Increase in Pediatric Magnet-Related Foreign Bodies Requiring Emergency Care

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Study objective: We describe magnetic foreign body injuries among children and obtain national estimates of magnetic foreign body injury incidence over time.

Methods: We searched the National Electronic Injury Surveillance System for cases of magnetic foreign bodies in children younger than 21 years in the United States, from 2002 to 2011. Cases were analyzed by location: alimentary or respiratory tract, nasal cavity, ear canal, or genital area.

Results: We identified 893 cases of magnetic foreign bodies, corresponding to 22,581 magnetic foreign body cases during a 10-year period (95% confidence interval [CI] 17,694 to 27,469). Most magnetic foreign bodies were ingested (74%) or intranasal (21%). Mean age was 5.2 years for ingested magnetic foreign bodies and 10.1 years for nasal magnetic foreign bodies (difference 4.9; 95% CI 4.1 to 5.6), suggesting different circumstances of injury. The incidence of pediatric magnet ingestions increased from 2002 to 2003 from 0.57 cases per 100,000 children per year (95% CI 0.22 to 0.92) to a peak in 2010 to 2011 of 3.06 cases per 100,000 children per year (95% CI 2.16 to 3.96). Most ingested magnetic foreign bodies (73%) and multiple magnet ingestions (91%) occurred in 2007 or later. Patients were admitted in 15.7% of multiple magnet ingestions versus 2.3% of single magnet ingestions (difference 13.4%; 95% CI 2.8% to 24.0%).

Conclusion: Magnet-related injuries are an increasing public health problem for young children, as well for older children who may use magnets for play or to imitate piercings. Education and improved magnet safety standards may decrease the risk small magnets pose to children. [Ann Emerg Med. 2013;■:1-6.]

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INTRODUCTION

The commercialization of small, high-powered, rare-earth magnets has been accompanied by a steady increase in reports of pediatric magnet-related injuries involving the alimentary and respiratory tracts, nasal cavity, ear canal, and genital areas.[1-3] This increase is partly due to increased marketing of sets of small magnets as desktop toys.[2] Among magnet-related injuries in children, ingestions are the most common, with an estimated 1,700 of them from magnet sets in the United States between 2009 and 2011.[1] The ingestion of multiple magnets, or a magnet together with another metal object, can cause severe morbidity because they can attract across loops of bowel and erode through intestinal walls.[2-5]

The goal of this study was to examine the epidemiology and temporal trends of single and multiple magnet-related emergency department (ED) visits by children in the United States, using a nationally representative database.

MATERIALS AND METHODS

The National Electronic Injury Surveillance System (NEISS), managed by the US Consumer Products Safety Commission, is a nationally stratified probability-weighted sample of 100 hospital EDs, including 7 children's hospitals. Hospitals were selected from the population of all US and US territory hospitals, with 24-hour EDs having at least 6 beds. Designated EDs collected injury-related data from the medical record for all injury cases. Data abstraction was done daily locally by a Consumer Products Safety Commission–trained NEISS Coordinator. Statistical weights were ascribed to provide national estimates for all US ED visits.[6]

ED visits from 2002 through 2011 for children younger than 21 years were identified with consumer product codes and search words in the narrative (Appendix E1, available online at http://www.annemergmed.com). No consumer product code existed for magnets, so cases were identified by narrative text search. Each potential case was entered onto a standardized Excel (Microsoft, Redmond, WA) spreadsheet. The narrative for each potential magnet case was reviewed by 2 authors to determine eligibility. The second reviewer used the Excel "Find" function to search for all the keywords used in the study to verify that there were not any classification errors. Six cases required further discussion after initial review. However, eligibility for all cases was resolved by consensus. Included cases were all injuries related to magnets: ingestion; aspiration; insertion in the nose, ear, vagina or rectum; or entrapment of oral tissues or genitalia.

Editor's Capsule Summary

What is already known on this topic

There has been an increase in magnet-related foreign bodies, but detailed epidemiology of pediatric emergency department presentations is unknown.

What question this study addressed

This study describes 893 cases weighted to represent 22,581 cases of magnet foreign bodies from the National Electronic Injury Surveillance System (NEISS) in children younger than 21 years, from 2002 to 2011.

What this study adds to our knowledge

Most magnet foreign bodies were ingested (74%) or intranasal (21%). Magnet ingestions increased during the 10-year period, and the majority of multiple magnet ingestions and serious complications occurred in 2007 or later.

How this is relevant to clinical practice

These data raise clinicians' awareness of the risks of magnet ingestions, particularly multiple magnets.

