After-Event Medical Monitoring and Risk Communication

Charles McKay MD, FACMT
Associate Medical Director, Connecticut Poison Control Center
Associate Clinical Professor, University of Connecticut School of Medicine
American College of Medical Toxicology

Faculty Disclosure

- Faculty: Charles McKay, MD, FACMT
  - No relationships with commercial interests, speakers bureau, or relevant consulting fees

Medical Monitoring

Ongoing or serial evaluation of individuals (clinical and/or laboratory) in order to identify adverse effects following exposure to some substance

Example: Clinical Monitoring

- Methylisocyanate-induced reactive airways disease
  - Peak flow measurements
  - ? Methacholine challenge testing
  - ? Removal of those with previous/underlying asthma or atopic conditions

Example: Laboratory Monitoring

- Using cholinesterase measurements as rule-out tests for nerve agent or organophosphate exposure
  - Population norms for plasma cholinesterase
  - Confirmatory testing by RBC Cholinesterase or serial plasma cholinesterase

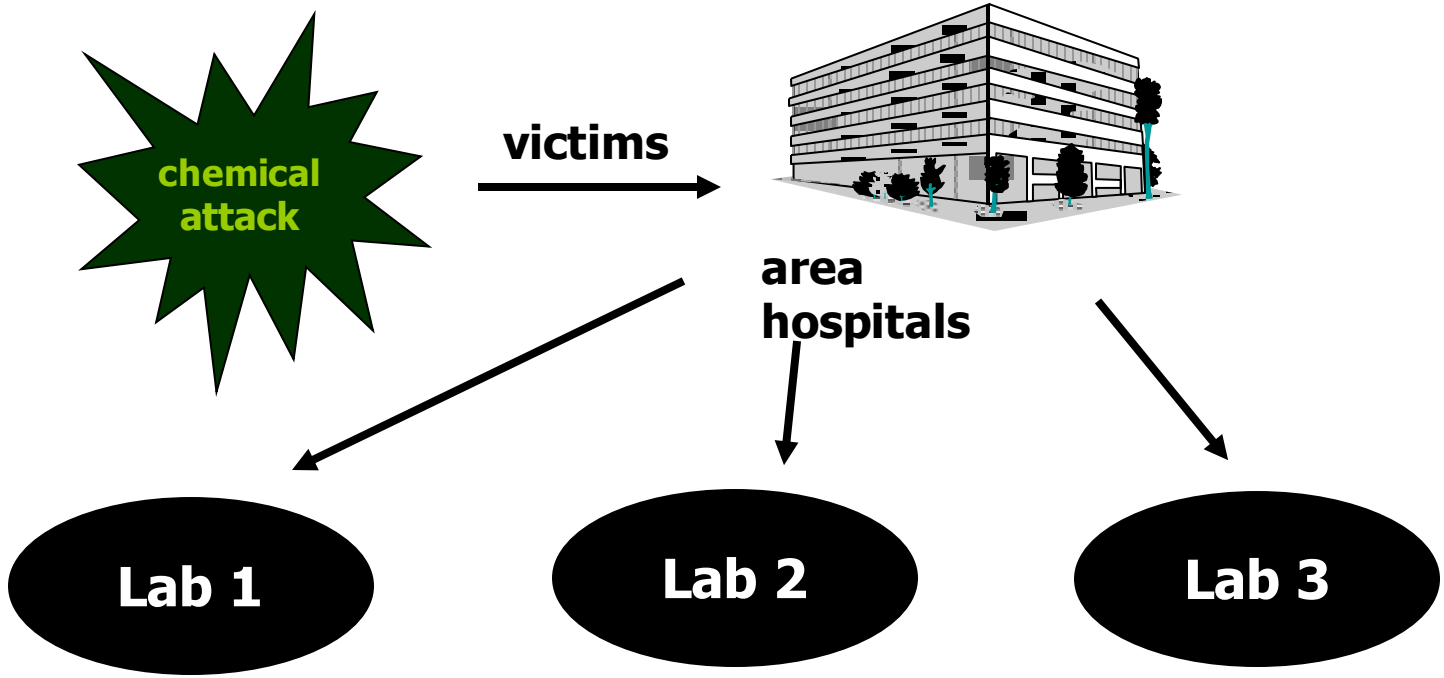
警察庁 (National Police Agency)

Nerve Agent vs. Anxiety/Stress Response

Nerve Agent Poisoning	Anxiety/Stress Response
Chest Tightness	Chest Tightness
Dyspnea	Dyspnea
Brady or Tachycardia	Tachycardia
Nausea/Vomiting	Nausea/Vomiting
Abdominal Cramps	Abdominal Cramps
Involuntary Urination	Involuntary Urination
Fasciculations	Tremor
Headache	Headache
Coma	Syncope
Diaphoresis	Diaphoresis
Pinpoint Pupils	Dilated Pupils

Medical Monitoring in Potential Mass Casualty Events

POTENTIAL AGENTS	MONITORING CAPABILITY?	
	Clinical	Laboratory
Cyanide	Rapid knock-down	Slow
Incapacitating Agents	Irritants/Sedatives	No
Volatile Organic Compounds	CNS depressants	No
Industrial Contaminants	Variable organ effects	No
Industrial Solvents	CNS/other organs	No
Heavy Metals	GNS/other organs	Slow
Nerve Agents	Cholinergic crisis	Yes
Mustard Agents	Skin/Pulmonary	No



