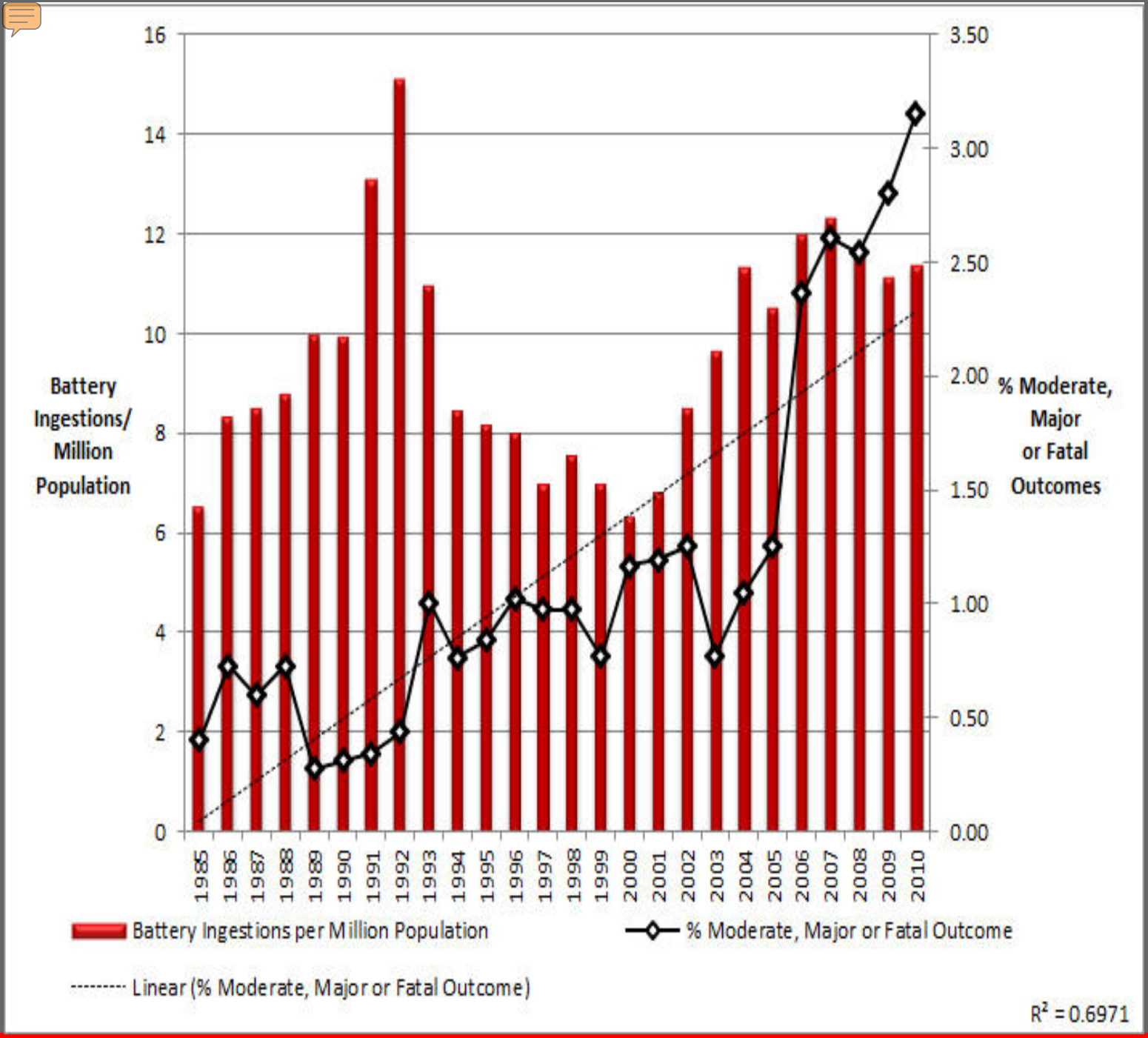
National Capital Poison Center

National Battery Ingestion Hotline: (202) 625-3333

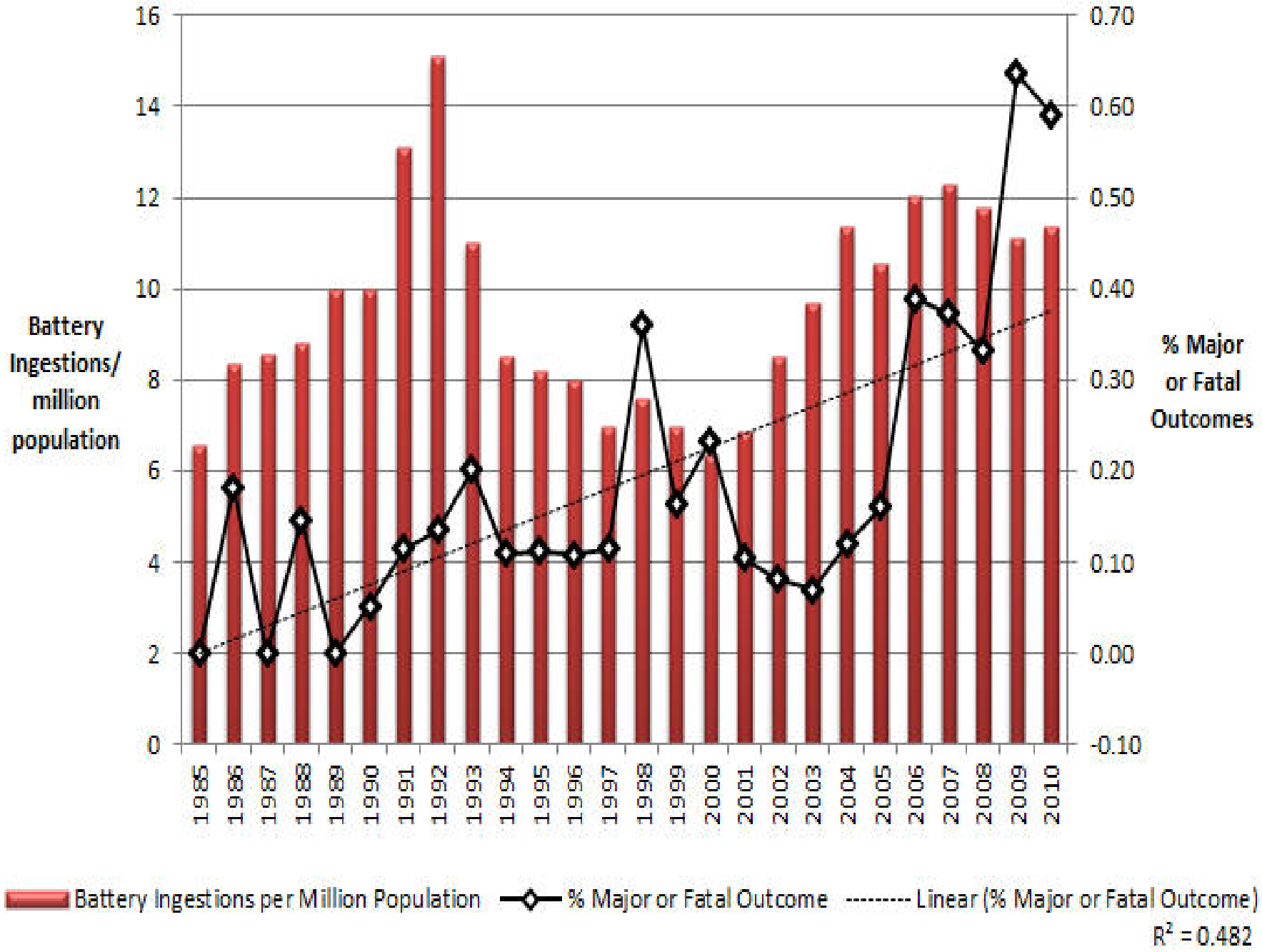
The Button Battery Ingestion Hazard

Toby Litovitz, MD



Data from the National Poison Data System (collected by all US poison center) show that the frequency of button battery ingestions over the past 26 years varies with no specific trend, but severity is dramatically increased.

POISON Help 1-800-222-1222


Battery Ingestions/ million population
% Major or Fatal Outcomes
16
14
12
10
8
6
4
2
0
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Battery Ingestions per Million Population
% Major or Fatal Outcome
Linear (% Major or Fatal Outcome)
R² = 0.482

NPDS Data – 2010

(data from the 60 US poison centers)

