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Case Conferences
Journal Clubs
Grand Rounds
CE Available

Online Courses
Evidence-based online courses on a variety of children's environmental health topics.
Interactive and Self-Paced
CE Available

Resource Catalog
Fact sheets, journal publications, reports, and other resources for parents, community members, patients and healthcare professionals
Topics included: Air Quality, Pesticides, Natural Disasters, BPA, Mold, Lead, Mercury
What’s floating around out there?

Thomas M. Nappe, DO
Rocky Mountain Poison & Drug Center
Denver Health & Hospital Authority
Region 8
This material was supported by the American College of Medical Toxicology (ACMT) and funded (in part) by the cooperative agreement FAIN: U61TS000238-02 from the Agency for Toxic Substances and Disease Registry (ATSDR).

Acknowledgement: The U.S. Environmental Protection Agency (EPA) supports the PEHSU by providing partial funding to ATSDR under Inter-Agency Agreement number DW-75-95877701. Neither EPA nor ATSDR endorse the purchase of any commercial products or services mentioned in PEHSU publications.
A 17-year-old male was found wandering the streets around midnight with altered mental status.

He reported that he was in the woods earlier that day and ate a large amount of berries that he foraged.

He claimed to have grinded the berries and distilled them, and then injected the distillate and ingested the remaining resin.
He soon decompensated with tachycardia, hypotension, and decreased mental status. He was resuscitated with IVF, started on vasopressors, intubated placed on CRRT.

Labs upon arrival (intubated)
- 14:50: 7.08/26/149/7.3
- 15:50: 7.2/23/220/10.4
  - Na 140, Cl 101 K 4.7, HCO3 11, BUN 40, Cre 3.02, Glu 147
  - AST 57, ALT 175, TBR 1.3, AP 315
  - Troponin 2.51, lactate 14.6
  - WBC 18.3, HGB 13.9, HCT 41.1, Plt 48
  - INR 5.9 → >15.2, Fib 91 → <20

He died 6 hrs after presenting to our facility, ~20 hrs after initial presentation.
Case 1

- What is the differential diagnosis?
- What other tests would you have considered?
- Would you have considered any other treatment modalities in this patient?
A “friend” who had recently seen the patient noted that he mentioned finding castor beans in the woods.

Postmortem evaluation revealed “ricinine” in his urine.
Ricin

- A toxalbumin extracted from castor beans (Ricinus communis)
- Inhibits protein syntheses by inhibiting 28S subunit of the 60S ribosome
- Causes multiorgan failure
  - Cardiac
  - Renal
  - Hepatic
  - Hematologic
A potential biomarker for Ricin (CDC)

Case report

Suicidal death after injection of a castor bean extract (*Ricinus communis* L.)

Vera Coopman a, Marc De Leeuw b, c, Jan Cordonnier a, *, Werner Jacobs c

a Department of Analytical Toxicology, Chemiphar N.V., Lieven Bauwensstraat 4, B-8200 Brugge, Belgium
b Emergency Department, Algemeen Stedelijk Ziekenhuis, Merenstraat 80, B-9300 Aalst, Belgium
c Centre for Forensic Medicine, Antwerp University Hospital, Wilrijkstraat 10, B-2650 Edegem, Belgium

- Patient presented after reportedly injecting himself with castor bean resin, and progressed to multiorgan failure and died 33 hours later. Ricinine found in the vitreous fluid was believed to be confirmatory
- CDC: Ricinine in biological specimen AND sample

http://emergency.cdc.gov/agent/ricin/qa.asp
Ricinine (3-cyano-4-methoxy-N-methyl-2-pyridone)

- **Ricinine** is a urinary biomarker used to confirm human exposure to *castor bean products* such as ricin.
- Ricinine may be detectable in the general population.
- Many consumer products contain castor oil, another castor bean product.
- The study characterized urinary ricinine concentrations from 989 individuals who were presumed to be unexposed to ricin.

- 1.2% of the urine specimens had detectable amounts of ricinine.
Case 1 (Concluded)

- Cause of death was not yet determined
Case 2
Case 2

- A 32-year-old man was making a handcrafted ceremonial knife in his kitchen at 2am, from what he thought was silver, which he obtained from his late grandfather’s dentist office.
- The knife was to cut the umbilical cord of his newborn baby who was due the next week.
- His 26-year-old pregnant wife was in the next room sleeping.
Case 2 (continued)

- His wife awoke to find him short of breath and coughing. She opened the windows and brought him to the emergency department, where he was dyspneic with a HR of 122, RR 34, and oxygen saturation of 88%, and a CXR was performed. After no improvement with supplemental oxygen, he required BIPAP for support.
Case 2: CXR
Case 2

- What metal is suspect and in what form?
- What sort of mercury exposure are we dealing with and what can we expect?
Goldfrank’s Table 98-2. Classes of Mercury Compounds