For 641 magnet-related cases with the diagnosis code "ingestion," the narrative consistently supported a diagnosis of known or suspected ingestion. For 42 cases coded as "aspiration," most were nasal foreign bodies (28), followed by likely ingestions, based on the narrative and patient disposition. On review, only 3 were likely aspiration events and were categorized as aspirations.

The NEISS database included a limited set of case variables: visit date, child age, 2 product codes, 2 diagnoses, patient disposition, location of injury, and a brief narrative abstracted from ED case records.[7]

ED disposition codes were categorized as (1) discharged, which included the disposition "treated and released"; or (2) admitted, which included "hospitalized," "transferred," or "held for observation."

Injuries were categorized as ingestions, aspirations, and other insertions. Magnets that were inserted into a nostril and then passed into the alimentary tract were categorized as ingestions. Magnet ingestions were categorized as single or multiple magnet ingestions according to details in the narrative (Appendix E2, available online at http://www.annemergmed.com).

We screened the narrative with search terms, as well as manual review, for further variables such as circumstances of injury and size, shape, type, and brand of magnet.

Primary Data Analysis

All weighted analyses were conducted with Stata/MP (version 12.1; StataCorp, College Station, TX). Because weighted estimates were unstable for small groups, we did not report weighted estimates for groups of 20 or fewer cases, per NEISS guidelines.[6] Therefore, national estimates for cases of magnet injury involving the ear, mouth, airway, rectum, or genitalia were computed as a group. Unless otherwise noted, sampling weights were used to generate national estimates. The incidence of magnet ingestions in the population younger than 21 years was calculated by using 2002 to 2011 annual population estimates for children younger than 21 years.[8,9] Estimates were reported as number of ED visits per 100,000 US children aged 0 to 21 years in the general population. Differences in age distributions for different foreign body locations were tested with analysis of variance estimates.

The Seattle Children's Institutional Review Board reviewed this study and found it to be exempt.

RESULTS

From a total pool of 3,628,355 ED visits in the NEISS from 2002 to 2011, our initial search strategies identified 955 potential cases of magnet injury, resulting in 893 eligible cases of magnet-related injury. This corresponded to an estimated 22,581 magnetic foreign body cases nationally during the 10-year period (2002 to 2011) (95% confidence interval [CI] 17,694 to 27,469). Ingestions accounted for 74% of cases, whereas 21% were nasal foreign bodies. The remainder (5%) were foreign bodies involving the mouth, ear canals, genitalia, rectum, or aspirations into the respiratory tract (Table).

Most magnet-related injuries involved a single object, occurred at home, and were magnets from kitchen gadgets or toys (Table). The NEISS database narrative was not sufficiently detailed to estimate the number of ED visits attributable to high-powered, rare-earth magnet sets. However, 23.4% of cases described the magnets as "small," "tiny," "bb," "minute," "teeny," "pellet," "pellets," little," or "sm."

There were 659 cases of magnet ingestion, including 4 cases of nasally inserted magnets in which the narrative indicated the magnets were identified in the gastrointestinal tract. Magnet ingestions increased from 2002 to 2003 from 0.57 cases per 100,000 children per year (95% CI 0.22 to 0.92) to a peak in 2010 to 2011 of 3.06 cases per 100,000 children per year (95% CI 2.16 to 3.96). Magnet ingestions were common among toddlers and young children and typically occurred in the home (71% of cases). For the majority of magnet cases (79%), the source of the magnet was not identified in the brief narrative entries. Magnet ingestions were significantly more likely to be reported in the second half of the 10-year study period, with an estimated 73% of all magnet ingestions and 91% of multiple magnet ingestion cases identified between 2007 and 2011 (Figure). During these years, 21% of magnet ingestions involved multiple magnets compared with 6% of magnet ingestions occurring in 2002 to 2006 (difference 15%; 95% CI 7.7% to 23.3%).

Table. Weighted characteristics of cases with magnet foreign bodies, 2002–2011.