Tier I
Local
Hospitals
TAT: 1-4 h

Tier II
Regional
DPHL
TAT: <24 h

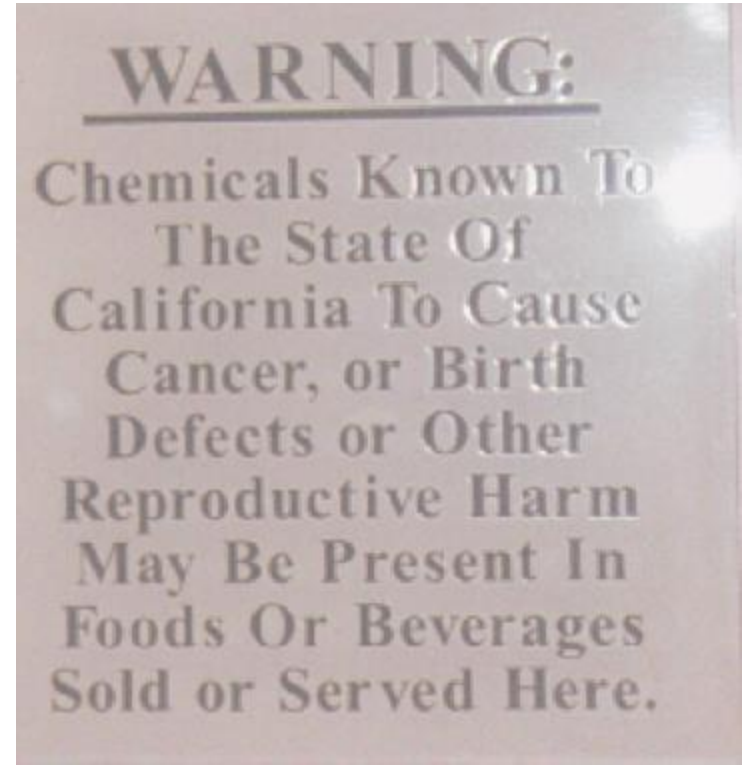
Tier III
National
CDC, FBI, etc.
TAT 1-7 d

Should Medical Monitoring Be Considered?

- Presumes an injury may or will occur
- Presumes an exam or test will identify either/both:
  - Those at risk
  - The injury itself, hopefully at an early stage
- Best utilized when an effective treatment or mitigation exists

The Existence of a Test Does Not Mean We Know What To Do With The Results

- CA Prop 65
  - The Safe Drinking Water and Toxic Enforcement Act of 1986
- Currently over 800 substances on list
- Does not emphasize dose/response consideration
- http://oehha.ca.gov/prop65/prop65_list/files/P65single061915.pdf




CAUTION
THIS SIGN HAS
SHARP EDGES
DO NOT TOUCH THE EDGES OF THIS SIGN
ALSO, THE BRIDGE IS OUT AHEAD

The Future of Biomonitoring: National Academy of Science Report 2006

- The relative value of biomonitoring efforts is dependant on what is communicated
- Is the sample population representative?
- Are the methods and analysis sound?
- Descriptive vs. Risk-based communication

The National Academy of Sciences Report on Biomonitoring, July 2006: http://books.nap.edu/catalog/11700/human-biomonitoring-for-environmental-chemicals

Interpretation and Communication

- Descriptive vs. Risk-Based Interpretation
  - Descriptive
    - Presence and concentration of a compound in the 50th, 95th percentiles of population
      - How well does the sample population represent the population of interest?
      - How well do the exposure settings match?
        - Acute vs. chronic
      - Are the matrices (e.g. blood, urine) the same or are there conversion estimates available?

Interpretation and Communication

- Risk-based interpretation
  - Good data only available for some compounds
  - Usually requires modeling and extrapolation
    - Does the primary literature (animal, human epidemiologic) adequately address dose range and potential confounders?
    - For any postulated low-level exposures, difficult to sort out confounders from genetically "sensitive population"
      - Mostly speculation

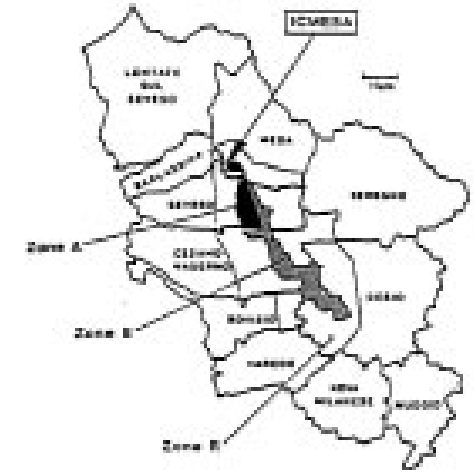
Applying Medical Monitoring To A Mass Casualty Event

- Sarin Tokyo Event
  - Cholinesterase monitoring of patients
  - Serial exams of exposed healthcare providers
- Seveso, Italy Dioxin Exposure
  - Acute and chronic effects
- South Wales Oil Spill (1995)
  - Perception

