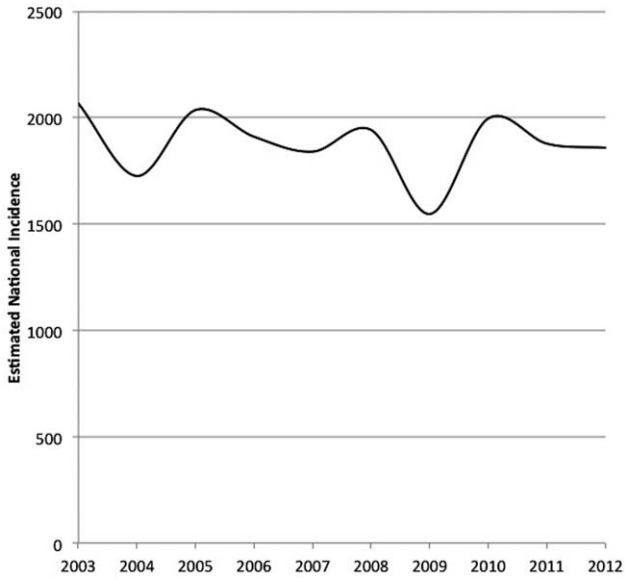

Fig. 1. Nationwide incidence of head and neck battery-related injury emergency department visits (excluding ophthalmologic causes).

data. This resource has proven invaluable in myriad prior analyses evaluating nationwide trends occurring in emergency medicine.[4–7] Briefly, this database collects data from 100 participating hospital EDs, which is used to derive a stratified probability sample of visits to the approximately 5,000 EDs nationwide that have at least six beds and are open 24 hours a day, 7 days a week.[8–10] From these figures, the NEISS creates annual estimates of each type of injury.[9] This resource allows one to search for injuries organized by several general diagnoses, specific consumer products, and patient demographics. Additionally, a one- to two-phrase narrative that describes other aspects of the patient visit is included for many cases.

We searched this database for BRI and evaluated results specifically relating to the head and neck. We were able to search for injuries with the anatomic designations including "head," "neck," "ear," "face," and "mouth. " We excluded ophthalmologic injuries in this analysis. Furthermore, all of the patient narratives for "face" injuries were examined to further filter out nasal injuries. This database provided annual sample sizes as well as derived national estimates for battery injuries throughout the body. The annual sample size of injuries organized by anatomic site was divided by the annual sample size of BRI for all sites, and this proportion was multiplied by the nationwide estimate to come up with specific values for injury incidence organized by anatomic site. For example, the NEISS reported 470 BRI-related ED visits (regardless of anatomic location) in 2012—and provided a derived estimate of 15,058 nationwide ED visits from this number. Because 29 of these 470 visits (6.2%) were related to injuries of the face, we multiplied 15,058 by 6.2% to come up with a figure of 929 battery-instigated facial injuries for 2012. In addition to annual estimates, we also analyzed data by patient demographics (including age and gender), injury diagnosis, and patient disposition. We examined data from the most recent available 10-year block (2003–2012). Data collection was completed in December 2013.

Statistical Analysis

Mann-Whitney U-tests and Fischer's exact test were used for comparison of continuous and categorical data, respectively. The threshold for statistical significance was set at $P < 0.05$, and SPSS version 20 (IBM, Chicago, IL) was used for statistical analysis.

RESULTS

Over the 10-year period from 2003 to 2012, there were an estimated 86,001 ED visits for BRI, and 18,803 (21.9%) ED visits were related to head and neck injuries as estimated using our sample size of 614 patients. Of the 614 visits for BRI in the head and neck that were analyzed, 570 (92.8%) visits involved patients who were discharged after ED treatment or examination. Twenty-nine (4.7%) patients were admitted to the hospital; 1.0% were transferred to another facility; 1.0% left the ED against medical advice; and 0.4% were held for observation. A total of 404 (65.8%) patients in the sample studied were male, and the remainder (34.2%) of 210 patients were female. Overall (Fig. 1) incidence of injury and anatomic site-specific (Fig. 2) incidence of injury fluctuated during the time period studied. Upon analysis of injuries by anatomic site, a plurality of visits (34.2%) was due to injuries to the nose. The face (excluding nose) and ears were the next most common sites of injury (Fig. 3). Patients with nose-related injuries were younger (median: 3 years of age; interquartile range: 3–4 years) than individuals presenting for injuries in other anatomic sites ($P < 0.0001$) (Fig. 3). The vast majority of primary diagnoses in the nose and ear were "foreign bodies" (97.1% and 93.0%, respectively)— significantly higher proportions than the incidence of foreign bodies in the other anatomic sites assessed in our analysis (P values both <0.0005) (Fig. 3). Diagnoses differed by