Study Variable	Ingested Magnet	Nasal Magnet	Other Magnet*	Total Magnet
Estimated number of cases, 2002–2011 (95% CI)	15,181 (11,884–18,478)	6,008 (3,926–8,089)	1,392 (821–1,964)	22,581 (17,694–27,469)
Mean age (95% CI), y	5.2 (4.9–5.5)	10.1 (9.5–10.7)	9.2 (8.0–10.4)	6.7 (6.3–7.1)
Age <5 y, %	53.3	9.5	†	38.9
Patient sex, % male	58.5	67.3	87.7	62.7
Race/ethnicity, %				
White	54.7	62.7	†	56.2
Black	4.2	8.7	†	6.1
Hispanic	9.3	†	†	7.9
Unknown	30.1	26.2	†	28.4
Other	†	†	†	†
Location of event, %				
Home	71.4	57.8	65.7	67.4
School	†	†	†	1.7
Other	†	†	†	†
Unknown	26.7	36.9	29.3	29.6
Disposition, %				
Admitted	4.5	†	†	3.6
Treated and released	95.5	98.2	98.0	96.4
Number of magnets, %				
Single	81.2	35.1	†	65.9
Multiple	16.7	62.9	60.9	31.7
Unknown	2.2	2.4	5.8	2.4
Estimated cases (95% CI)‡				
2002–2003	944 (369–1,520)	2,532 (1,419–3,646)	†	3,782 (2,490–5,074)
2004–2005	1,531 (951–2,111)	1,958 (1,137–2,780)	†	3,923 (2,560–5,286)
2006–2007	3,804 (2,567–5,040)	820 (282–1,359)	†	5,046 (3,514–6,578)
2008–2009	3,919 (2,737–5,101)	†	†	4,567 (3,315–5,818)
2010–2011	4,983 (3,520–6,447)	†	†	5,263 (3,774–6,753)

*"Other magnet" cases include aspirated magnets; magnets inserted in ear, vagina, or rectum; and magnets entrapping oral or genital tissue.
†Cell count is too small to produce weighted estimate.
‡NEISS data are collected yearly but are grouped in 2-year intervals below.

Multiple magnet ingestions resulted in admission 15.7% of the time, whereas only 2.3% of single magnet ingestion patients were admitted (difference 13.4%; 95% CI 2.8% to 24.0%). The narrative typically described the circumstances of injury rather than medical outcomes; consequently, it was not possible to derive a national estimate of reported complications. However, at least a few cases had severe consequences, including 2 with perforated bowel and 6 others who required emergency surgery. All but 1 of these more serious outcomes occurred between 2009 and 2011. Although magnet-related deaths have been reported in the literature and lay press,[4] there were no reported deaths among our sample.

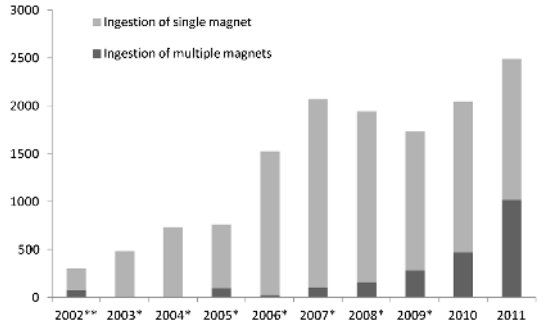

Figure. Estimated number of single versus multiple magnet ingestion cases, US EDs, 2002 to 2011.

There were 186 cases of nasal magnets, 63% of which involved multiple magnets. Reports of nasal magnets declined significantly when data from 2002 to 2006 versus 2007 to 2011 were compared: 85% (95% CI 76% to 91%) of nasal magnet cases identified in this study occurred in the first 5-year period, whereas only 15% (95% CI 9% to 24%) of nasal cases occurred in the second 5-year period. The mean age for nasal magnets was 10.1 years versus 5.2 years for ingested magnets (difference 4.9; 95% CI 4.1 to 5.6). Atypically for nasal foreign bodies, nasal magnets were most frequent in preteens and younger teens. These magnets were specifically described as magnetic earrings or nose rings in 17% and as kitchen gadgets in 78%. For magnets from kitchen gadgets, the narrative typically did not specify why the magnet was inserted nasally, but several cases indicated that nonjewelry magnets were used to imitate nasal piercings.

LIMITATIONS

This retrospective study has several limitations. There is no validated search tool to query the database. Our broad initial electronic query may have missed cases because of unanticipated misspellings or categorizations of magnet injuries. Additionally, because the NEISS captures ED visits, injuries managed exclusively in the clinic or inpatient settings would have been missed. Many children with magnet ingestions may never present to the health care system. However, most cases with significant morbidity would likely be referred to an ED. Magnet injuries may have been overestimated if ingestions that were suspected but ultimately ruled out were still included in the study. Because data were anonymous, it is possible that children with multiple ED visits after a single event were included more than once.

Increasing awareness of the dangers of magnets among both the general public and medical professionals may have led to a relative increase in health care use during the course of our study period. This could have resulted in overestimation of the rate of increase in magnet-related injuries found in our study.

Generally, the NEISS database did not permit us to reliably distinguish between ingestion of traditional magnets and the more powerful neodymium ("rare-earth") magnets. The short narrative in the NEISS did not support an analysis of motivations and contexts behind these injuries and provided only limited data on disposition as a proxy for clinical outcomes. We cannot be certain that there were no changes in the quality of NEISS narrative recording during the course of the study.