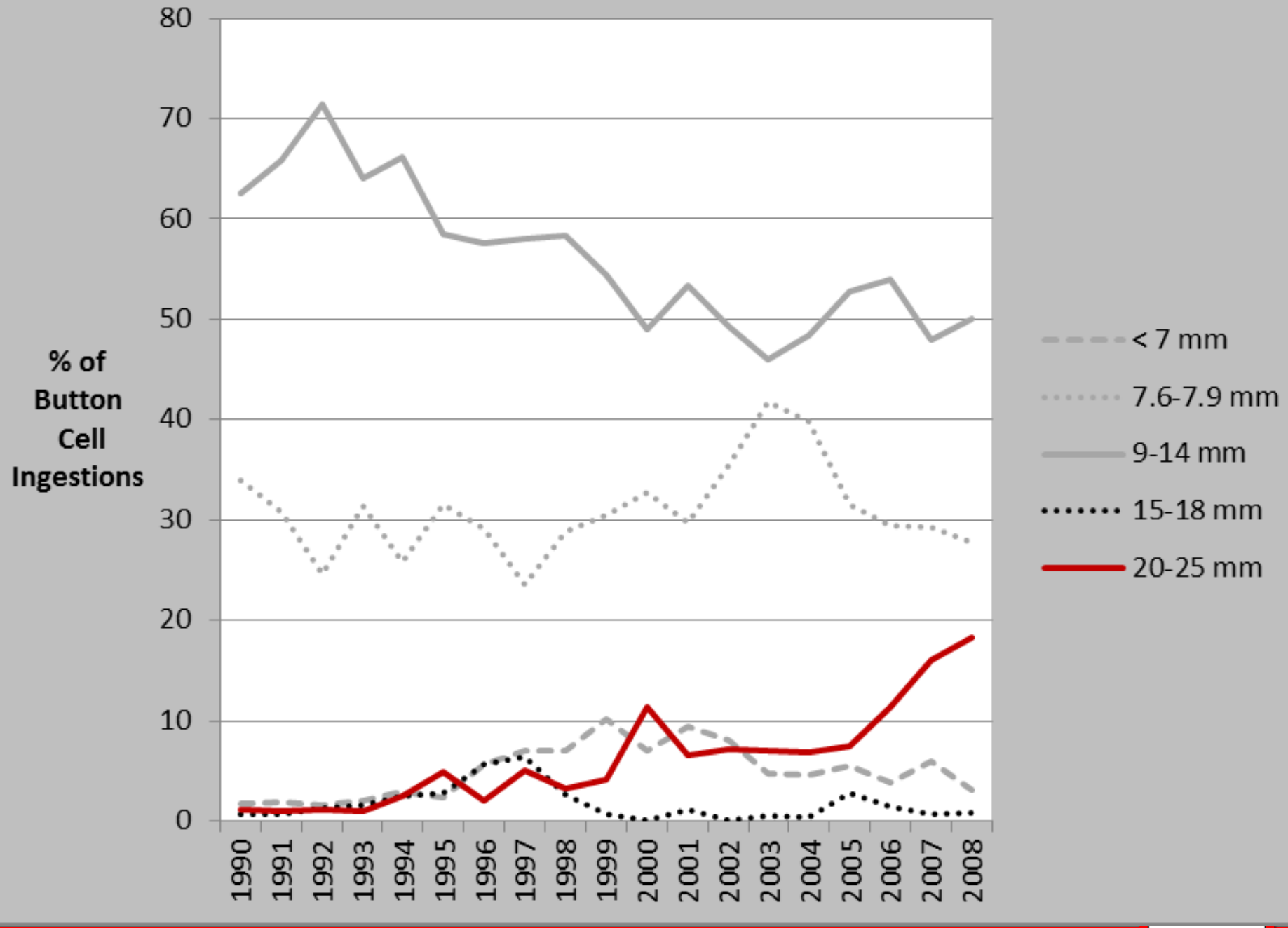
- 3,549 button battery ingestions
- 11.4 ingestions/million pop.
- 2,405 (68%) < 6 years
- 19 major effects
- 2 fatalities