Seveso, Italy 1976

- Worst environmental exposure to TCDD
- Early rise in induced abortions and circulatory deaths
- Late statistically significant rise in non-Hodgkin's lymphoma (Relative Risk 2.8, with CI: 1.1, 7)
- Significance of lymphoma risk?
  - Baseline incidence 10/100,000 or so
- Risk communication?
  - How and when would one screen?
  - How to translate data from one event to another?
    - U.S. population estimates from NHANES: TCDD <10 ppt (vs >200 ppt in Seveso-exposed)

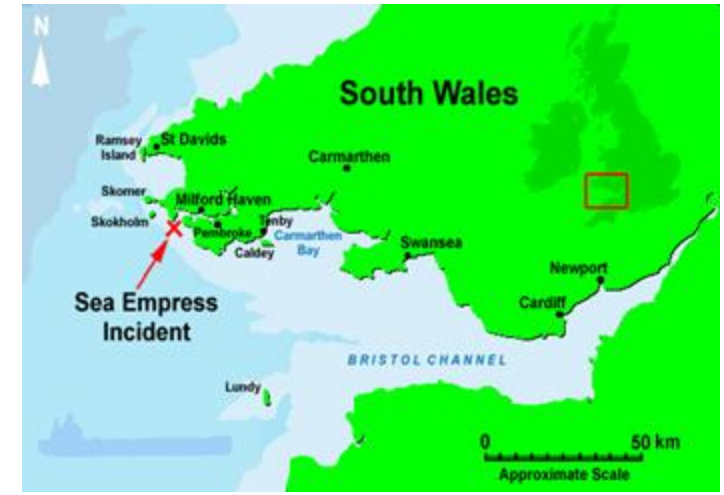
Zone	Population 20-75 ans	Contamination du sol en µg/m3 (min - max)
A	735	15.5 - 580
B	4700	1.7 - <50
R	31800	0.9 - <5



http://www.mines.inpl-nancy.fr/~verdel/cindy/fiches2001/seveso.php

Sea Empress Oil Spill 1996

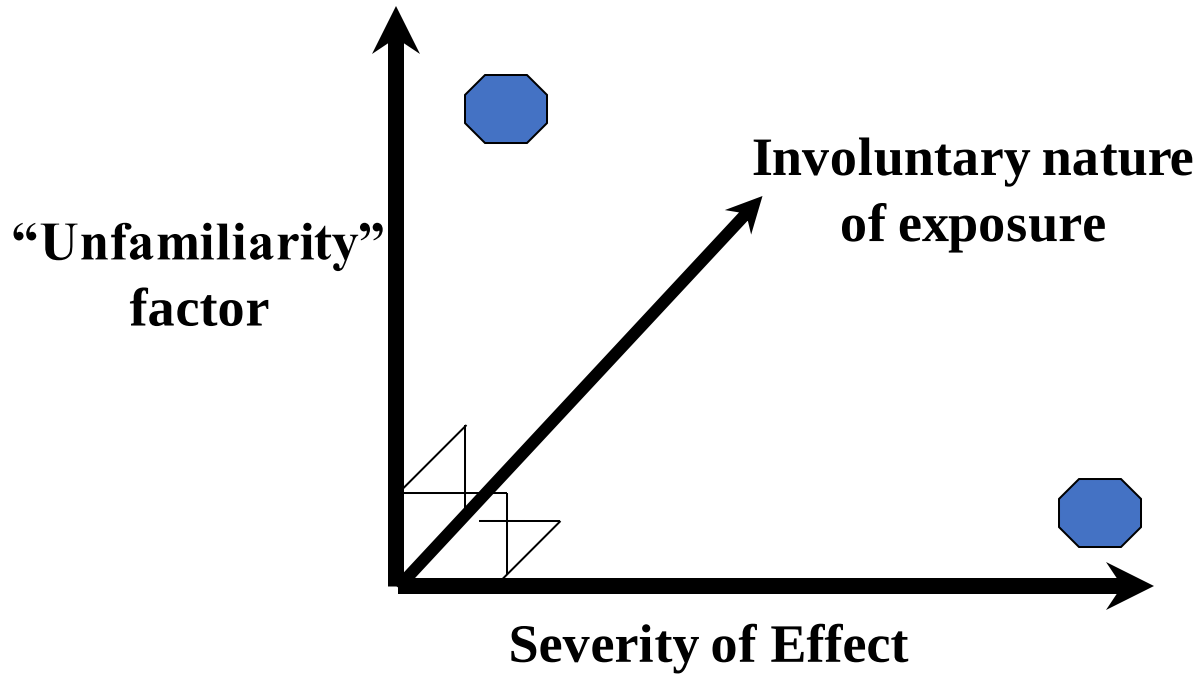
- 70,000 tonnes of oil spilled into an environmentally sensitive area
- 39% of residents near the spill complained of persistent headaches, irritive, or psychological symptoms
- 20% of people in unaffected, but nearby areas, complained of similar symptoms, with 1 in 5 thinking that their symptoms were related to the oil spill



Should Medical Monitoring Be Considered?

