Complete Summary

GUIDELINE TITLE

Elemental mercury exposure: an evidence-based consensus guideline for out-of-hospital management.

BIBLIOGRAPHIC SOURCE(S)

Caravati EM, Erdman AR, Christianson G, Nelson LS, Woolf AD, Booze LL, Cobaugh DJ, Chyka PA, Scharman EJ, Manoguerra AS, Troutman WG. Elemental mercury exposure: an evidence-based consensus guideline for out-of-hospital management. Clin Toxicol (Phila) 2008 Jan;46(1):1-21. PubMed

GUIDELINE STATUS

This is the current release of the guideline.

COMPLETE SUMMARY CONTENT

SCOPE
METHODOLOGY - including Rating Scheme and Cost Analysis
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SCOPE

DISEASE/CONDITION(S)

Elemental mercury exposure

Note:

- This guideline addresses small spills and human exposures to elemental mercury. Exposures to organic mercury compounds (e.g., methylmercury) or inorganic mercuric salts (e.g., mercuric chloride) are not included.
- In addition, this guideline does not address chronic occupational exposure or large industrial releases of elemental mercury. It focuses primarily on small spills (typically less than 5 mL) that occur in a home or public area. It does not address aspiration or intravenous exposure to elemental mercury.

GUIDELINE CATEGORY

Evaluation
Management
Risk Assessment

CLINICAL SPECIALTY

Emergency Medicine
Family Practice
Internal Medicine
Obstetrics and Gynecology
Pediatrics

INTENDED USERS

Advanced Practice Nurses
Allied Health Personnel
Emergency Medical Technicians/Paramedics
Nurses
Pharmacists
Physicians

GUIDELINE OBJECTIVE(S)

To assist poison center personnel in the appropriate out-of-hospital triage and initial out-of-hospital management of patients with suspected exposures to small amounts of elemental mercury by:

- Describing the process by which a specialist in poison information should evaluate an exposure to elemental mercury
- Identifying the key decision elements in managing cases of elemental mercury exposure
- Providing clear and practical recommendations that reflect the current state of knowledge
- Identifying needs for research

TARGET POPULATION

Children and adults including pregnant women with suspected exposure to elemental mercury

INTERVENTIONS AND PRACTICES CONSIDERED

Evaluation

1. Assessment of key decision elements for triage
    - Patient intent
    - Route of exposure
    - Presence of symptoms
    - Time of onset of toxicity

- Whether there was intentional heating of elemental mercury

Management

1. Referral to an emergency department
2. Home observation or non-urgent outpatient evaluation
3. Referral for evaluation of surgical removal of mercury injected into soft tissue
4. Decontamination including removing jewelry and washing the affected area with mild soap and water, removing contaminated clothing and placing it in a sealed plastic double-bag for proper disposal
5. Evaluation by obstetrician or primary care provider for asymptomatic pregnant women
6. Proper clean-up according to Environmental Protection Agency (EPA) guidelines
7. Consulting local authorities for proper disposal of contaminated items

Note: Emesis induction and administration of activated charcoal were considered but not recommended.

MAJOR OUTCOMES CONSIDERED

- Mortality
- Signs and symptoms of toxicity
- Environmental risk factors for elemental mercury poisoning

METHODOLOGY

METHODS USED TO COLLECT/SELECT EVIDENCE

Hand-searches of Published Literature (Primary Sources)
Hand-searches of Published Literature (Secondary Sources)
Searches of Electronic Databases

DESCRIPTION OF METHODS USED TO COLLECT/SELECT THE EVIDENCE

Search Strategy

A single investigator performed literature searches for relevant articles. The National Library of Medicine's PubMed database was searched (through May 2006) using elemental mercury poisoning as a Medical Subject Headings (MeSH) term, limited to humans. The PubMed database was further searched using mercury as a textword (title, abstract, MeSH term, CAS registry) plus either poison* or overdos* or intox*, or toxic* limited to humans. This process was repeated in International Pharmaceutical Abstracts (1970–May 2006, excluding abstracts of meeting presentations), Science Citation Index (1977–May 2006), Database of Abstracts of Reviews of Effects (accessed May 2006), Cochrane Database of Systematic Reviews (accessed May 2006), and Cochrane Central Register of Controlled Trials (accessed May 2006). Reactions (1980–May 2006), the elemental mercury poisoning management in Poisindex, and the bibliographies of recovered articles were reviewed to identify previously undiscovered articles. Furthermore, North American Congress of Clinical Toxicology (NACCT) abstracts

published in the Journal of Toxicology Clinical Toxicology (1995–2004) and Clinical Toxicology (2005) were reviewed for original human data.