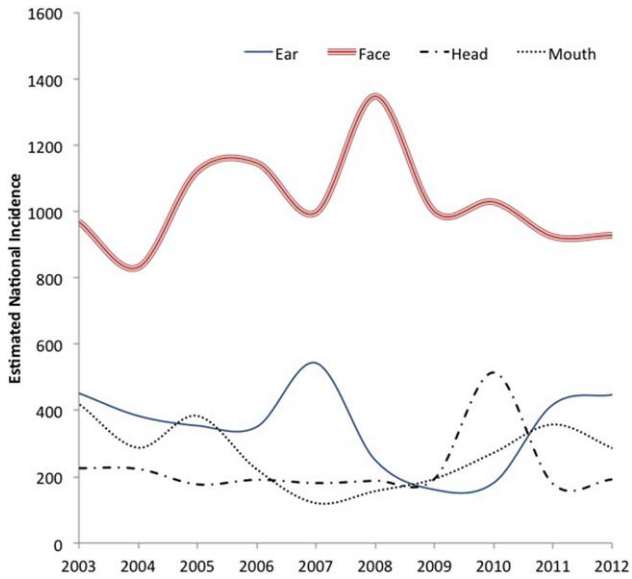

Fig. 2. Incidence of battery-related injury organized by anatomic subsites reported by the National Electronic Injury Surveillance System (NEISS). Note that data illustrated ranges from 2003 through 2012. The NEISS does not differentiate between nose and face (i.e., nasal injuries are part of "face," so for the purposes of estimating incidence in this figure, Face (including nose) is shown as one trendline). [Color figure can be viewed in the online issue, which is available at www.laryngoscope.com.]

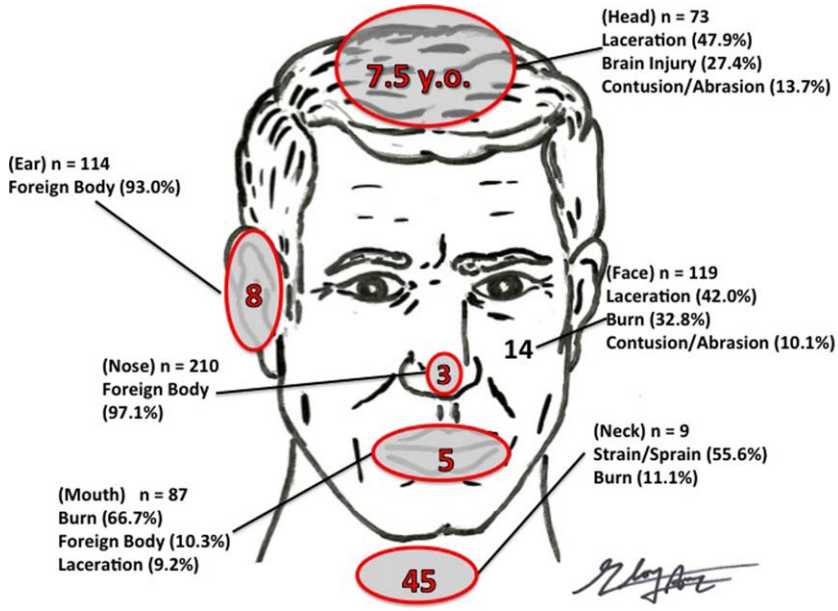

Fig. 3. Most frequent battery-related-injury diagnoses organized by anatomic location. Median age (in years) is shown within each anatomic location. Source: Illustration by Jean Anderson Eloy. [Color figure can be viewed in the online issue, which is available at www.laryngoscope.com.]

anatomic site; for example, two-thirds of mouth injuries were related to burns, whereas the most common injuries in the face (excluding the nose) and head were lacerations (Fig. 3). Among patients sustaining head lacerations, assault (patients either directly struck by battery or had battery thrown at them) and having a battery fall on their head were the most frequent mechanisms of injury (48.5% and 22.9%, respectively). Among facial lacerations, assault and being struck by falling batteries were also the most common mechanisms of injury (21.2% and 19.2%, respectively).