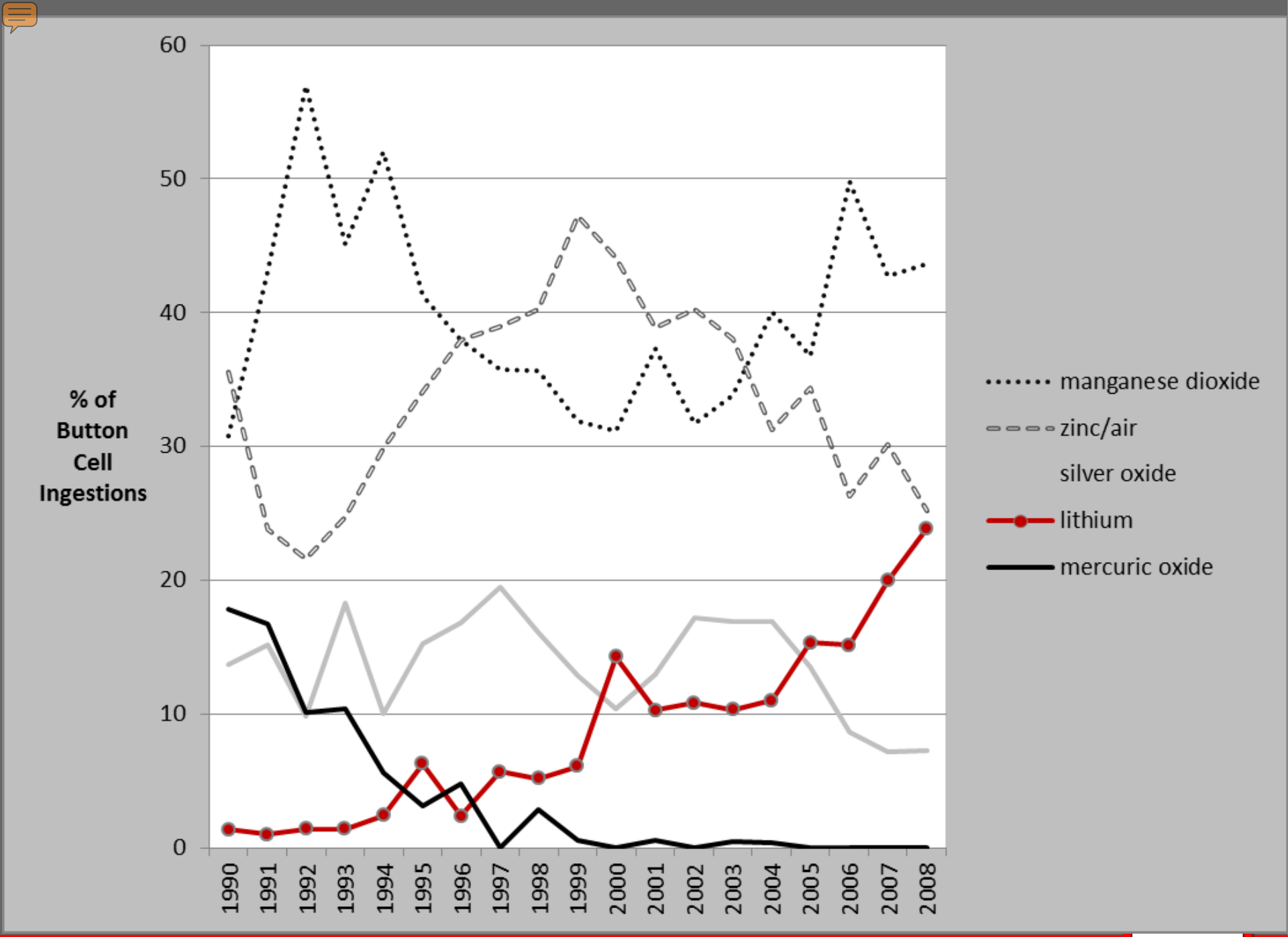
Methods: 3 Data Sources

- NPDS: **56,535** button battery ingestion cases
  - 1985-2009
  - Limited detail; data only useful for frequency and outcome trends
- NBIH: **8,648** battery ingestions
  - 7-1-1990 thru 9-30-2008 (18.25 years)
  - NBIH founded 1982, prior cases published previously
  - **8,161** button cell and **487** cylindrical cell ingestions
  - Data on clinical course and battery characteristics
- **13 (now 16) fatal** & **73 (now 85) major** outcome cases from all sources (NBIH; lit)

202-625-3333

Litovitz T, Whitaker N, Clark L, White NC, Marsolek M. Emerging battery ingestion hazard: Clinical implications. Pediatrics 2010; 125(6):1168-1177. Epub 2010 May 24


% of Button Cell Ingestions
80
70
60
50
40
30
20
10
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
< 7 mm
7.6-7.9 mm
9-14 mm
15-18 mm
20-25 mm


% of Button Cell Ingestions
60
50
40
30
20
10
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
manganese dioxide
zinc/air
silver oxide
lithium
mercuric oxide

20-mm lithium cell

- CR 2032 (most)
- CR 2025
- CR 2016

95% of ingested batteries are one of these sizes:

- 11.6 mm
- 7.9 mm*
- 20 mm
- 5.8 mm*

*for hearing aids

18 mm dime
19 mm penny
21 mm nickel
24 mm quarter

POISON Help
1-800-222-1222

Outcome Predictors

LOGISTIC REGRESSION MODEL:

Clinically Significant Outcome
(Moderate, Major, or Death)
NBIH Data

	OR	P
20-25 mm	24.59	<.0001
< 4 years	3.24	<.0001
> 1 battery	2.12	.016
male	1.49	.042

- 94% of major outcome or fatal cases involved ≥ 20 mm diameter batteries (31 of 33 cases)
- Lithium more likely associated with clinically significant outcomes.
- All fatalities and 85% of major effects occurred in children < 4 years.
- For 20-25 mm cells: clinically significant outcome 3.2x more likely with new cells.
- **A major effect or death occurred in 12.6% of children < 6 years who ingested a 20-25 mm button battery.**

Battery Size in Major or Fatal Cases

- 92% of 34 known diameter batteries implicated in major or fatal ingestions were 20 mm lithium cells (2000-2009 data only)

- When smaller cells implicated in major or fatal cases, child was younger (22 days to 10 months).