DISCUSSION

A number of studies have already identified magnet ingestion as an emerging health concern.[3,10] Several authors and the Consumer Products Safety Commission described costly, serious, and potentially fatal consequences of magnet ingestions in children.[3,5,10] These reports raised awareness of the potential severity of magnet ingestions and provided detailed descriptions of cases and outcomes. Consequently, an updated algorithm for management of magnet ingestions was published by the North American Society of Pediatric Gastroenterology, Hepatology, and Nutrition.[2] Our study builds on earlier work to provide nationally representative estimates of the incidence of magnet injuries in the United States. We document a significant increase in incidence rates of magnet ingestions during a 10-year period. However, because of a decrease in the incidence of nasal magnetic foreign bodies, the incidence of overall magnet injuries presenting to US EDs has been fairly stable. It is unclear why nasal injuries declined while ingestions increased.

Ingestions were the most common magnet-related injuries, as noted by earlier studies.[10] The incidence of magnet ingestions requiring emergency care was higher than previously reported, with an estimated 15,181 (95% CI 11,884 to 18,478) magnetic foreign body ingestions during 10 years and 6,843 (95% CI 5,203 to 8,483) ingestions from 2009 to 2011. Previous reports include 480 magnetic foreign body ingestion cases reported by gastroenterologists during 10 years[3] and national estimates of 1,700 ED visits from 2009 to 2011 for injuries from high-powered magnet sets alone.[1] The severity of injuries caused by magnet ingestions appeared to have increased since 2009, with more ingestions requiring emergency surgery or hospitalization.[2]

In addition to the changing incidence of magnet ingestions and nasal foreign bodies over time, we also identified patterns of use that may have led to magnet-related injuries. There were proportionally more nasal injuries that involved older children, possibly because strong, attractive-appearing magnets are being used by older children to imitate nose, tongue, lip, or cheek piercings, events that frequently involved multiple magnets.[5] We did not find an explanation for the decrease in nasal magnet injuries in later versus earlier years of study.

Because of their powerful attractive forces, rare-earth magnets pose a particularly serious health hazard if swallowed. The national incidence of magnet ingestions has increased rapidly, possibly because of the increasing availability of small, strong magnets sold in magnet sets in recent years. Despite efforts to educate the public about the dangers of high-powered magnet sets, warning labels are ineffective.[1] The Consumer Products Safety Commission has proposed safety standards for small, high-powered magnets, based on the "unreasonable risk of injury associated with children ingesting high-powered magnets that are part of magnet sets."[1]

Clinicians caring for children and teens need to be aware of the risk of magnet ingestions and specifically ask about ingestions when evaluating children with abdominal pain. When 2 or more magnets have been ingested, prompt evaluation, imaging, and consultation with gastroenterology or surgical colleagues are warranted.

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Appendix E1. NEISS search strategies for magnet-related foreign body injury.

Include if Product Code=	Include if Narrative Text Contains:*	Exclude if Diagnosis Code=	Manually Review if:	Exclude if Narrative Text Contains:
N/A	magnet, magnit, magnat, manget, magent, hematite, haematite, buckyball, buckyball, buckball, "bucky ball," "buckey ball," buckycube, neocube, nanodot, nanocube, cybercube, magcube, "neo cube," neoxcube, neocubix, eurocube, neoclick, cubognetic, magnetix, "k'nex," magnabild, geomag, magneatos, magnext, goobi, bornimago, "roger's connection," magz, cuballs,	Laceration	All cases	"non magnetic," non-magnetic, "ruled out," "not," "none," "0 found," "no fb," "feared complaint," "worried well," "well baby," "well infant," "well child," without other foreign body diagnosis **Manually reviewed and excluded:** radiograph results reported as negative; ocular injuries from magnetic foreign bodies; magnet-related harm to programmable equipment such as ventriculoperitoneal shunts; "magnet" ball came from a specified brand of construction set in which the balls are typically nonmagnetic (eg, Magnetix)

*Unless the search terms are contained in quotation marks, the search algorithm identified cases with the text string anywhere in the narrative text. For example, a search for *magnet* would also detect *magnets*, *magnetic*, *magnetized*, etc.

Appendix E2. Strategies for additional variables.

Magnet	Include if Narrative Text Contains:*	Manual Review
Single	single, "one," solitary, "magnet," "magent," "magnit," "magnat," "ball"	All cases
Multiple	multiple, many, group, several, bunch, together, pair, couple, magnets, magents, magnits, magnats, balls	All cases

*Unless the search terms are contained in quotation marks, the search algorithm identified cases with the text string anywhere in the narrative text.