- Only in larger context of risk communication
- Clinical Monitoring: Only if a clinical measurement is demonstrated to have good correlation with outcome of interest
  - Problem of screening and specificity/sensitivity
- Laboratory Monitoring: Make sure a reference measurement is available
  - E.g. population measurements by NHANES

OUTRAGE May Not Correlate With Severity of Effect Alone



Factors That May Alter Acceptance of Risk

More Acceptable

- Natural “cause”
- Associated with a trusted source
- Familiar
- Voluntary
- Potentially beneficial
- Statistical (low harm likelihood)
- Fairly distributed/shared by all
- Affects adults

Less Acceptable

- Man-made “cause”
- Not associated with a trusted source
- Exotic
- Involuntary
- Limited or absent benefit
- Catastrophic (high harm likelihood)
- Unfairly distributed (injustice)
- Affects children

What is Risk Communication?

- Sharing of information about a real or potential hazard which enables:
  - Understanding
  - Effective decision-making
  - Appropriate response
  - Cooperation
  - Calming of fears
  - Responding to criticism
- Risk communication is as much about "communication" as it is about "risk"
- Good risk communication may not make a situation better. Bad risk communication will make a situation worse.

Where Does It Fit In Response to a Chemical Event?

- Risk Communication is the final component of a risk characterization
- Risk Characterization
  - Risk Assessment
    - Hazard Identification
    - Exposure Pathway
    - Modifying Factors
    - Toxicity Assessment
  - Risk Communication

Risk Communication

“Given these definitions, here is the First Law (maybe the only law) of Risk Communication: outrage, not hazard, drives reputation. Even significant hazards are usually tolerated when outrage is low, and even insignificant hazards are usually rejected when outrage is high.”

-Peter Sandman

Spectrum of Scenarios and Response

EVENT OR SETTING	**APPROPRIATE RESPONSE**
• Low risk – Low outrage	➢Informational (or none)
• Low risk – High outrage	➢Outrage Management
• High risk – Low outrage	➢Advocacy
• High risk – High outrage	➢Crisis Communication/Action

The Peter M. Sandman Risk Communication Website. http://www.psandman.com/

Risk Communication Bottom Line

- “Here is the situation.”
  - You are (not) in danger (now, ever)
  - Your children are (not) in danger (now, ever)

- “You do (not) need to do something.”
  - Your options include the following…

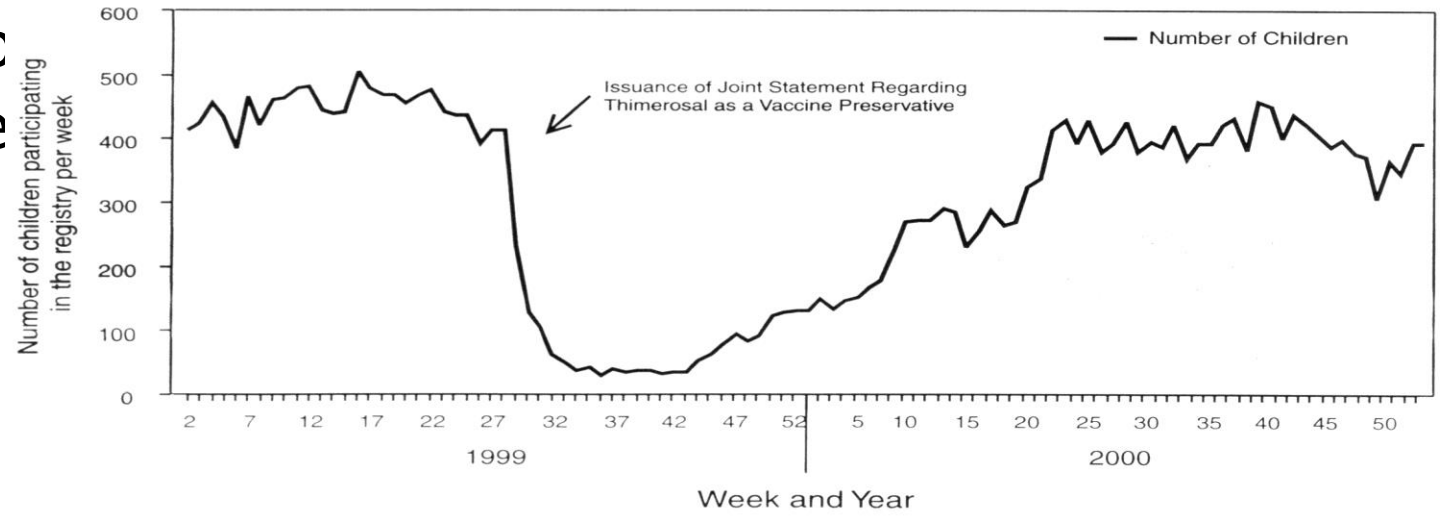
Consequences of Poor Risk Communication

- Promotes distrust
- Decreases compliance with recommended measures
- Increases duration, complexity and cost of response efforts, necessitating more elaborate means
- Results in use of limited resources in a less productive and inappropriate way

Real World Dangers of Poor Risk Communication

- Unfounded and misinterpreted concerns about thimerosal-containing vaccines
- Abrupt decline in Hepatitis B vaccination of neonates
- Nc
  He

FIGURE 2. Number of children who received first dose of Hepatitis B vaccine ≤5 days after birth — United States, 1999–2000



Summary

- Post-event medical monitoring may be indicated in the assessment of an exposure
- If performed, medical monitoring requires defined clinical and/or laboratory parameters and must be done with an appropriate control group
- Healthy skepticism is important in interpreting reported medical monitoring data
- Medical monitoring is only one component of risk assessment and communication
  - Good risk communication may not improve a “bad situation”, but poor risk communication will make a bad situation worse!