- Ingested batteries that lodge in the esophagus cause most of the problems
- Most of the batteries that lodge are large
- Batteries of any size that pass to the stomach are likely to pass thru the gut without a problem
- Batteries placed in the nose, ear or vagina can cause tissue necrosis and severe injuries, too. These batteries are usually smaller cells.

Ingestion Injuries

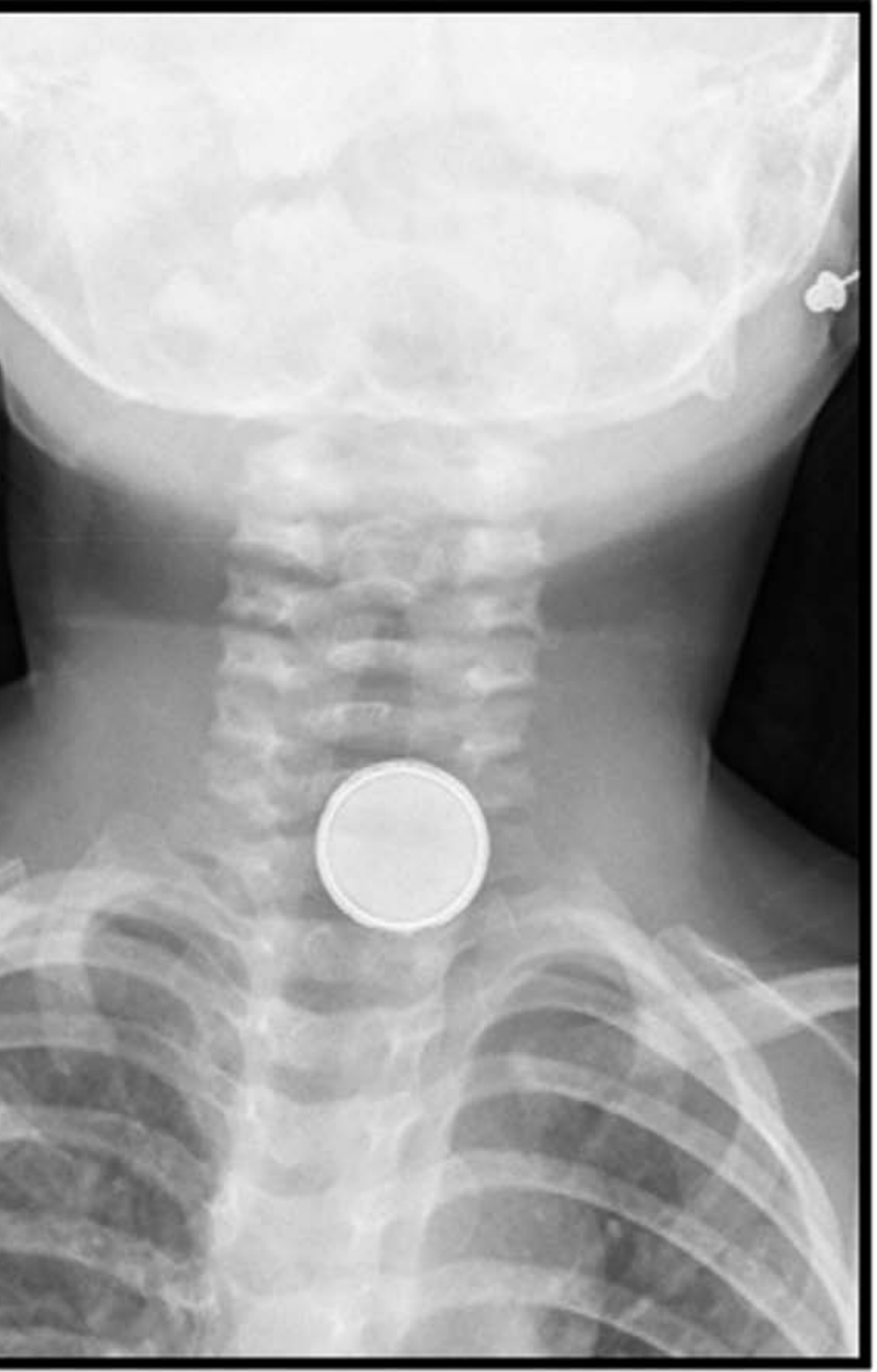
- Esophageal burns, perforations, strictures
- Tracheoesophageal (TE) fistulas, tracheal damage
- Exsanguination from fistulization into a vessel
  - Aorto-esophageal (AE) fistulas always lethal
- Vocal cord paralysis
- Spondylodiscitis
- Death
- Injuries extend after removal, with TE fistulas developing up to 9 days, AE fistulas up to 18 days, and strictures months after battery removal.
- Batteries co-ingested with a magnet cause intestinal perforations.

