Turning Public Health Data into Action: Preventing Medication Overdoses in Young Children

*Developments over a Decade*

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Director, Medication Safety Program

2015-2016 Seminar Series: Pharmaceutical Safety, Value and Innovation

April 18, 2016
Alternative Topics

- Desiderata for designing health surveillance systems
- The big mistake in the Institute of Medicine report “To Err is Human”
- Last call for the “Beers Criteria”
- Why we still need Coumadin clinics in 2016
- Insulin is #1 (cause of adverse drug events)
- Should we ditch dietary supplements?
Disclaimer

- The findings and conclusions in this presentation are those of the author and do not necessarily represent the views of the Centers for Disease Control and Prevention.
Outline

- Data: National surveillance of morbidity from pediatric medication overdoses and exposures
- Theory: Application of principles of Injury Prevention
- Practice: PROTECT
- Future: Thoughts and suggestions?
Bottom Line Up Front (BLUF)

- A Public Health Approach should be the framework for patient safety
- Population-based data should be used to identify, prioritize, and monitor medication safety problems
- Injury prevention principles should guide safety interventions

Pharmacoepidemiol Drug Saf, online release 2006

JAMA 2016; early release, April 14, 2016
The Public Health Approach

- Identify (Quantify) the Harm
- Identify Risk & Protective Factors
- Design Intervention
- Evaluate Impact
Quantifying Harm: The Injury Pyramid

- Deaths
- Admits
- Emergency Visits
- Office Visits
- Exposures without Healthcare intervention
Poisoning Mortality is Mostly Medications: Children <5 Years

- Since Poison Prevention Packaging Act, 1970s

- Poisonings remain predominantly from medications

[Link to graph and data source]
Poisoning *Morbidity*: Children <5 Years
ED Visits for Unsupervised Medication Ingestions in Children <5 years Increased

www.cdc.gov/injury/wisqars/index.html
National Electronic Injury Surveillance System-Cooperative Adverse Drug Event Surveillance Project (NEISS-CADES)
NEISS-CADES: Population Representative Surveillance

- National Electronic Injury Surveillance Systems (NEISS)
  - Operated by the US Consumer Product Safety Commission (CPSC)
  - Cooperative Adverse Drug Event Surveillance (CADES)
  - Collaboration with FDA, CDC

- National Probability Sample
  - 160 hospital Emergency Departments (EDs)
  - Stratified by hospital size/children’s hospitals
  - Cases weighted by inverse probability of selection

[Map of the United States with marked locations]
NEISS-CADES: Data Collection

- Ongoing, active surveillance based on chart abstraction
- Data based on narrative and clinical impression

1. Patient visits ED
2. Clinician charts impression, testing & treatments
3. Abstractor identifies ADEs & records data
4. Data transferred to CPSC
5. Clinical data reviewed by CDC
NEISS-CADES: Case Definition

Injury from use of a drug

- “Injury” from the use of a drug
  - ED visit

- Injury “from the use of” a drug
  - Visit the treating physician explicitly attributes to drug effects
  - Pathognomonic drug-symptom sequence
  - Therapeutic intent

- Injury from the use of “a drug”
  - Prescription product
  - Over-the-counter product
  - Dietary supplement
  - Vaccine

- Allergic Reactions
- Side Effects
- Supra-therapeutic Effects
- Errors
NEISS-CADES: Key Limitations

- Only ED visits
  - Not outpatient visits, during hospitalizations, or death prior to ED
  - Disposition from ED but no inpatient follow-up

- Underestimates ED visits
  - Requires physician recognition & documentation
  - Requires abstractor identification & abstraction
  - High (93%) predictive value positive; lower sensitivity (~40%)*
National Surveillance of Emergency Department Visits for Outpatient Adverse Drug Events
Infant Deaths Associated with Cough and Cold Medications — Two States, 2005