References

Environmental Protection Agency: Risk Assessment Website Portal www.epa.gov/risk/

Fowle JR III, Dearfield KL: Risk Characterization Implementation Core Team. Risk Characterization Handbook. Environmental Protection Agency, SciencePolicy Council, Washington, DC, December 2000. Available at www.epa.gov/OSA/spc/pdfs/rchandbk.pdf

Agency For Toxic Substance and Disease Registry, Environmental Protection Agency: A citizen's guide to risk assessments and p ublic health assessments at contaminated sites. www.atsdr.cdc.gov/publications/01-0930CitizensGuidetoRiskAssessments.pdf

Agency For Toxic Substance and Disease Registry: Toxicological Profile for mercury. March 1999. Available at www.atsdr.cdc.gov/ toxprofiles/tp46.html

Ames BN, Profet M, Gold LS: Nature's chemicals and synthetic chemicals: Comparative toxicology. Proc Natl Acad Sci 1990;87:7782–7786.

Centers for Disease Control and Prevention: A comprehensive immunization strategy to eliminate transmission of hepatitis B vi rus transmission in the United States. MMWR 2005;54(RR16):1-23. www.cdc.gov/mmwr/preview/mmwrhtml/rr5416a1.htm

Centers for Disease Control and Prevention: Impact of the 1999 AAP/USPHS joint statement on thimerosal in vaccines on infant hepatitis B vaccination practices. MMWR 2001;50(6):94-97. www.cdc.gov/mmwr/preview/mmwrhtml/mm5006a3.htm

Centers for Disease Control and Prevention. Crisis and Emergency Risk Communication. 2012 Edition. Atlanta, GA:U.S. Centers f or Disease Control and Prevention (August 2012). Available: http://emergency.cdc.gov/cerc/resources/pdf/cerc_2012edition.pdf

Covello V, Allen F: Seven cardinal rules of risk communication. US Environmental Protection Agency, Office of Policy Analysis, Washington, DC, 1988.

Fischhoff B, Lichtenstein S, Slovic P, Keeney D: Acceptable Risk. Cambridge, MA, Cambridge University Press, 1981.

Glassner B: The Culture of Fear: Why Americans Are Afraid of the Wrong Things. New York City, NY, Basic Books, 2nd ed, 2004.

Golbeck AL, Ahlers-Schmidt CR, Paschal AM, Dismuke SE: A definition and operational framework for health numeracy. Am J Prev Med 2005;29(4):375-376.

McKay CA. Risk Assessment and Communication. in Goldfrank LR, Hoffman RS, Howland MA, Lewin NA, Nelson LS, Flomembaum NE (eds.) Goldfrank's Toxicologic Emergencies. McGraw-Hill Publishers, NYC, 11th edition, 2019.

McKay C, Scharman, EJ. Intentional and inadvertent chemical contamination of food, water, and medication. Emerg Med Clin North Am 2015;33(1): 153-177. http://www.ncbi.nlm.nih.gov/pubmed/25455667

Manuel J. Crisis and emergency risk communication lessons from the Elk River spill. Environmental Health Perspectives, 2014.

Sandman P: The Peter Sandman risk communication website. www.psandman.com/index.htm

Slovic P: Perception of risk. Science 1987;236:280–285.

APPENDIX

- Cardinal rules (components) of risk communication
- Contrast/comparison of “crisis risk communication” and “formal risk characterization”
- Practical risk communication tips
- Message mapping and practice scenarios

Components of Risk Communication

- Accept and involve people as partners
- Plan carefully
- Listen to the specific concerns
- Be honest, frank, and open
- Work with other credible sources
- Meet the needs of the media
- Speak clearly and compassionately
- Evaluate your efforts

Formal Risk Characterizations

- Terminology used by CDC, EPA
  - E.g. public health concern vs. public health threat
- Public health hazard categories are statements about whether people could be harmed by conditions present at the site in the past, present, or future…The five public health hazard categories are
  - No public health hazard
  - No apparent public health hazard
  - Indeterminate public health hazard
  - Public health hazard
  - Urgent public health hazard

http://www.atsdr.cdc.gov/glossary.html#G-P-

What Do These Mean?

- No public health hazard
- No apparent public health hazard
- Indeterminate public health hazard
- Public health hazard
- Urgent public health hazard

- ➢ No exposure (past, present or future)
- ➢ Exposure possible; no risk
- ➢ Critical information is not available
- ➢ Long-term exposures (>1yr) may result in harm
- ➢ Short-term exposures (<1yr) may result in harm; action

Factors That Impact Risk Communication

- Nature of previous encounters with healthcare field
- Lack of prior patient-healthcare worker relationship
- Incomplete or inadequate response to questions
- The provision of information contrary to "popular understanding" or media representation
- Loss of credibility
- Lack of appreciation of individual or cultural differences in perception of risk or applicability of data
- Incomplete or limited comprehension of scientific or statistical principles