These children need…

- Multiple surgical procedures to repair esophagus or trachea
- Long term tube feedings
- Permanent tracheostomy
- Repeated, even weekly, esophageal dilation
- Repeated diagnostic testing (esophagram, MRI, endoscopy)

Why physicians can't just fix the problem through better treatment:

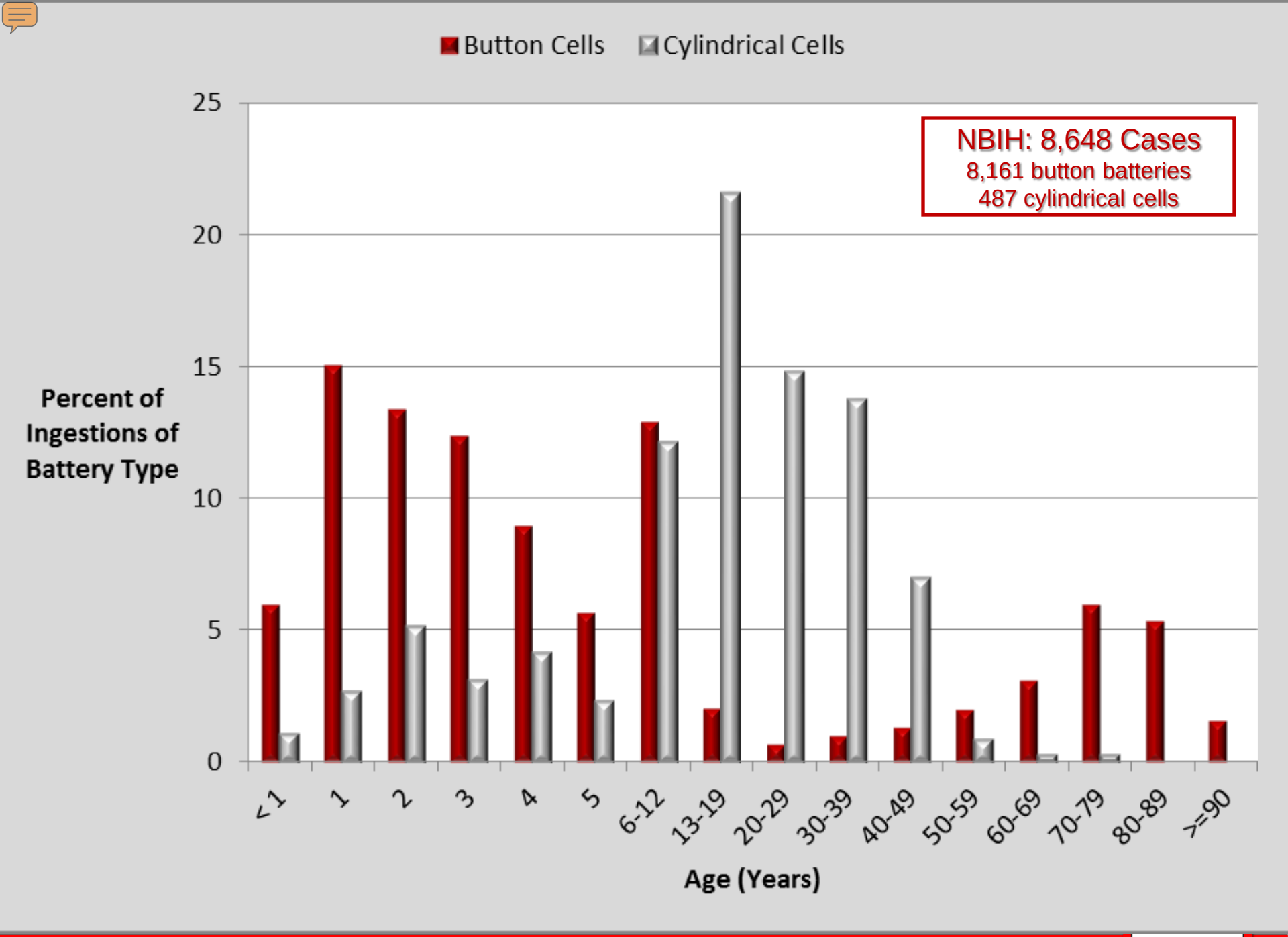
- Severe damage in just 2 hours
- Diagnosis missed: 54% of fatalities; 27% of majors
  - Ingestions not witnessed (92% of fatal; 56% of major)
  - 36% of patients with esophageal batteries are initially asymptomatic
  - Nonspecific presenting symptoms (vomiting, fever, poor appetite, cough, wheezing, drooling, dehydration)
  - Mistaken for coins
- Delayed intervention: referral for peds endoscopy



Grisel JJ, Richter GT, Casper KA, Thompson DM. Acquired tracheoesophageal fistula following disc-battery ingestion: Can we watch and wait? Int J Pediatr Otorhinolaryngol 2008;72:699-706.