“2004–2005, an estimated 1,519 children aged <2 years were treated in U.S. emergency departments for adverse events, including overdoses, associated with cough and cold medications.*”

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age (mos)</th>
<th>Sex</th>
<th>Underlying cause of death†</th>
<th>Significant medical conditions, contributing factors, and findings on autopsy</th>
<th>Nasal decongestant postmortem blood levels</th>
<th>Antihistamine postmortem blood levels</th>
<th>Other medication (e.g., cough suppressant or antipyretic) postmortem blood levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Male</td>
<td>Pseudoephedrine intoxication</td>
<td>Interstitial pneumonia, recent hospitalization for fever</td>
<td>Pseudoephedrine 4,749 ng/mL</td>
<td>None detected</td>
<td>None detected</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>Female</td>
<td>Pseudoephedrine and dextromethorphan intoxication</td>
<td>Bronchopneumonia and empyema on autopsy</td>
<td>Pseudoephedrine 6,832 ng/mL</td>
<td>None detected</td>
<td>Dextromethorphan 1,909 ng/mL, acetaminophen 35 µg/ml</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>Male</td>
<td>Drug poisoning</td>
<td>Infant found lying in crib in prone position, reported history of colic, born preterm (33 weeks), small fracture of left distal tibia, acute anoxic encephalopathy on autopsy</td>
<td>Pseudoephedrine 7,100 ng/mL</td>
<td>Doxylamine 1,000 ng/mL</td>
<td>Dextromethorphan 390 ng/mL, acetaminophen 1.9 µg/ml</td>
</tr>
</tbody>
</table>
Adverse Events From Cough and Cold Medications in Children

What’s Known on This Subject

Recent attention has focused on potential harmful effects of children’s cough and cold medications. FDA is currently weighing recommendations from its advisory committee to decide whether these medications should continue to be marketed to children less than 6 years.

What This Study Adds

This study adds nationally representative morbidity data about age-specific adverse events from cough and cold medications in children and puts it in the context of all other medications and makes targeted safety recommendations.
## Adverse Events From Cough and Cold Medications in Children

### 2004 – 2005

<table>
<thead>
<tr>
<th>Case Characteristics</th>
<th>ED Visits Attributed to Cough and Cold Medications</th>
<th>ED Visits Attributed to Other Medications</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cases, n</td>
<td>National Estimate</td>
</tr>
<tr>
<td></td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>95% CI</td>
</tr>
<tr>
<td><strong>Age, y</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;2</td>
<td>66</td>
<td>1609</td>
</tr>
<tr>
<td>2–5</td>
<td>199</td>
<td>4541</td>
</tr>
<tr>
<td>6–11</td>
<td>36</td>
<td>942</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>145</td>
<td>3215</td>
</tr>
<tr>
<td>Male</td>
<td>156</td>
<td>3877</td>
</tr>
<tr>
<td><strong>Type of ingestion</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unsupervised ingestion</td>
<td>200</td>
<td>4674</td>
</tr>
<tr>
<td>Supervised administration without documented medication error</td>
<td>77</td>
<td>1836</td>
</tr>
<tr>
<td>Supervised administration with documented error</td>
<td>24</td>
<td>582</td>
</tr>
<tr>
<td><strong>Disposition</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Admitted, observed, or transferred</td>
<td>31</td>
<td>491c</td>
</tr>
<tr>
<td>Treated and released or left against medical advice</td>
<td>270</td>
<td>6601</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>301</td>
<td>7091</td>
</tr>
</tbody>
</table>
### Adverse Events From Cough and Cold Medications in Children

<table>
<thead>
<tr>
<th>Type of Error</th>
<th>&lt;2 y</th>
<th>2–5 y</th>
<th>6–11 y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excess dose administered</td>
<td>5</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Wrong medication administered</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Confused units of measure</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>&gt;1 medication with same active ingredient administered</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wrong formulation administered</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Other errorsa</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>12</strong></td>
<td><strong>8</strong></td>
<td><strong>4</strong></td>
</tr>
</tbody>
</table>

