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## **Zinc Pennies in the Esophagus**

Robin A. Dyleski, M. Saif Siddiqui, James F. Mayhew, Dawn N. Bothwell, Benjamin

B. Cable and Eric A. Mair

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relative benefit was especially notable when the patients wore the biographer at night.

The second-generation GlucoWatch G2 Biographer has an improved alert, called the down alert, that projects forward from the data over the last several readings and alerts the patient to the possibility of hypoglycemia in the next 10 to 20 minutes. Given the delay between blood and biographer readings of ~15 minutes, the currently available G2 Biographer detects hypoglycemia in real time. The latest version also provides twice as many readings, as often as every 10 minutes, which also somewhat reduces lag time. This feature may provide additional value to users, allowing them to detect hypoglycemia earlier.

The biographers measure glucose at micromolar concentrations in nanoliters of fluid, compared to conventional meters that measure millimolar glucose concentrations in microliters of fluid. Measuring glucose in the micromolar range in such small fluid volumes is subject to environmental factors such as motion, temperature, and sweating, which can interfere with and corrupt the measurement process. Similar factors affect conventional glucose meters, but these measurements are done at a 1000-fold-higher glucose concentration with a hand-held device that is not closely applied to the user. To ensure that only accurate data are presented to the user by the biographer, numerous data integrity checks are performed during each measurement cycle. If the data do not pass any of these checks, the value is not reported to the user. This increases the overall accuracy of the device, because inaccurate data are omitted. Thus, the patient gets ~55 readings per use with the G2 Biographer in our studies and skips ~20% of the readings. This is many, many more readings than patients get with conventional glucose monitoring because of the low sampling frequency.

Recent research and development efforts at Cygnus, Inc have focused on improving the data-integrity checks, essentially making them smarter, allowing more data to be presented to the user. These results have been successful. Results from a recent study conducted in the home environment using the improved integrity checks show that the number of skipped readings is reduced by >60%.<sup>1</sup> Future versions of the device will incorporate these improved data screens.

RICHARD C. EASTMAN, MD  
Cygnus, Inc.  
Redwood City, CA 94063

#### REFERENCE

1. Harper W, Wei C, Eastman R, Lesho M. Further enhancements to the utility of the GlucoWatch G2 Biographer [abstract]. *Diabetes*. 2003; 52(suppl 1):A95

## Zinc Pennies in the Esophagus

To the Editor.—

We read with interest the case report of a child with a penny lodged in the esophagus by Bothwell et al.<sup>1</sup> In our pediatric otolaryngology and anesthesia practice, we see a number of such patients annually. Before diagnosis of chronic esophageal foreign bodies, it is not unusual for some of these children to have been treated for new-onset asthma for several weeks to months. Most often, the "asthma" resolves following removal of the foreign body. Although reactions as severe as that described by the authors in their case report have not been seen, almost all have some esophageal mucosal and/or muscular reaction to the presence of the penny, especially if it has been present for more than a few days.

Our concern with this report and discussion is the emphasis on zinc toxicity in this patient despite neither a documented zinc blood level measurement nor explicit, distinct signs of toxicity. It is only in conclusion that the authors suggest careful evaluation of small children who present with marked respiratory symptoms suggestive of asthma or stridor, who do not improve as expected with proper medical therapy.

We believe that the important message to be learned from the presentation of this case report is that a foreign body ingestion/aspiration needs to be an early consideration for any child who

fails to respond to appropriate medical treatment of their respiratory symptoms. This would help to reduce severe esophageal injuries associated with zinc-containing pennies as described in the report.

ROBIN A. DYLESKI, MD, FASC  
M. SAIF SIDDIQUI, MD  
JAMES F. MAYHEW, MD, FAAP  
Arkansas Children's Hospital  
Little Rock, AR 72202-3591

#### REFERENCE

1. Bothwell DN, Mair EA, Cable BB. Chronic ingestion of a zinc-based penny. *Pediatrics*. 2003;111:689–691

In Reply.—

Coin ingestion with esophageal impaction is not a new or rare problem. Four percent of children have swallowed a coin (the most commonly swallowed foreign body in the United States).<sup>1</sup> Small children use their mouths to explore the world. They specifically like to put coins in their mouths because they are shiny, plentiful, and relatively easy to pick up. Children also see adults "play with them" all the time. Although esophageal coins may spontaneously pass in up to 28% of children,<sup>2</sup> we routinely endoscopically remove them in the majority of cases without sequelae. Rarely, long-term esophageal coin impaction may lead to untoward complications including death.<sup>3,4</sup>

Our goal in presenting a child with long-term esophageal penny impaction was to alert pediatricians to the specific problem associated with post-1982 penny ingestion.<sup>5</sup> Since 1982, to reduce minting costs the United States has produced a penny composed primarily of zinc with only a very thin layer of copper coating. Zinc is highly reactive with gastric acid and causes local corrosion leading to potential mucosal erosion, abrasion, and perforation. Systemic toxicity may present with signs of lethargy, severe gastroenteritis, and even multisystem organ failure. We clearly stated that our child had normal zinc lab values without systemic toxicity yet sustained severe local ulceration and scarring of the esophagus. Since publication of our article we treated another case of long-term penny esophageal impaction in a small child presenting with a chronic cough of unclear etiology. Again, local zinc reactivity led to extensive ulcerative esophagitis and granulation.