Mechanism of injury

- Generation of an external electrolytic current
  - Hydrolyzes tissue fluids
  - Produces hydroxide at battery's negative pole
  - Most severe damage adjacent to negative pole
  - Lithium cells are 3V (others 1.5V) → more current, more hydrolysis, more rapid injury
- Leakage of alkaline electrolyte does not occur with lithium cells
- Physical pressure (not sufficient to cause significant damage, as shown with coins)
- Injury is from local effects; systemic poisoning from battery ingredients virtually never occurs


Button Cells
Cylindrical Cells
NBIH: 8,648 Cases
8,161 button batteries
487 cylindrical cells
Percent of Ingestions of Battery Type
25
20
15
10
5
0
<1
1
2
3
4
5
6-12
13-19
20-29
30-39
40-49
50-59
60-69
70-79
80-89
>=90
Age (Years)

Source	< 6 yo (%)	Adult (%)
Battery obtained directly from product	**61.8**	4.2
Loose or sitting out	**29.8**	80.8
Battery packaging	**8.2**	3.0
Whole hearing aid containing battery swallowed	**0.2**	12.1

Consumer electronics industry could provide the single most important intervention.
Secure battery compartments could potentially eliminate 61.8% of pediatric battery ingestions.

Litovitz T, Whitaker N, Clark L: Preventing battery ingestions: an analysis of 8648 cases. Pediatrics 2010;125(6):1178-1185. Epub 2010 May 24

Intended Use of Ingested Battery	N	% (of known)
Hearing aid (2514) or cochlear implant (14)	2528	36.27
Game/toy	1538	22.07
Watch	775	11.12
Calculator	400	5.74
Flashlight, light, lantern, laser light, pointer, nightlight, penlight	320	4.59
Remote control (TV, garage door, key fob)	200	2.87
Keychain: laser, flashlight, whistle, toy, calculator, laser pointer	167	2.40
Clock, clock radio, timer, stopwatch	125	1.79
Jewelry (flashing, lighted, musical, tongue ring, earring, necklace)	121	1.74
Book	116	1.66
Camera	112	1.61
Telephone/pager	81	1.16
Noisemaker	76	1.09
Pen (lighted, laser)	60	0.86

NBIH (1990-2008) : all ages, all sizes

Intended Use of Ingested Battery	N	% of known
Miscellaneous	48	0.69
badge, candle, cup, fishing lure, door chime, dog collar, electric meter, battery charger, gun scope, invisible fence, lighted eraser, lighted tweezers, lighted whistle, mat/rug, mirror light, picture frame, printer/scanner, scale, teapot, toothbrush, tool, trophy, wi-fi locator		
Music or video players/recorders/microphones/headphones	38	0.55
cassette, CD, DVD, walkman, iPod, mp3 player, Tivo, etc		
Radio	32	0.46
Computer/PDA	29	0.42
Thermometer	29	0.42
Attire	26	0.37
flashing, lighted, or musical barrette, buckle, costume, glove, shoe, shoelace, sock, sun glasses, button, body light, etc		
Musical instrument (guitar, flute, piano)	24	0.34
Exercise equipment	22	0.32
Book light, book mark	20	0.29
Magnet (lighted, flashing)	16	0.23
Greeting card	15	0.22
Ornament	15	0.22
Alarm/monitor (auto, baby, bedwetting, door, motion, window)	14	0.20
Bicycle equipment/light	12	0.17
Medication pump, medical equipment	11	0.16

NBIH: 146 ingestions of 20 mm lithium cells, children < 6, known intended use, Jul 1990-Sept 2008

Intended Use	N	%
Remote control (including key fobs [4], garage door openers [5], remotes for media devices, etc)	55	37.7
Game/toy	22	15.1
Calculator	11	7.5
Watch	8	5.5
Computer/PDA	7	4.8
Camera	6	4.1
Bicycle/exercise equipment (headlamp, ab stimulator or belt)	6	4.1
Thermometer (tympanic [4])	6	4.1
Flashlight	5	3.4
Shoes/jewelry	3	2.1
Book/booklight/bookmark	3	2.1
Other (cell phone, greeting card [2], glucometer [2], VCR, dog collar, invisible fence, keychain, wi-fi locator, rifle scope, scale)	14	9.6

Intended Use (85 majors, 16 deaths)

Intended Use	N
Camera (especially older cases)	10
Remote control (excl. fobs and garage door openers)	10
Game/toy	8
Watch	5
Calculator	4
Key fob	3
PDA/computer	2
Scale (bathroom)	2
Shoe	2
Thermometer (digital ear)	2
Other (single cases of each): garage door opener, electric candle, music player, hair dryer, ab belt, talking book, flashlight, bicycle computer, singing greeting card	9

3 batteries were obtained from the battery packaging.