Schaefer MK et al., Pediatrics 2008;121:783-7
“Why do you rob banks?... Because that’s where the money is”

Attributed to
Innovator, Gentleman & Convicted Felon
Slick Willy Sutton
Sutton’s Law: 1st Step of Public Health Approach

“Where the highest costs are incurred, therein lies the highest potential for over-all cost reduction”

-- Sutton’s Law applied to management accounting

“Where the greatest number of Adverse Drug Events (ADEs) occur, therein lies the highest potential for over-all harm reduction”

-- Public health approach applied to medication safety
The Public Health Approach
Unintentional Exposures Cause Most ADE Emergency Visits in Children <5 Years Old

<table>
<thead>
<tr>
<th>Type</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unintentional Overdose/Exposure</td>
<td>58%</td>
</tr>
<tr>
<td>Allergic Reactions</td>
<td>28%</td>
</tr>
<tr>
<td>Side Effects</td>
<td>5%</td>
</tr>
<tr>
<td>Vaccine Reactions</td>
<td>8%</td>
</tr>
<tr>
<td>Secondary Effects</td>
<td>1%</td>
</tr>
</tbody>
</table>

Medications Cause Most Emergency Visits For Unintentional Exposures

~1 out of every 150 two-year-olds
Unsupervised Ingestions Cause More Emergency Visits Than Administration Errors
Trends in Emergency Department Visits for Unsupervised Pediatric Medication Exposures, 2004–2013

<table>
<thead>
<tr>
<th>Medication Type</th>
<th>ED Visits: Annual National Estimate</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>Medication dosage form</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oral solid (eg, tablet)</td>
<td>45,079</td>
<td>72.5</td>
</tr>
<tr>
<td>Oral liquid</td>
<td>9,546</td>
<td>15.4</td>
</tr>
<tr>
<td>Unspecified oral&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2,134</td>
<td>3.4</td>
</tr>
<tr>
<td>Nonoral medication</td>
<td>5,104</td>
<td>8.2</td>
</tr>
<tr>
<td>Unspecified dosage form</td>
<td>305&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.5</td>
</tr>
<tr>
<td>Medication prescription status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prescription</td>
<td>31,802</td>
<td>51.2</td>
</tr>
<tr>
<td>OTC</td>
<td>26,967</td>
<td>43.4</td>
</tr>
<tr>
<td>Unspecified prescription status</td>
<td>3,399</td>
<td>5.5</td>
</tr>
</tbody>
</table>

<sup>a</sup> Includes all medication exposures that cannot be categorized as oral solid or oral liquid.

<sup>b</sup> Includes all unspecified dosage forms.
Trends in Emergency Department Visits for Unsupervised Pediatric Medication Exposures, 2004–2013

<table>
<thead>
<tr>
<th>Oral Solid (eg, tablets)</th>
<th>Oral Liquid</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Annual National Estimate</td>
</tr>
<tr>
<td></td>
<td>No.</td>
</tr>
<tr>
<td>Prescription</td>
<td>28540</td>
</tr>
<tr>
<td>OTC</td>
<td>13870</td>
</tr>
<tr>
<td>Unspecified</td>
<td>2670</td>
</tr>
</tbody>
</table>
4 drugs implicated in ~95% of ED Visits for ingestions

Most are infant, oral OTC liquid medications

<table>
<thead>
<tr>
<th>Oral OTC liquid medications</th>
<th>No.</th>
<th>%</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetaminophen</td>
<td>2607</td>
<td>32.9</td>
<td>25.6–40.1</td>
</tr>
<tr>
<td>Cough and cold remedies</td>
<td>2182</td>
<td>27.5</td>
<td>20.2–34.9</td>
</tr>
<tr>
<td>Ibuprofen</td>
<td>1248</td>
<td>15.7</td>
<td>11.8–19.7</td>
</tr>
<tr>
<td>Diphenhydramine</td>
<td>1235</td>
<td>15.6</td>
<td>11.4–19.8</td>
</tr>
</tbody>
</table>
Trends in Emergency Department Visits for Unsupervised Pediatric Medication Exposures, 2004–2013