Five major toxicology textbooks were reviewed for recommendations on the management of elemental mercury poisoning and for citations of additional articles with original human data in the chapter bibliographies. The Toxic Exposure Surveillance System (TESS) maintained by the American Association of Poison Control Centers was searched for deaths resulting from unintentional elemental mercury poisoning. These cases were abstracted for review by panel members. All US poison control centers were surveyed in 2006 to ascertain their out-of-hospital management and triage practices for elemental mercury poisonings.

Criteria Used to Identify Applicable Studies

The recovered citations were entered into an EndNote library and duplicate entries were eliminated. The abstracts of these articles were reviewed, searching specifically for those that dealt with estimations of doses with or without subsequent signs or symptoms of toxicity and management techniques that might be suitable for out-of-hospital use (e.g., gastrointestinal decontamination). Articles that did not meet either of the preceding criteria, did not add new data (e.g., some reviews, editorials), or that exclusively described inpatient-only procedures (e.g., dialysis) were excluded.

NUMBER OF SOURCE DOCUMENTS

Not stated

METHODS USED TO ASSESS THE QUALITY AND STRENGTH OF THE EVIDENCE

Weighting According to a Rating Scheme (Scheme Given)

RATING SCHEME FOR THE STRENGTH OF THE EVIDENCE

Level of Evidence	Description of Study Design
1a	Systematic review (with homogeneity) of randomized clinical trials
1b	Individual randomized clinical trials (with narrow confidence interval)
1c	All or none (all patients died before the drug became available, but some now survive on it; or when some patients died before the drug became available, but none now die on it.)
2a	Systematic review (with homogeneity) of cohort studies
2b	Individual cohort study (including low quality randomized clinical trial)
2c	"Outcomes" research
3a	Systemic review (with homogeneity) of case-control studies
3b	Individual case-control study
4	Case series, single case reports (and poor quality cohort and case control studies)

Level of Evidence	Description of Study Design
5	Expert opinion without explicit critical appraisal or based on physiology or bench research
6	Abstracts

METHODS USED TO ANALYZE THE EVIDENCE

Systematic Review with Evidence Tables

DESCRIPTION OF THE METHODS USED TO ANALYZE THE EVIDENCE

Data Extraction Process

A trained physician abstractor reviewed all articles that were retrieved from the original search. The complete paper was reviewed for original human data regarding the toxic effects of elemental mercury or original human data directly relevant to the out-of-hospital management of patients with elemental mercury exposure. Relevant data (e.g., dose, effects, time of onset of effects, therapeutic interventions or decontamination measures provided, efficacy or results of any interventions, and overall patient outcome) were compiled into a table and a brief description of each article was written. This evidence table is available at http://www.aapcc.org/DiscGuidelines/mercury%20evidence%20table%202006-10-30.pdf.

The table of all abstracted articles was then forwarded to the panel members for review and consideration in developing the guideline. Efforts were made to locate foreign language articles and have their crucial information extracted, translated, and tabulated. The abstractor created and distributed a written summary of the data. All of the abstracted articles were made available on a secure American Association of Poison Control Centers (AAPCC) website for reading by the panel members.

METHODS USED TO FORMULATE THE RECOMMENDATIONS

Expert Consensus (Delphi)

DESCRIPTION OF METHODS USED TO FORMULATE THE RECOMMENDATIONS

An expert consensus panel was established to develop the guideline (see Appendix 1 of the original guideline document). The American Association of Poison Control Centers (AAPCC), the American Academy of Clinical Toxicology (AACT), and the American College of Medical Toxicology (ACMT) appointed members of their organizations to serve as panel members. To serve on the expert consensus panel, an individual had to have an exceptional record in clinical care and scientific research in toxicology, board certification as a clinical or medical toxicologist, significant US poison control center experience, and be an opinion leader with broad esteem. Two specialists in poison information were included as full panel members to provide the viewpoint of the end-users of the guideline.