Types of injuries varied among age groups, with the most frequent injuries in minors and adults being foreign bodies and burns, respectively (Table I). Further broken down by specific age groups, nearly one-half of all ED visits involved patients between the ages of 2 and 5 (Table II; and the most frequent site of injury in this age group was the nose (Fig. 4). Of note, batteries as foreign bodies were most common among children in the 2- to 5-year-old and 6- to 12-year-old age groups, and were largely not an issue among older cohorts except among the elderly. Fourteen of 31 (45.2%) cases involving patients ≥ 65 years of age were related to hearing aid batteries becoming dislodged and stuck in the ear canal.

TABLE I.
Battery Injury Comparison of Adults and Minors.

Diagnosis	% of Injuries in Minors	% of Injuries in Adults
Foreign Body	62.7%	18.5%
Laceration	16.0%	15.1%
Burn	10.5%	44.5%
Contusion/abrasion	3.2%	6.7%
Brain injury	2.8%	4.2%
Other	4.3%	25.2%

Minors encompasses individuals younger than 18 years of age.

DISCUSSION

The potential for significant sequelae stemming from batteries has been previously noted. Specifically, the otolaryngologic literature has focused on the hazards of battery ingestion.[3] It is well known that among the

TABLE II.
Battery Injury Organized by Age Group.

Age Range (n)	Most Frequent Diagnoses
<1 (n = 15)	Contusion abrasion: 33.3%
(2.4%)	Brain injury: 33.3%
	Foreign body: 13.3%
	Burn: 13.3%
2–5	Foreign body: 75.3%
(n = 295)	Burns: 8.8%
(48.0%)	Contusion/abrasion: 8.8%
	Laceration: 8.5%
6–12	Foreign body: 48.5%
(n = 134)	Laceration: 30.6%
(21.8%)	Brain injury: 14.2%
Adolescents	Laceration: 36.0%
(n = 25)	Foreign body: 20.0%
(4.1%)	Burns: 20.0%
Adults < 40	Burns: 27.7%
(n = 47)	Laceration: 19.1%
(7.7%)	Foreign body: 8.5%
40–64	Burns: 46.3%
(n = 41)	Laceration: 12.2%
(6.7%)	Brain injury: 7.3%
Senior citizens	Foreign body: 51.6%
(n = 31)	Laceration: 12.9%
(5.0%)	Burns: 12.9%

Note: Twenty-six of 614 (4.2%) patients who reported injuries did not have a reported age; thus, they were excluded from this table.

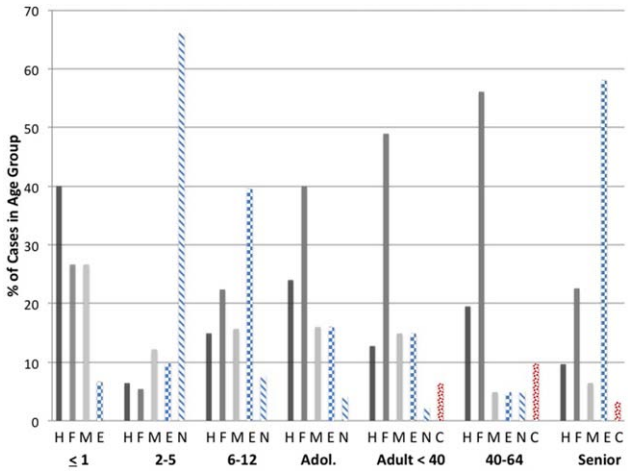

Fig. 4. Most common anatomic sites of battery-related injury organized by age group. Dark bars (H) = head, intermediate gray (F) = face, light gray (M) = mouth, horizontal stripes (E) = ears, diagonal stripes (N) = nose, dotted pattern (C) = neck. Adol. = adolescents (ages 13–17), Senior = senior citizens (65 and older). [Color figure can be viewed in the online issue, which is available at www.laryngoscope.com.]

various foreign bodies that are commonly ingested, batteries are especially likely to cause esophageal damage and erode into other vital structures such as the aorta.[1,2,10] The leakage of alkaline contents, direct forces causing injury, and even electrical currents are all potential mechanisms of injury.[3,11] Consequently, it is crucial to exercise caution and understand the potential mechanisms of injury when evaluating young children who may have been around batteries and who are now manifesting undifferentiated symptoms.

A prior analysis utilizing the NEISS noted that children under the age of 4 were the most common pediatric cohort sustaining injury from batteries, consistent with figures noted in our analysis (Table II).[12] Although this prior study represents a valuable starting point in examining these injuries, the current analysis is the first to comprehensively focus on emergencies of the head and neck. Furthermore, the prior study restricted data analysis to children under the age of 13. We also were interested in examining whether similar issues arose in older children. To the best of our knowledge, this is the first analysis examining the incidence of BRI ED visits among adults.