<table>
<thead>
<tr>
<th>Oral OTC solid medications</th>
<th>No.</th>
<th>%</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetaminophen</td>
<td>3017</td>
<td>19.2</td>
<td>15.6–22.7</td>
</tr>
<tr>
<td>Vitamins/minerals</td>
<td>2687</td>
<td>17.1</td>
<td>13.9–20.3</td>
</tr>
<tr>
<td>Ibuprofen</td>
<td>1663</td>
<td>10.6</td>
<td>8.1–13.0</td>
</tr>
<tr>
<td>Herbals/alternative therapies</td>
<td>1629</td>
<td>10.4</td>
<td>8.0–12.7</td>
</tr>
<tr>
<td>Acetaminophen and/or aspirin-containing analgesic combinations</td>
<td>1170</td>
<td>7.4</td>
<td>5.5–9.3</td>
</tr>
<tr>
<td>Aspirin</td>
<td>1021</td>
<td>6.5</td>
<td>3.8–9.2</td>
</tr>
<tr>
<td>Diphenhydramine</td>
<td>906</td>
<td>5.8</td>
<td>4.0–7.5</td>
</tr>
<tr>
<td>Second-generation antihistamines</td>
<td>706</td>
<td>4.5</td>
<td>3.1–5.9</td>
</tr>
<tr>
<td>Cough and cold remedies</td>
<td>678</td>
<td>4.3</td>
<td>2.4–6.2</td>
</tr>
<tr>
<td>Antiulcer agents</td>
<td>506</td>
<td>3.2</td>
<td>1.6–4.9</td>
</tr>
<tr>
<td>Oral prescription solid medications</td>
<td>ED Visits: Annual National Estimate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>----------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>95% CI</td>
</tr>
<tr>
<td>Opioid analgesics</td>
<td>4661</td>
<td>13.8</td>
<td>11.8–15.8</td>
</tr>
<tr>
<td>Benzodiazepines</td>
<td>4293</td>
<td>12.7</td>
<td>10.8–14.7</td>
</tr>
<tr>
<td>Antidepressants</td>
<td>3594</td>
<td>10.7</td>
<td>8.9–12.4</td>
</tr>
<tr>
<td>β-blockers</td>
<td>2080</td>
<td>6.2</td>
<td>5.0–7.4</td>
</tr>
<tr>
<td>Amphetamine-related stimulants</td>
<td>1965</td>
<td>5.8</td>
<td>4.5–7.1</td>
</tr>
<tr>
<td>Centrally acting antiadrenergics</td>
<td>1847</td>
<td>5.5</td>
<td>4.0–6.9</td>
</tr>
<tr>
<td>Anticonvulsants</td>
<td>1715</td>
<td>5.1</td>
<td>4.0–6.2</td>
</tr>
<tr>
<td>Oral hypoglycemics</td>
<td>1454</td>
<td>4.3</td>
<td>2.6–6.0</td>
</tr>
<tr>
<td>Skeletal muscle relaxants</td>
<td>1437</td>
<td>4.3</td>
<td>3.2–5.3</td>
</tr>
<tr>
<td>Calcium channel blockers</td>
<td>1377</td>
<td>4.1</td>
<td>2.6–5.5</td>
</tr>
<tr>
<td>Atypical antipsychotics</td>
<td>1318</td>
<td>3.9</td>
<td>2.8–5.0</td>
</tr>
<tr>
<td>Angiotensin-converting enzyme inhibitors</td>
<td>1239</td>
<td>3.7</td>
<td>2.8–4.5</td>
</tr>
</tbody>
</table>