Systemic zinc toxicity from penny ingestion is well-described in the veterinary literature.<sup>6–8</sup> On a recent visit to our local zoo, the corresponding author noted a sign near an animal cage admonishing visitors not to toss coins into the fountain inside the cage. The zookeeper explained that animals (like children) will swallow the shiny coins (especially pennies), leading to either esophageal obstruction and airway ramifications or zinc toxicity.

Prior to 1982, the United States minted coins that were ~95% copper and <5% zinc. Beginning in 1982, the proportion of each metal was reversed because the value of the copper in a penny was becoming more valuable than a penny. Since 1982, the United States has minted pennies as copper-coated zinc wafers. Canada also changed to the primarily zinc penny in 1997. However, in 2001, Canada switched to a copper-plated steel penny (~95% steel and ~5% copper), which is potentially less toxic from long-term local exposure. Perhaps the United States should follow Canada's lead.

We emphasized two practical conclusions from our case report. First and foremost, any child with a chronic cough or wheeze without a clear cause must undergo a detailed evaluation to include a workup for foreign-body ingestion. This workup commonly includes a chest radiograph and may include endoscopy. Second, zinc-based pennies are common and, if ingested, have the potential to create acute and chronic inflammatory responses more than other similar types of coinage. Early detection is stressed. We agree wholeheartedly with the comments from our colleagues at Arkansas Children's Hospital as stated in this letter

to the editor and a similar one.<sup>9</sup> We echo these concerns in our article and in our pediatric otolaryngology practice.

DAWN N. BOTHWELL, MD  
BENJAMIN B. CABLE, MD  
Pediatric Otolaryngology Service  
Tripler Army Medical Center  
Honolulu, HA

ERIC A. MAIR, MD, FAAP  
Pediatric Otolaryngology Service  
Wilford Hall Medical Center  
San Antonio, TX

## REFERENCES

1. Connors GP, Chamberlain JM, Weiner PR. Pediatric coin ingestion: a home-based survey. *Am J Emerg Med.* 1995;13:638–640
2. Soprano JV, Fleisher GR, Mandl KD. The spontaneous passage of esophageal coins in children. *Arch Pediatr Adolesc Med.* 1999;153:1073–1076
3. Byard RW, Moore L, Bourne AJ. Sudden and unexpected death—a late effect of occult intraesophageal foreign body. *Pediatr Pathol.* 1990;10:837–841
4. Dahiya M, Denton JS. Esophagoaortic perforation by foreign body (coin) causing sudden death in a 3-year-old child. *Am J Forensic Med Pathol.* 1999;20:184–188
5. Bothwell DN, Mair EA, Cable BB. Chronic ingestion of a zinc-based penny. *Pediatrics.* 2003;111:689–691
6. Mikszewski JS, Saunders HM, Hess RS. Zinc-associated acute pancreatitis in a dog. *J Small Anim Pract.* 2003;44:177–180
7. Agnew DW, Barbiers RB, Poppenga RH, Watson GL. Zinc toxicosis in a captive striped hyena. *J Zoo Wildl Med.* 1999;30:431–434
8. Meurs KM, Breitschwerdt EB, Baty CJ, Young MA. Postsurgical mortality secondary to zinc toxicity in dogs. *Vet Hum Toxicol.* 1991;33:579–583
9. Ghafoor AU, Siddiqui SM, Mayhew JF, Dyleski RA, Razzzaq S. Esophageal foreign body vs. asthma. *J Am Board Fam Pract.* 2003;16:184–185

## Timing of Sexual Maturation

To the Editor.—

I read with interest the article of Sun et al<sup>1</sup> on the timing of sexual maturation among US children that was based on data of the Third National Health Examination Survey (NHANES III).<sup>2</sup> The authors estimated that the median age at onset of sexual maturation in boys, ie genital stage 2 (G2) according to Tanner classification, is 10.03 years for non-Hispanic white boys, 9.20 years for non-Hispanic black boys, and 10.29 years for Mexican American boys. In this study G2 occurs much earlier than in previous reports on the sexual maturation of US<sup>3</sup> or European<sup>4</sup> boys, which generally find the onset of puberty to occur at or after the age of 11 years. Furthermore, in the article the median age at G3 for non-Hispanic white boys was 12.32 years, for non-Hispanic black boys 11.78 years, and for Mexican American boys 12.53 years. These data are most astonishing because they suggest that, in 50% of the boys, the transition from G2 to G3 takes 2.2 to 2.8 years. For those practicing pediatric endocrinology it is well-known that it is unusual for an adolescent to remain in the same pubertal stage for >2 years, and in that case the subject should be investigated for possible pubertal arrest. A long transition time (1.6–2.49 years) was also reported for G4 to G5, whereas for G3 to G4 the transition time, in the ethnic groups studied, ranged from 1.2 to 1.62 years. Unfortunately, the authors did not comment on this matter in their article.