NBIH:

121 cells

20 mm Li

ingested

Jul 2008-Jun 2010

known intended use

	N	%
Remote control	53	43.8
Game/toy	13	10.7
Scale (bathroom, kitchen, other)	9	7.4
flashlight, doll house light, light, nightlight	7	5.8
Watch	6	5.0
Calculator	4	3.3
Book light	3	2.5
Key fob	3	2.5
Candle	2	1.7
computer	2	1.7
Dog collar	2	1.7
Glucometer, BP cuff	2	1.7
Key chain light	2	1.7
Hat light, lighted baseball cap	2	1.7
Tea light	2	1.7
Bicycle computer	1	0.8
Cell phone	1	0.8
Clock	1	0.8
Garage door opener	1	0.8
weather device	1	0.8
Ornament	1	0.8
PDA	1	0.8
Safety goggles	1	0.8
Thermometer	1	0.8

All lighted products: 18 (14.9%)

The Solution: Multifactorial

- Parents need to be better informed so they know to keep batteries out of reach of children, watch for insecure battery compartments, and get an immediate x-ray if a battery is ingested
- MDs need to be better informed so they can make diagnosis and intervene faster
- Consumer electronics industry needs to secure battery compartments
- Battery industry needs to use child-resistant packaging for 20 mm lithium cells

UL 60065

- Warning level needs to be stronger than "CAUTION" since fatality is a risk; alert symbol also needed
- Warning label needs to identify the serious consequences of ingestion
- Passing impact testing should augment, not replace securing the battery compartment with a screw
- Product scope is too narrow (only audio/video equipment included)

How to proceed?

- Secure battery compartments should be required on all consumer electronics, not just media devices.
  - Secure with a screw and require a tool for access.
  - Compartments must not open spontaneously upon impact or when a product is dropped.
  - At a minimum, secure battery compartments should be required for products using ≥ 20 mm button cells.
- Packaging for 20 mm (or larger) button cells should be child-resistant.
- What's the most efficient way to get standards for all consumer products? Do we need to petition CPSC?

National Capital Poison Center

POISON Help 1-800-222-1222

- SEND SINGING CARD
- PREVENT POISONINGS
- ORDER FREE MATERIALS
- ACT FAST
- DONATE NOW
- Learn the Poison Prevention Jingles!
- SIGN UP NOW FOR OUR EMAIL NEWSLETTER
- THE POISON POST®
- ABOUT US
- POISON INFO
- POISONING STATS
- BUTTON BATTERIES
- EN ESPAÑOL
- FOR KIDS, BY KIDS
- FEEDBACK
- OTHER POISON CENTERS
- COURSE REGISTRATION
- CASE STUDIES

ACT FAST - if you think someone has been poisoned!

- If you find your 2-year-old with an open bottle of medicine
- If your spouse mixes household cleaners and can't stop coughing
- If your teenager overdoses
- If that liquid in the glass wasn't soda
- If you think someone has been poisoned....

Call 1-800-222-1222 right away!

Here's how we help you....FREE!

We save lives and reduce illness from poisonings.
Quick action could save a life. About half of poisoning emergencies involve small children, but we also provide immediate life-saving information for suicide attempts, medication errors, chemical spills, occupational exposures, product misuse, drug interactions and pet poisonings.

We reduce your health care costs.
About 72% of Poison Center callers are treated at home...safely. That saves the region's residents over $18 million/year in unnecessary health care costs.

We prevent poisonings.
Reported poisonings are monitored for new or unusually dangerous hazards. When we identify a problem, we urge manufacturers and government regulators to change the formulation, improve the closure or even ban the product.

You can help us.

The poison center helps more than 41,000 poison victims a year - FREE!

We rely on your generous contributions to keep this service running.

Donate here, online, or through United Way (8476) or CFC (28290).

Poison Prevention Information

Get more information on preventing poisoning.

Get FREE stickers and magnets with the Poison Center emergency phone number.

Remember, call the Poison Center if you suspect a poisoning:

www.poison.org

NATIONAL CAPITAL POISON CENTER

POISON Help 1-800-222-1222

Additional Information?

- Litovitz T, Whitaker N, Clark L, White NC, Marsolek M. Emerging battery ingestion hazard: Clinical implications. Pediatrics 2010; 125(6):1168-1177. Epub 2010 May 24

- Litovitz T, Whitaker N, Clark L: Preventing battery ingestions: an analysis of 8648 cases. Pediatrics 2010;125(6):1178-1185. Epub 2010 May 24.

- www.poison.org
  - Battery ingestion stats
  - Lists of fatalities (16) and severe cases (85)
  - Media coverage of cases
  - Mechanism of injury