Trends in Emergency Department Visits for Unsupervised Pediatric Medication Exposures, 2004–2013
“If you don’t know where you are going... Any road will get you there”

Cheshire Cat
Louis Carroll’s
Alice in Wonderland
ED Visits for Unintentional Medication Exposures in Children <5: Key Risk Groups

- 95% Ingestions
  - 50% Rx products
    - >90% solids, spectrum of adult products
  - ~40% OTC products
    - ~30% liquids (4 pediatric products)

- 5% Errors
  - >50% are children <2
ED Visits for Unintentional Medication Ingestions in Children <5 years has Increased

www.cdc.gov/injury/wisqars/index.html

National Electronic Injury Surveillance System-Cooperative Adverse Drug Event Surveillance Project (NEISS-CADES)
ED Visits for Unintentional Medication Ingestions vs. Car Occupant Injuries
Children <5 years

![Graph showing ED visits in thousands for medication exposures and car occupant injuries from 2004 to 2010.](www.cdc.gov/injury/wisqars/index.html)
Pediatric Mortality, Children ≤5 years: Poisonings vs. Motor Vehicle Occupants


Motor vehicle occupants <5 years old from www.iihs.org/iihs/topics/t/child-safety/fatalityfacts/child-safety
“Injuries are the result of the transfer of energy in such ways and amounts … as to harm people”

William Haddon Jr.
Physician, Innovator, &
Administrator of NHTSA
Motor Vehicles & Medicines

### Motor vehicles
- Transfer kinetic energy

### Medications
- Transfer chemical energy

“Too much” of either causes unintended injuries
1970s, 1980s: Cars & Child Seats
Safety Features: 1970s Cars and Car Seats

1. Seatbelts

1. Child-sized seats and belts
2008 Car & Child Seat
Safety Features: 2008 Car

1. Seatbelts *(with Automatic Tensioning System)*
2. Dual-Stage, Dual-Threshold Front Airbags (SRS)
3. Front Side Airbags with Passenger-Side Occupant Position Detection System (OPDS)
4. Side Curtain Airbags
5. Driver’s and Front Passenger’s Active Head Restraints
6. Anti-Lock Braking System (ABS) with Electronic Brake Distribution (EBD)
7. Vehicle Stability Assist (VSA)
8. Advanced Compatibility Engineering Body Structure (ACE)
9. Tire Pressure Monitoring System (TPMS)
10. Daytime Running Lights (DLR)
Infant Car Seats: 2008

1. Child-sized seat and belts
2. 5 point harness
3. Chest clips
4. Rear-facing (<20 pounds)
5. Locking belt clips
6. Lower Anchors and Tether for Children (LATCH) integrated system
Safety Features: Since 2008

11. Multi-angle Rearview Camera
12. Next Generation body structure
13. Rollover Sensor
14. Traction Control
15. Forward Collision Warning (FCW)
16. Lane Departure Warning (LDW)
17. Adaptive Cruise Control
Safety Features: 1970s Medicine

1. Child-resistant safety caps
2008 Medicines

Significantly improved for child safety?
1970s → 2010s

Safety Innovations?
The Public Health Approach

1. Identify (Quantify) the Harm
2. Identify Risk & Protective Factors
3. Design Intervention
4. Evaluate Impact
Injury Prevention Framework For Intervention

- Identify plausible interventions
- Consider 2 prevention approaches
- Engage 3 implementation strategies (3 E’s)
1. Identify Plausible Interventions: Phase-Factor Matrix

<table>
<thead>
<tr>
<th>Factor</th>
<th>Host (Patient)</th>
<th>Agent (Car/Drug)</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-event</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Event (Crash/Ingestion)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-event</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
“An ounce of prevention is worth a pound of cure”

Benjamin Franklin
So... Ideally Intervene *Before* the Event

<table>
<thead>
<tr>
<th>Phase</th>
<th>Factor</th>
<th>Host (Patient)</th>
<th>Agent (Drug)</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-event</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Event (Ingestion)</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Post-event</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
“People [toddlers] are gonna drink!”