Guideline Writing and Review

The lead author prepared a draft guideline. The draft was submitted to the expert consensus panel for comment. Using a modified Delphi process, comments from the expert consensus panel members were collected, copied into a table of comments, and submitted to the lead author for response. The lead author responded to each comment in the table and, when appropriate, the guideline draft was modified to incorporate changes suggested by the panel. The panel again reviewed the revised guideline draft and, if there was no strong objection by any panelist to any of the changes made by the lead author, the draft was prepared for the external review process.

RATING SCHEME FOR THE STRENGTH OF THE RECOMMENDATIONS

The rating scheme for the strength of the recommendation (A-D, Z) is directly tied to the level of evidence supporting the recommendation.

Grade of Recommendation	Level of Evidence
A	1a
	1b
	1c
B	2a
	2b
	2c
	3a
	3b
C	4
D	5
Z	6

COST ANALYSIS

A formal cost analysis was not performed and published cost analyses were not reviewed.

METHOD OF GUIDELINE VALIDATION

External Peer Review
Internal Peer Review

DESCRIPTION OF METHOD OF GUIDELINE VALIDATION

External review of the second draft was conducted by distributing it electronically to American Association of Poison Control Centers (AAPCC), American Academy of Clinical Toxicology (AACT), and American College of Medical Toxicology (ACMT) members and the secondary review panel. The secondary review panel consisted of representatives from the federal government, public health, emergency services, pediatrics, pharmacy practice, and consumer organizations (see Appendix 3 of the original guideline document). Comments were submitted via a

discussion thread on the AAPCC web site or privately through e-mail communication to AAPCC staff. All submitted comments were rendered anonymous, copied into a table of comments, and reviewed by the expert consensus panel and the lead author. The lead author responded to each comment in the table and his responses and subsequent changes in the guideline were reviewed and accepted by the panel.

RECOMMENDATIONS

MAJOR RECOMMENDATIONS

Grades of recommendation (A-D, Z) and levels of evidence (1a-6) are defined at the end of the "Major Recommendations" field.

1. Patients with exposure due to suspected self-harm, abuse, misuse, or potentially malicious administration should be referred to an emergency department immediately regardless of the exposure reported **(Grade D)**.
2. Patients with symptoms of acute elemental mercury poisoning (e.g., cough, dyspnea, chest pain) should be referred immediately to an emergency department for evaluation regardless of the reported dose. Patients with symptoms of chronic toxicity (rash, tremor, weight loss, etc.) should be referred for healthcare evaluation, the timing and location of which is guided by the severity of illness and circumstances of the exposure **(Grade C)**.
3. If the elemental mercury was recently heated (e.g., from stove top, oven, furnace) in an enclosed area, all people within the exposure area should be evaluated at a healthcare facility due to the high risk of toxicity **(Grade C)**.
4. If the elemental mercury was vacuumed or swept with a broom, the health department should be contacted to perform an environmental assessment for mercury contamination. Consider healthcare referral for those exposed to documented high air mercury concentrations **(Grade C)**.
5. Patients ingesting more mercury than in a household fever thermometer or those with abdominal pain after ingestion should be referred to an emergency department for evaluation **(Grade C)**. Do not induce emesis or administer activated charcoal.
6. Asymptomatic patients with brief, unintentional, low-dose vapor exposures can be observed at home. Asymptomatic patients can be evaluated as non-urgent outpatients if there is concern for exposures to high doses (e.g., more than contained in a thermometer) or for chronic duration **(Grade D)**.
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 emergency department is not required **(Grade D)**.
8. Patients with elemental mercury deposited or injected into soft tissue should be referred for evaluation of surgical removal **(Grade C)**.
9. All elemental mercury spills should be properly cleaned up, including the small amount of mercury from a broken thermometer. Brooms and vacuum cleaners should not be used to clean up elemental mercury. The clean-up of any spill larger than a broken thermometer should be performed by a professional company, state health department, or the U.S. Environmental protection Agency (EPA). Detailed instructions are provided on the EPA website: http://www.epa.gov/mercury/spills/index.htm **(Grade D)**.