<table>
<thead>
<tr>
<th></th>
<th>Chemical Formula</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elemental</td>
<td>Hg⁰</td>
<td>Quicksilver</td>
</tr>
<tr>
<td></td>
<td>Hg⁺</td>
<td>Mercurous ion</td>
</tr>
<tr>
<td>Inorganic</td>
<td>HgCl</td>
<td>Calomel, mercurous chloride</td>
</tr>
<tr>
<td></td>
<td>Hg²⁺</td>
<td>Mercuric ion</td>
</tr>
<tr>
<td></td>
<td>HgCl₂</td>
<td>Mercuric chloride</td>
</tr>
<tr>
<td>Organic</td>
<td>Short-chain alkyl—mercury compounds</td>
<td>Methylmercury</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ethylmercury</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dimethylmercury</td>
</tr>
<tr>
<td></td>
<td>Long-chain mercury compounds</td>
<td>Methoxyethylmercury</td>
</tr>
<tr>
<td></td>
<td>Aryl mercury compounds</td>
<td>Phenylmercury</td>
</tr>
</tbody>
</table>
### Goldfrank’s Table 98-3. Exposures to Mercury

<table>
<thead>
<tr>
<th>Elemental</th>
<th>Inorganic</th>
<th>Organic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Manufacturing/Industrial</strong></td>
<td>Barometers</td>
<td>Agriculture</td>
</tr>
<tr>
<td></td>
<td>Bronzing</td>
<td>Embalming</td>
</tr>
<tr>
<td></td>
<td>Ceramics</td>
<td>Fungicides</td>
</tr>
<tr>
<td></td>
<td>Chlorine manufacture</td>
<td>Laboratory reagents</td>
</tr>
<tr>
<td></td>
<td>Electroplating</td>
<td>Laboratory reagents</td>
</tr>
<tr>
<td></td>
<td>Jewelry</td>
<td>Tanneries</td>
</tr>
<tr>
<td></td>
<td>Paints</td>
<td>Taxidermy</td>
</tr>
<tr>
<td></td>
<td>Paper pulp</td>
<td>Vinyl chloride manufacture</td>
</tr>
<tr>
<td></td>
<td>Photography</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Metal refineries</td>
<td></td>
</tr>
<tr>
<td><strong>Medical/Medical</strong></td>
<td>Amalgam</td>
<td>Antiseptics</td>
</tr>
<tr>
<td></td>
<td>Sphygmomanometry</td>
<td>Calomel</td>
</tr>
<tr>
<td></td>
<td>Tissue fixatives</td>
<td>Disinfectants</td>
</tr>
<tr>
<td></td>
<td>Thermometers</td>
<td>Laxatives</td>
</tr>
<tr>
<td></td>
<td>Weighted nasogastric tubes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Patent</td>
<td></td>
</tr>
<tr>
<td><strong>Food/Other</strong></td>
<td>Ritualistic use</td>
<td>Bactericidals</td>
</tr>
<tr>
<td></td>
<td>Esthetic?</td>
<td>Preservatives</td>
</tr>
<tr>
<td></td>
<td>Ayurvedic</td>
<td>Pharmaceuticals</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Seafood</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grains (contaminated)</td>
</tr>
</tbody>
</table>
### Goldfrank's Table 98-3. Differential Characteristics of Mercury Exposure

<table>
<thead>
<tr>
<th>Primary route of exposure</th>
<th>Elemental</th>
<th>Inorganic</th>
<th>Organic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inhalation</td>
<td>Oral</td>
<td>Oral</td>
</tr>
<tr>
<td>Primary tissue distribution</td>
<td>CNS, kidney</td>
<td>Blood (transient, acute)</td>
<td>CNS, kidney, liver, blood, hair</td>
</tr>
<tr>
<td></td>
<td>Renal, Gl</td>
<td>Kidney</td>
<td>Aryl: renal, Gl</td>
</tr>
<tr>
<td>Clearance</td>
<td>Renal, Gl</td>
<td>CNS (delayed)</td>
<td>Methyl: Gl</td>
</tr>
<tr>
<td>Clinical effects</td>
<td>Tremor</td>
<td>Tremor, erethism</td>
<td>Paresthesias, ataxia, tremor, tunnel vision, dysarthria</td>
</tr>
<tr>
<td>CNS</td>
<td>+++</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Pulmonary</td>
<td>+</td>
<td>+++ (caustic)</td>
<td>+</td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td>+</td>
<td>+++ (ATN)</td>
<td>+</td>
</tr>
<tr>
<td>Renal</td>
<td>+</td>
<td>++</td>
<td>–</td>
</tr>
<tr>
<td>Acrodynia</td>
<td>+</td>
<td>BAL, DMSA</td>
<td>BAL, DMSA</td>
</tr>
<tr>
<td>Therapy</td>
<td>BAL, DMSA</td>
<td>DMSA (early)</td>
<td>DMSA (early)</td>
</tr>
</tbody>
</table>

ATN = acute tubular necrosis; BAL = British anti-Lewisite; CNS = central nervous system; DMSA = dimercapto-succinic acid; GI = gastrointestinal.
The husband was weaned off BIPAP 6 hours later and was doing well. A call was placed to the Poison Center to discuss the asymptomatic pregnant wife.