Risk Communication is a Science… and an Art

Communication in a crisis is affected by a number of factors

- High stress places limitations on what a listener can take in
  - People retain an average of **7** bits (range 5-9) of information in **low-medium stress situations**
  - `People retain an average of **3** bits of information (range 1-5) in **medium to high stress situations**
- What others say will affect the impact of your messages
  - "I found this on the internet…"

Keys to Successful Risk Communication

- Anticipation, preparation, and practice (APP)
- Non-verbal communication skills
- Visuals (graphics, stories, analogies)
- Aim at 6^{th}-8^{th} grade level of education (AGL - 4)

Use Visuals

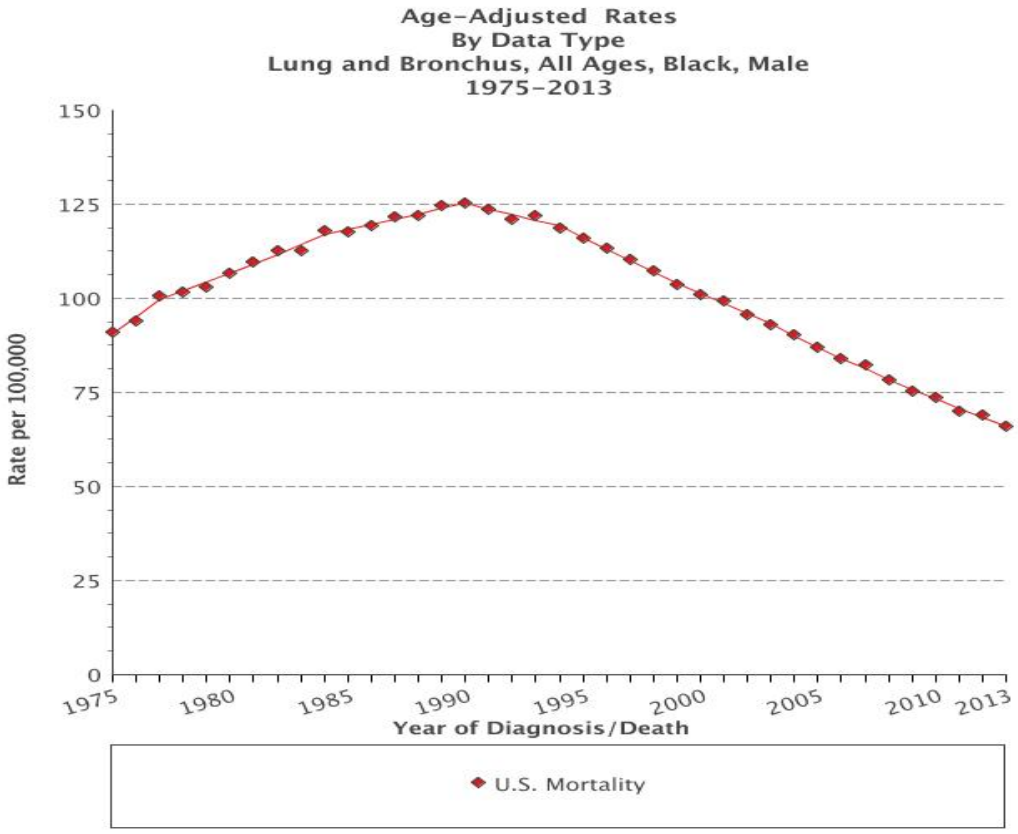
- Can result in up to 50% greater attention
- Can lead to up to 50% greater understanding
  - e.g., pattern recognition and familiarity
- Can provide up to 50% greater information retention
- Use of webs, plots, idea and concept maps

Example: Lung Cancer Risk (narrative)

- Mortality from lung cancer has shown downwards trends over the last decade or so, related largely to impacts of smoking cessation efforts from their highest levels seen following World War II. The increase in the proportion of woman smokers and the long latency period of lung cancer is also likely responsible for the continued increase seen in this population through the 1990s, only more recently beginning to fall.

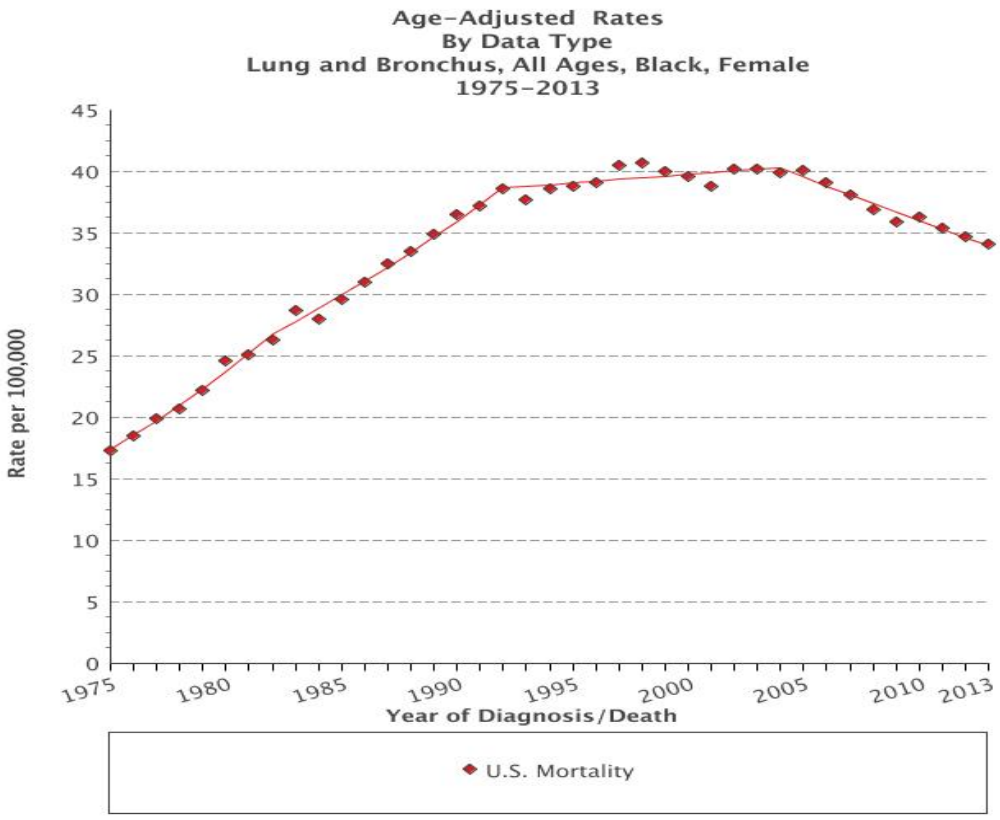
Risk of Lung Cancer (visual depiction)