Al Capone
(as played by Robert De Niro)

*The Untouchables*
So... Modify the Drug & Environment

<table>
<thead>
<tr>
<th>Phase</th>
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<tr>
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<td></td>
</tr>
<tr>
<td>Post-event</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
2. Prevention Approaches

Active
- Require individual action for the intervention to be effective

Passive
- Provide *automatic* protection (because no one is perfect)
2. Prevention Approaches

**Active**

*DISPOSE WITH CARE.* Be responsible for the sharps you use. Activate safety features. Dispose in sharps containers.

**Passive**
3. “E’s” of Implementation

Engineering

Education

Enforcement

Crash Course: Child Passenger Safety

SEAT BELTS MUST BE WORN $86 FINE
CLICK-IT OR TICKET!
3. “E’s” of Implementation

- Engineering
- Education
- Enforcement

Needlestick Safety and Prevention Act, 2000
Putting Theory Into Practice

Preventing Overdoses and Treatment Errors in Children Taskforce
PROTECT

Advancing Children’s Medication Safety

What is PROTECT?
The PROTECT Initiative is an innovative collaboration bringing together public health agencies, private sector companies, professional organizations, consumer/patient advocates, and academic experts to develop strategies to keep children safe from unintentional medication overdoses.
3 PROTECT Initiatives based on Injury Theory

1. Packaging innovation to limit ingestions
2. Labeling/dosing standards to reduce errors
3. Education campaign for safe use & storage
Packaging Innovation: Add Passive, Dose-Limiting Protection

Re-engagement Required

Passive Protection?
Protecting your Buns from “Watery Stuff”
Dissemination of Innovation
Packaging Innovation
Add Passive, Dose-Limiting Protection

Re-engagement Required

Passive Protection

Flow Restrictors
(Restricted Delivery Systems)

Unit-Dose Packaging
(Child resistance incorporated into every dose)
Pediatric Product Enhancements

NEW PRODUCT DOSING DEVICE ENHANCEMENTS FOR INFANTS’ AND CHILDREN’S TYLENOL®

April 14, 2011

Dear Healthcare Professional:

I am pleased to inform you that McNeil Consumer Healthcare will be introducing dosing device enhancements on Infants’ and Children’s TYLENOL® products that will be available this upcoming cold and flu season. These enhancements are intended to help reduce the incidence and magnitude of accidental acetaminophen exposures in cases of unsupervised ingestions. McNeil has also shared these plans with other manufacturers of pediatric acetaminophen products.

Infants’ TYLENOL® will include a new, enhanced bottle with a protective flow restrictor opening and push-in syringe. We believe this innovation will:

- Increase dosing accuracy through use of the new, product-specific dosing syringe
- Provide caregivers with better control when dispensing the medication, reduce spillage and increase the ease of administration to infants
- Further reduce the risk of children being able to get to the medicine in the bottle

Children’s TYLENOL® will feature a new, enhanced bottle with a protective flow restrictor opening designed to be used with a dosing cup.
Efficacy of Flow Restrictors in Limiting Access of Liquid Medications by Young Children

- If not fully closed, how easily can caps be opened?
- Can flow restrictors (FRs) alone prevent access?
- If accessed, will FRs reduce the amount removed?
- Can FRs delay how quickly bottles are emptied?
Figure 3: Time Required for Children to Empty Open Control Bottles, Incompletely-closed Control Bottles, and Bottles with Flow Restrictors

Abbreviations: FR-bottle, bottle with a flow restrictor
*Time not recorded for 1 trial with an incompletely-closed control bottle.
Efficacy of Flow Restrictors in Limiting Access of Liquid Medications by Young Children

- >90% children emptied incompletely-closed bottles
  - FRs alone limited amount removed
    - 19% emptied >5 after 10 minutes
    - 11% emptied >25 mL
- FRs slowed child access
  - No children emptied FR-bottles in <6 minutes
  - 6% emptied after 10 minutes
- Older children were more successful
  - No children 36-41 months removed >5 mL
- Limitation: Results only apply to designs tested
How safe is your baby’s medicine bottle?
Infant Tylenol and other liquid acetaminophen products have a new safety feature. Consumer Reports put it to the test.