Our analysis emphasizes that parents should maintain vigilance around children who are in the proximity of batteries or electronic toys that may contain batteries because the majority of ED visits analyzed involved pediatric patients. Moreover, rather than focusing on batteries that are ingested intact, special attention should also be paid to children who chew or attempt to open batteries; this can cause chemical burns and thermal burns, necessitating medical attention (Fig. 3). Burns were the most common etiology of oral injury and were also a common cause of injury to the face.

Batteries acting as foreign bodies were the most frequent mechanism of injury among both the 2- to 5-year olds and preadolescent age cohorts (Table II); other injuries predominated in older age groups. Among those $\geq$65 years of age, however, foreign bodies were also a leading mechanism. Nearly one-half of injuries among this cohort were related to hearing aid batteries becoming lodged in the external auditory canal. This may be an underappreciated trend; much of the literature focuses on pediatric ingestion as a leading BRI cause.[1,3,12] When left in the ear canal, button batteries may eventually leak their alkalotic elements, causing a tissue reaction via low-voltage burns and corrosion—and ultimately leading to tissue necrosis. Facilitating injury among this patient population is the fact that button batteries used in certain hearing aid models can easily be mistaken for hearing aids themselves, and patients might place these directly into the ear canal.[13] One survey of elderly patients supports the potential for this mistake, reporting that nearly 20% of patients reported "lots of trouble" using their hearing aids.[13,14] Our present analysis reinforces this issue and suggests that patients should be counseled extensively regarding this potential complication when being evaluated for hearing aids.

Our hope is that information from this analysis can be used to augment clinical decision making and guide history-taking in certain scenarios. The diverse array of injuries reported reinforces the importance of asking about and ruling out battery ingestion when noting any oral burns or suspicions of foreign bodies. Additionally, if patients are able to hurt themselves through one mechanism with a battery, it may also be beneficial to rule out alternate methods of injury. For example, a child that has lodged a battery in the nose certainly may have had access to a second battery, and it may be important to conduct a thorough oral cavity and oropharyngeal exam to ensure that there are no burns or findings suspicious for another foreign body. Among those already presenting with one BRI, thinking about diagnoses organized by anatomic location (Fig. 3) or age group (Table I, Table II) may guide a thorough history and examination with the aim of ruling out additional injuries.

Although our analysis is the first to estimate the national incidence of battery injuries in the head and neck—and furthermore, it examines injury among all age groups—there are several weaknesses inherent to our study design. Importantly, whereas the NEISS is an excellent tool for estimating nationwide ED visits, numerous patients may present to other venues. For example, individuals with lacerations, foreign bodies, and other injuries described in our analysis may choose to be evaluated by their primary care physician or through an urgent care center. Consequently, our estimates are imperfect and likely an underestimate of BRI. Nonetheless, we still estimated nearly 20,000 ED visits over the past 10 years using this database. In this era of increasing consciousness of health care-related costs, this represents a substantial number of visits—and it is clear that many professionals, including otolaryngologists, have likely encountered patients like this in the ED. Another limitation relates to the heterogeneity of data available in this analysis. Many cases did not describe specific battery types, only general descriptions. Hence, access to individual patient data beyond the

one-sentence to two-sentence narratives provided by the NEISS would have been invaluable in looking at unique aspects of cases that are not comprehensively illustrated. Consequently, although the NEISS database may be an important tool for looking at certain statistical trends and has been invaluable in myriad other analyses,[3–10,12] further studies with complete patient medical records may be complementary.

CONCLUSION

Battery-related injury occurring in the head and neck has a significant impact on our health care system; there have been nearly 20,000 emergency department visits over the past decade. Mechanisms of injury include but are not limited to ingestion leading to burns, foreign bodies in the ears and nose, and facial lacerations. Diagnoses vary by age and anatomic location, but a considerable male predilection was noted. Furthermore, although pediatric patients are primarily affected, particularly those between 2 and 5 years of age, injuries do occur among adults. The prevalence of foreign bodies in the elderly, particularly dislodged hearing-aid batteries, necessitates comprehensive patient education to increase awareness of this complication. Awareness of demographic and anatomic-specific trends reported in this analysis may be an invaluable adjunct for history-taking and clinical examination.

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