MEN



Cancer sites include invasive cases only unless otherwise noted.

WOMEN



Cancer sites include invasive cases only unless otherwise noted.

How to Do Risk Communication

- Develop key messages
- Anticipate questions
- Anticipate follow-up questions
- Don’t lose your cool
- Know what you should not say
- Know and cite credible sources
  - Peer-reviewed journals, textbooks
  - Positions of major scientific organizations

Practical Tips

- Assuming high stress, use 3 messages
- Rule of thumb: **3** messages X **9** words per message = **27** words
- The first message is the one they will remember most (primacy)
- The last one is the second most remembered (recency)
- These guidelines are used to create messages in anticipation of what will be asked = "**message maps**"

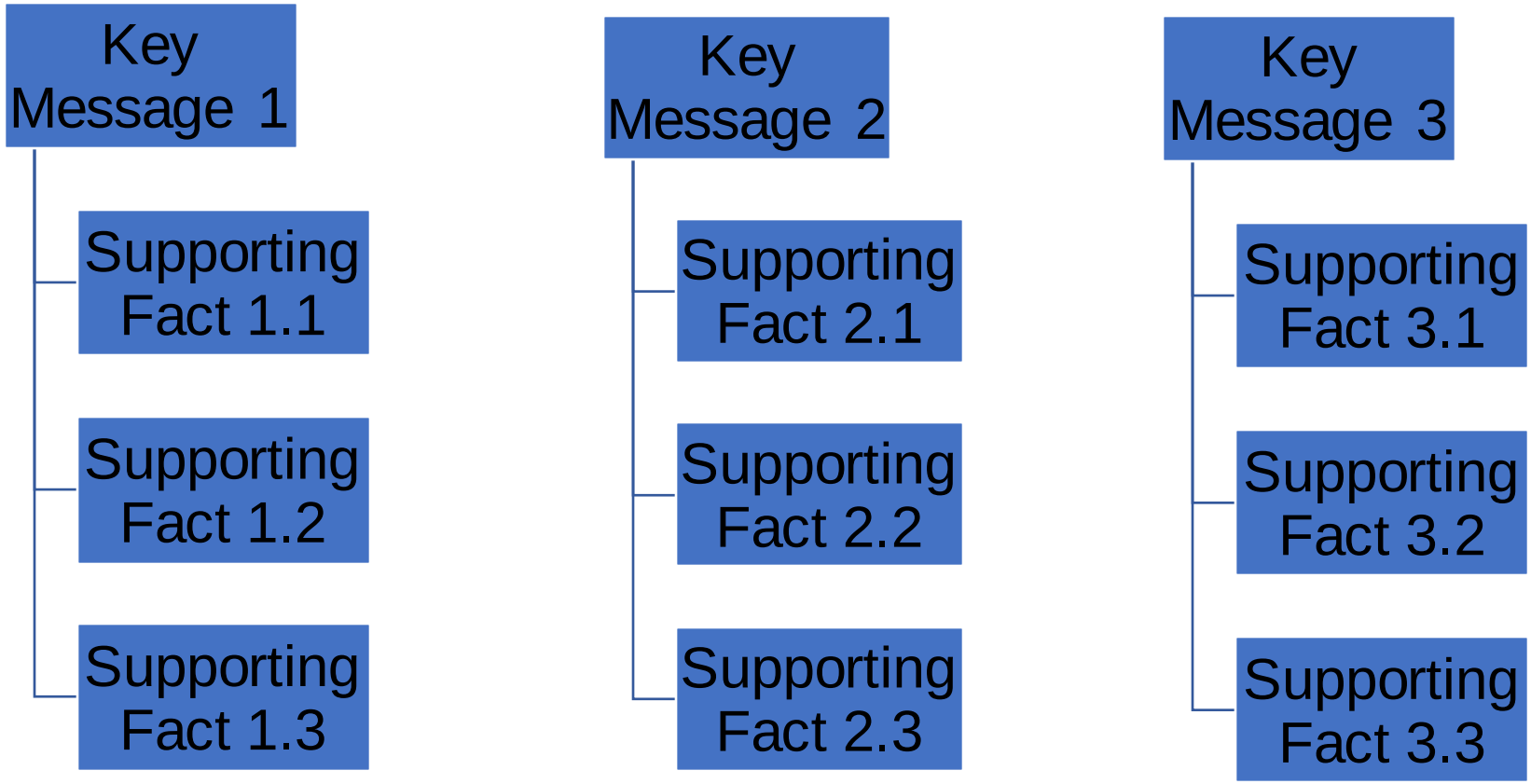
Practical Tips (cont.)