- Should any **tests** should be ordered to assess, and if so which tests?
- Should mother be **chelated**?
Mercury - Diagnostic Testing

- **24 hour urine**
  - Chronic exposure
  - Confirmatory
  - Acid washed container

- **Whole blood**
  - Acute inorganic
  - Organic Hg

- **Renal function**
Mercury - Treatment (Chelation) Options

- **Elemental or inorganic**
  - Dimercaprol (BAL)
  - Succimer if can tolerate PO

- **Organic**
  - DMSA or succimer
  - *BAL may increase brain organic Hg concentration*
Mercury - Potential Adverse Effects of Chelation

- **Succimer**
  - Also chelates zinc and copper
  - Could have adverse outcomes for pregnant patient and child

- **Dimercaprol (BAL)**
  - May increase organic Hg brain concentration

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INCREASED BRAIN UPTAKE OF MERCURY INDUCED BY 2,3-DIMERCAPTO-PROPA-NOL (BAL) IN MICE EXPOSED TO PHENYLMERCURIC ACETATE

M. BERLIN AND R. RYLANDER

Institute of Hygiene, Karolinska Institutet, and the Department of General Hygiene, National Institute of Public Health
Stockholm, Sweden

Accepted for publication July 24, 1964
Fig. 3. Autoradiograms of sagittal whole-body sections of mice 8 days after injection of phenyl-\textsuperscript{203}Hg acetate (0.5 mg Hg/kg) (upper) and phenyl-\textsuperscript{203}Hg acetate (0.5 mg Hg/kg) + BAL (0.4 mg/kg) (lower). Dosages given in text. The isotope reference scales accompanying the sections are shown; the activity ratio between adjacent steps is $\frac{1}{2}$. The upper section is taken from a pregnant mouse.
Case 2 (continued)

- Mother’s whole blood Hg > 600 μg/dL
- Should she be chelated?
Elemental mercury exposure: An evidence-based consensus guideline for out-of-hospital management


American Association of Poison Control Centers, Washington, District of Columbia, USA

7. Pregnant patients unintentionally exposed to elemental mercury and who are asymptomatic should be evaluated by their obstetrician or primary care provider as an outpatient. Immediate referral to an ED is not required (Grade D).

http://www.tandfonline.com/doi/pdf/10.1080/15563650701664731
19-year-old-woman with acute exposure to mercury vapor at home by heating mercury-gold amalgam

- N/V, dyspnea 8hrs after
- Chelated with penicillamine for 8 days
- Delivered a normal-term infant 26 days later
- [Hg]blood day of exposure – Mother: 26 μg/dL
- [Hg]blood day of delivery – Mother: 3.8 μg/dL, infant: 3 μg/dL
29-year-old-woman with chronic exposure to Hg vapor during weeks 1-17 of gestation from mercury spilled on the carpet.

- Asymptomatic
- 24-hour urine Hg of 230 μg/L
- Normal-term infant
  - Hair total mercury 3 ng/g at birth
  - Normal exam at 2 years old
Elemental mercury exposure: An evidence-based consensus guideline for out-of-hospital management

- 15-week pregnant woman working in a mercury thermometer plant
  - Elevated urine inorganic mercury 875 μg/L on routine screening.
  - “Viable male infant” delivered
Case 2 (concluded)

- Patient was not chelated
- Delivery occurred uneventfully
- Follow-up [Hg] trended downward for mother
- Hg detectable in newborn’s blood (46 μg/dL)
- Hg concentrations trended downward and both remained asymptomatic

7. Pregnant patients unintentionally exposed to elemental mercury and who are asymptomatic should be evaluated by their obstetrician or primary care provider as an outpatient. Immediate referral to an ED is not required (Grade D).
Treatment of syphilis and constipation

1800s: “Hatters’ Shakes,” “Danbury Shakes”
- Mercuric nitrate used to press animal furs into felt
- Danbury, CT – center for felt hat making
- The “Mad Hatter”

1900s: Calomel (HgCl) for teething

1940s: Minamata Bay, Japan
- Minamata Bay Disease resulted from methyl Hg accumulation in marine life which was then eaten
- Was due to pollution from vinyl chloride plant
- Profound developmental delay in prenatal exposure;
- Many unreported deaths

1971: Iraq
- Methyl Hg used as a fungicide on seed grain that was supposed to be for planting but instead was baked into bread
- >6500 sick, >400 died
1978 – Assassination of Georgi Markov
- Modified umbrella used to fire a tiny ricin-contaminated pellet into his leg
- Died several days later in hospital
- Pellet removed from leg on autopsy
- KGB claimed responsibility years later

2013 – Ricin-containing letters sent to Mayor Bloomberg and President Obama by actress Shannon Richardson, now serving 18 years
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