Published: December 2013
Implementing Flow Restrictors / Restricted Delivery Systems

- Added to all infant & some children’s acetaminophen
- Established efficacy of flow restrictors (child testing)
- Developing definitions & efficacy standards
Solid Dose Forms

- **Opportunity**
  - Existing (F) standards for unit-dose packaging
  - Buprenorphine “natural experiment”

- **Challenges**
  - More potential active ingredients
  - CR-packaging does not benefit primary users
  - Prescription & OTC products
  - Adherence (pill minders)
  - Convenience (transferring)
“A spoonful of sugar makes the medicine go down”

Sung Mary Poppins (Julie Andrews)
Composed by Robert and Richard Sherman
1964 film *Mary Poppins*
Medication Errors

- Dosing mix-ups were frequent errors
  - Clinically significant >3-fold
    - TBSP vs. TSP (3-fold)
    - 1 / 2 vs. ½ (4-fold)
    - 10 vs. 1.0 (10-fold)

- Intervention
  - Standardize conventions
    - No more “drams”, fl. oz., dropperfuls
  - Always include matching dosing devices

Budnitz et. al. Pediatrics 2014; e283-90
8.13 Meters

Jesse Owens
Long Jump World Record
1936 - 1960
Medication Errors: Making the Jump to Metrics

- Current intervention: promote “mL only”
  - OTC: Manufacturer ➔ Caregiver
  - Rx: Prescriber ➔ Manufacturer ➔ Pharmacy
Education on Safe Storage

1. Pick a place children cannot reach
2. Put medicines away every time
3. Make sure the safety cap is locked
4. Teach children medicine safety
5. Tell guests about medicine safety
6. Be prepared (800) 222-1222
## Medical Product Safety

**MPS-5.4** Reduce emergency department (ED) visits for medication overdoses among children less than 5 years of age

<table>
<thead>
<tr>
<th>Baseline:</th>
<th>32.8 ED visits per 10,000 children less than 5 years of age occurred in 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target:</td>
<td>29.5 ED visits per 10,000 children less than 5 years of age</td>
</tr>
<tr>
<td>Target-Setting Method:</td>
<td>10 percent improvement</td>
</tr>
</tbody>
</table>
2008 → 2010s

→

→

→

→
Private Sector Implementation
Cough and Cold Medication Adverse Events After Market Withdrawal and Labeling Revision

Withdrawal of OTC infant CCMs

OTC CCMs labels revised to warn against their use by children aged <4 years
Trends in Emergency Department Visits for Unsupervised Pediatric Medication Exposures, 2004–2013

Unsupervised Exposures

- National estimate
- Modeled estimate
Trends in Emergency Department Visits for Unsupervised Pediatric Medication Exposures, 2004–2013

Unsupervised Exposures

Estimated No. of Visits

- National estimate
- Modeled estimate

Trends in Emergency Department Visits for Unsupervised Pediatric Medication Exposures, 2004–2013

Unsupervised Exposures

Caregiver Administration
THANK YOU

For more information, contact CDC
1-800-CDC-INFO (232-4636)

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

>53,000 Emergency Department (ED) visits for medication poisonings in children <5 years old each year

“To help develop new prevention strategies and assess their effectiveness in reducing the most common and most severe incidents among young children, additional data on the incident circumstances, specific medications involved, and patient outcomes are needed”