10. Patients with dermal exposures should remove all jewelry and wash the affected area with mild soap and water. Remove all contaminated clothing and place these items in a sealed plastic double-bag for proper disposal **(Grade D)**.
11. Do not discard elemental mercury in household trash, plumbing drains, or sewer systems. Consult local authorities for the proper disposal of low-level elemental mercury-contaminated household items and thermometers **(Grade D)**.

Definitions:

Grades of Recommendation and Levels of Evidence

Grade of Recommendation	Level of Evidence	Description of Study Design
A	1a	Systematic review (with homogeneity) of randomized clinical trials
	1b	Individual randomized clinical trials (with narrow confidence interval)
	1c	All or none (all patients died before the drug became available, but some now survive on it; or when some patients died before the drug became available, but none now die on it.)
B	2a	Systematic review (with homogeneity) of cohort studies
	2b	Individual cohort study (including low quality randomized clinical trial)
	2c	"Outcomes" research
	3a	Systemic review (with homogeneity) of case-control studies
	3b	Individual case-control study
C	4	Case series, single case reports (and poor quality cohort and case control studies)
D	5	Expert opinion without explicit critical appraisal or based on physiology or bench research
Z	6	Abstracts

CLINICAL ALGORITHM(S)

An algorithm is provided in Appendix 4 of the original guideline document for triage for elemental mercury exposure.

EVIDENCE SUPPORTING THE RECOMMENDATIONS

TYPE OF EVIDENCE SUPPORTING THE RECOMMENDATIONS

The type of supporting evidence is identified and graded for each recommendation (see "Major Recommendations").

BENEFITS/HARMS OF IMPLEMENTING THE GUIDELINE RECOMMENDATIONS

POTENTIAL BENEFITS

Appropriate out-of-hospital triage and initial management of patients with suspected elemental mercury exposure

POTENTIAL HARMS

Not stated

QUALIFYING STATEMENTS

QUALIFYING STATEMENTS

- This guideline was developed for the conditions prevalent in the United States. While the toxicity of elemental mercury is not expected to vary in a clinically significant manner in other nations, the out-of-hospital conditions could be much different. Do not extrapolate this guideline to other settings unless it has been determined that the conditions assumed in this guideline are present.
- This guideline is based on an assessment of current scientific and clinical information. The expert consensus panel recognizes that specific patient care decisions may be at variance with this guideline and are the prerogative of the patient and the health professionals providing care, considering all of the circumstances involved. This guideline does not substitute for clinical judgment.

Limitations of the Literature

The elemental mercury literature suffered from many potential limitations that could affect the interpretation of the data for this guideline. Most of the data were retrospective and estimates of spill or exposure amount, exposure duration, and the nature or onset of symptoms were usually based on patient or family recall, often several weeks or months after the exposure originally occurred. Exposure might have occurred by more than one route (e.g. dermal, ingestion, inhalational) in a given individual, but the extent to which each occurred was generally not reported or might not have been known. The local environmental conditions (e.g., location, temperature, ventilation, vacuuming, heating) were not often reported with inhalational exposures. Many of these factors can have a critical impact on the amount of mercury inhaled and resulting toxicity.

Air mercury measurements can help circumvent some of the limitations in using quantitative assessments of exposure amounts. However, they have their own limitations as potential estimates of cumulative or peak exposure. Air measurements represent only one point in time and space and can fluctuate depending on a number of factors (e.g., higher concentrations generally associated with higher temperatures, poorer ventilation, and vacuuming). Thus, their interpretation depends on environmental context, which was often not reported. In many instances, it was not clear when the airborne mercury

measurements were made in relation to the spill/exposure, where in spatial proximity to the exposure the air samples were obtained, or whether samples were taken at the breathing space or surface level. Breathing space concentrations are typically much lower than corresponding measurements taken directly above an elemental mercury spill or contaminated object. In addition, abatement measurements were frequently performed after peak exposure and might have underestimated the actual concentration at the time of exposure. In some cases, air mercury concentrations were reported but not exposure amounts or vice versa.