In NHANES III, pubertal assessment was performed by trained physicians. A one-stage variance was allowed between the quality-control standard and the assessment by the physician. The lengthy transition from G2 to G3 or from G4 to G5 determined in the study of Sun et al most probably is the result of not including testicular volume in pubertal assessment. Estimation of scrotal skin changes, such as thinning, reddening, or rugation, may be subjective, and furthermore they do not necessarily reflect the activation of the central nervous system-gonadal axis, if they are not accompanied by an increase in testicular volume. A misinterpretation of stage G4 for G5 or the opposite does not make much

difference, because sexual maturation is well-advanced. However, the misinterpretation of G1 for G2 may result in unnecessary laboratory investigations and in a population study will lead to false recommendations about the onset of puberty of the population. Sun et al conclude that 25% of non-Hispanic black, non-Hispanic white, and Mexican American boys enter G2 at 7.5, 8.6, and 8.9 years respectively; this means that 3% (ie, the normal cutoff limit) of the male population enters puberty at an even earlier age. If these data are adopted as reference for the timing of male sexual maturation, it will result in nondiagnosis of precocious puberty in a number of boys that may have a life-threatening cause of sexual precocity.

I believe that up-to-date national studies on the pubertal maturation of children are needed. Ideally these studies should be performed by pediatric endocrinologists and should include measurement of testicular volume in boys.

ANASTASIOS PAPADIMITRIOU, MD  
Endocrinology Clinic  
Penteli Children's Hospital  
Palea Penteli, Athens 152 36, Greece

## REFERENCES

1. Sun SS, Schubert CM, Chumlea WC, et al. National estimates of the timing of sexual maturation and racial differences among US children. *Pediatrics.* 2002;110:911–919
2. NHANES III. Analytic and Reporting Guidelines: The Third National Health and Nutrition Examination Survey (1988–94). [NHANES III Reference manuals and reports CD-ROM]. Hyattsville, MD: National Center for Health Statistics, Centers for Disease Control and Prevention; 1997
3. Biro FM, Lucky AW, Fuster GA, Morrison JA. Pubertal staging in boys. *J Pediatr.* 1995;127:100–102
4. Papadimitriou A, Stephanou N, Papantzas K, Glynos G, Philippidis P. Sexual maturation of Greek boys. *Ann Hum Biol.* 2002;29:105–108

In Reply.—

We read with interest Dr Papadimitriou's response to our recent article presenting ages at entry into stages of sexual maturation for US children.<sup>1</sup> Dr Papadimitriou is concerned about the relatively early median ages for entry into genital stage two (G2), the first signs in boys of pubertal changes in the genitalia. Also, he raises the issue of the measurement of testicular volume as an important aspect for this determination.

It is important to note that the original descriptions of the genital stages for boys by Reynolds and Wines,<sup>2</sup> subsequently made popular by Tanner,<sup>3</sup> were based on criteria to be assessed from nude photographs, and accordingly, did not include any palpation or measurement of testicular size. Consequently, the criteria for G2 that specify "enlargement of scrotum and testes"<sup>3</sup> were based on a visual inspection only. These criteria were applied in the assessment of sexual maturation stages in the Third National Health Examination Survey (NHANES III)<sup>4</sup> and were analyzed in our report.

Dr Papadimitriou compares our median ages for entry into G2 with the results of two studies of boys, one in the United States<sup>5</sup> and the other in Greece.<sup>6</sup> In these studies, conventional visual criteria of Tanner for G2 were modified to include a minimum measured testicular volume of 2 mL in one study<sup>6</sup> and 3 mL in the other.<sup>5</sup> However, the means and standard deviations (SDs) of testicular volume in another study of boys rated visually in G1, indicating prepubescence, was 3.3 mL (SD, 1.6 mL), and for G2, 6.79 mL (SD, 2.25).<sup>7</sup> Consequently, in the United States and Greek studies presented by Dr Papadimitriou more than half of the boys considered as G1 would have had testicular volumes >3 mL, and, at the same time, ~40% of those G2 boys had testicular volumes <3 mL. Clearly, testicular volume has considerable variation within genital stages when assessed by the visual criteria. By altering the criteria for G2 to include minimum thresholds for testicular volume, the median ages for entry into the stages are later than those using only the visual criteria.

The Tanner stages reported by Biro<sup>5</sup> were mean ages in a stage. In our report, we presented median ages at entry into a stage and mean ages in a stage for each indicator. As we stated in our article, "median age at entry for a maturity stage will be earlier than the

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