Individuals can differ in their responses to similar exposures because of inter-individual differences in minute ventilation, toxicokinetics, or toxicodynamics. Such potential differences make comparing the data between patients, or extrapolating it to the broader population, difficult. The symptoms of mild mercury poisoning are nonspecific and its diagnosis might be under-reported in the literature. Urine and blood mercury concentrations are limited in their ability to confirm or rule out a significant exposure. Depending on the circumstances (e.g., the acuity of exposure, timing of measurements, laboratory performance), urine or blood concentrations might not reflect the actual exposure. In some cases, background occupational exposure might have been present and could have contributed to a patient's reported symptoms or biological mercury measurements.

In cases describing mercury spills from broken thermometers, the thermometer size or volume of mercury was generally not reported. Different thermometers contain different amounts of mercury.

In the few large cases series included in the evidence table, elemental mercury exposure amounts, air concentrations, and frequency or severity of subsequent effects were often reported as a ranges, percentages or mean values, so that individual doses resulting in specific effects could not be distinguished.

In several instances, the quality of data might have been lower than implied by the level of evidence score. For example, an article classified as level 2b could have been a cohort analysis of the relationship between urine mercury concentrations and symptom severity, but the quality of data relating to the more pertinent relationship of exposure amount or air level vs. symptom severity might have been only a level 4. Most studies reviewed were not designed to specifically assess a toxic exposure threshold (i.e., the relationship between air concentration or spill amount and clinical effects), yet this was a primary question that the guideline panel sought to answer from the review of the literature.

The number of articles reporting gastrointestinal or subcutaneous exposures was limited. This could be the result of the infrequency of such exposures, an inherent lack of toxicity by these routes, poor recognition of such cases, or simply a lack of reporting. It was difficult to draw robust conclusions from this data.

IMPLEMENTATION OF THE GUIDELINE

DESCRIPTION OF IMPLEMENTATION STRATEGY

An implementation strategy was not provided.

IMPLEMENTATION TOOLS

Clinical Algorithm

For information about availability, see the "Availability of Companion Documents" and "Patient Resources" fields below.

INSTITUTE OF MEDICINE (IOM) NATIONAL HEALTHCARE QUALITY REPORT CATEGORIES

IOM CARE NEED

Getting Better

IOM DOMAIN

Effectiveness
Timeliness

IDENTIFYING INFORMATION AND AVAILABILITY

BIBLIOGRAPHIC SOURCE(S)

Caravati EM, Erdman AR, Christianson G, Nelson LS, Woolf AD, Booze LL, Cobaugh DJ, Chyka PA, Scharman EJ, Manoguerra AS, Troutman WG. Elemental mercury exposure: an evidence-based consensus guideline for out-of-hospital management. Clin Toxicol (Phila) 2008 Jan;46(1):1-21. PubMed

ADAPTATION

Not applicable: The guideline was not adapted from another source.

DATE RELEASED

2007 Apr 9

GUIDELINE DEVELOPER(S)

American Association of Poison Control Centers - Professional Association

SOURCE(S) OF FUNDING

Health Resources and Services Administration, U.S. Department of Health and Human Services

GUIDELINE COMMITTEE

Not stated

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FINANCIAL DISCLOSURES/CONFLICTS OF INTEREST

There are no potential conflicts of interest reported by the expert consensus panel or project staff regarding this guideline.

GUIDELINE STATUS

This is the current release of the guideline.

GUIDELINE AVAILABILITY

Electronic copies: Available in Portable Document Format (PDF) from the American Association of Poison Control Centers.

Print copies: Available from the American Association of Poison Control Centers, 3201 New Mexico Avenue NW, Suite 330, Washington, DC 20016

AVAILABILITY OF COMPANION DOCUMENTS

None available

PATIENT RESOURCES

None available

NGC STATUS

This NGC summary was completed by ECRI Institute on December 17, 2007. The information was verified by the guideline developer on January 14, 2008.

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