- 3 positives are used to answer 1 negative, and a 4th is added to make positive > neg.
- Rule of 3 in high stress situations:
  - 3 key messages
  - Repeat key message 3 times
  - Provide 3 supporting statements for each message
- Communication "rules"
  - 3 x 3 = 3
  - 9 x 1= 0

What Should People Take Away?

- Uncertainty significantly impacts the ability of an individual to take appropriate action
- People should not leave with the impression
  - “No one knows what is going on or what we should do."
- Important to convey:
  - Likely **magnitude** of the risk
  - **Urgency** of the risk
  - **Personal applicability** of a risk characterization
  - **Uncertainties** of the risk assessment
  - **Management options**

Message Map


Key Message 1
Supporting Fact 1.1
Supporting Fact 1.2
Supporting Fact 1.3
Key Message 2
Supporting Fact 2.1
Supporting Fact 2.2
Supporting Fact 2.3
Key Message 3
Supporting Fact 3.1
Supporting Fact 3.2
Supporting Fact 3.3

Exercise

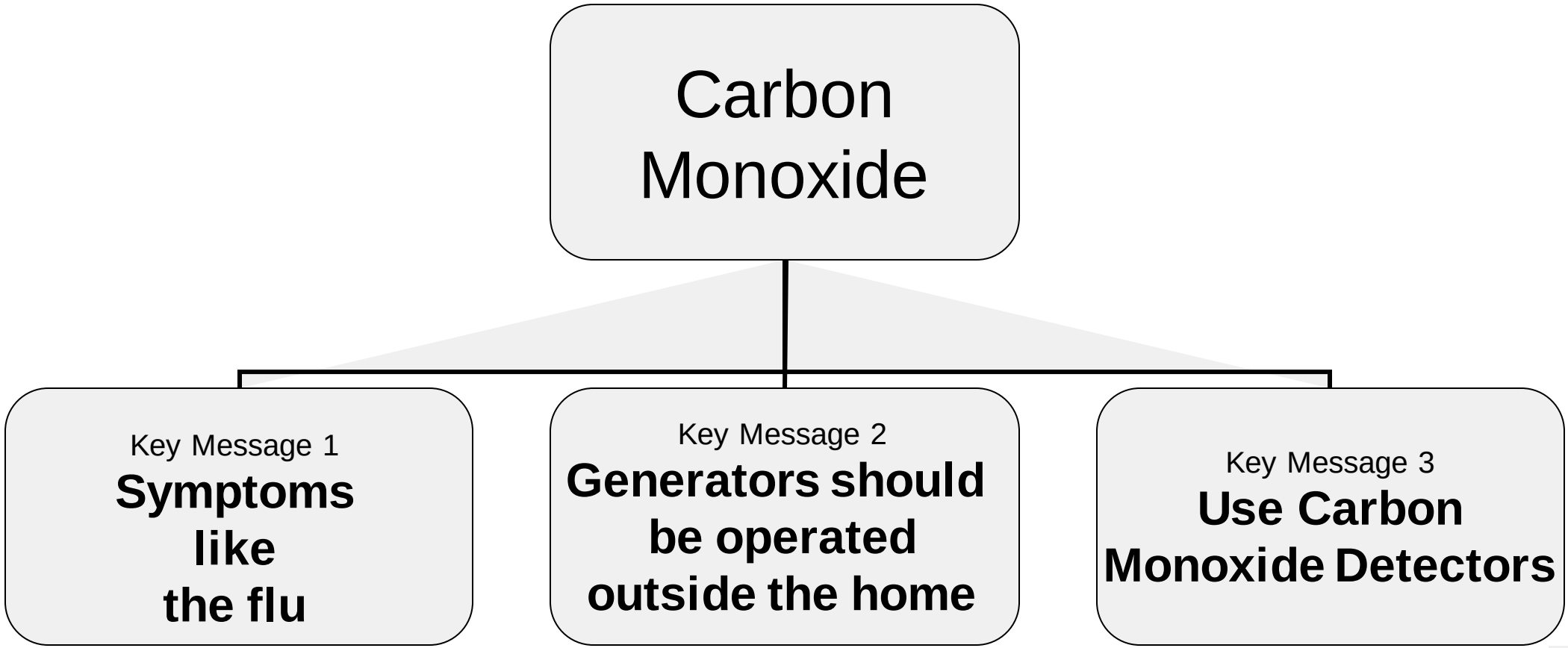
- You are managing disaster response in an area that was just struck by a hurricane. The night before, two separate families were killed by carbon monoxide. In both cases, the families had operated a generator indoors. You are asked to make a statement.

- What would your statement include?

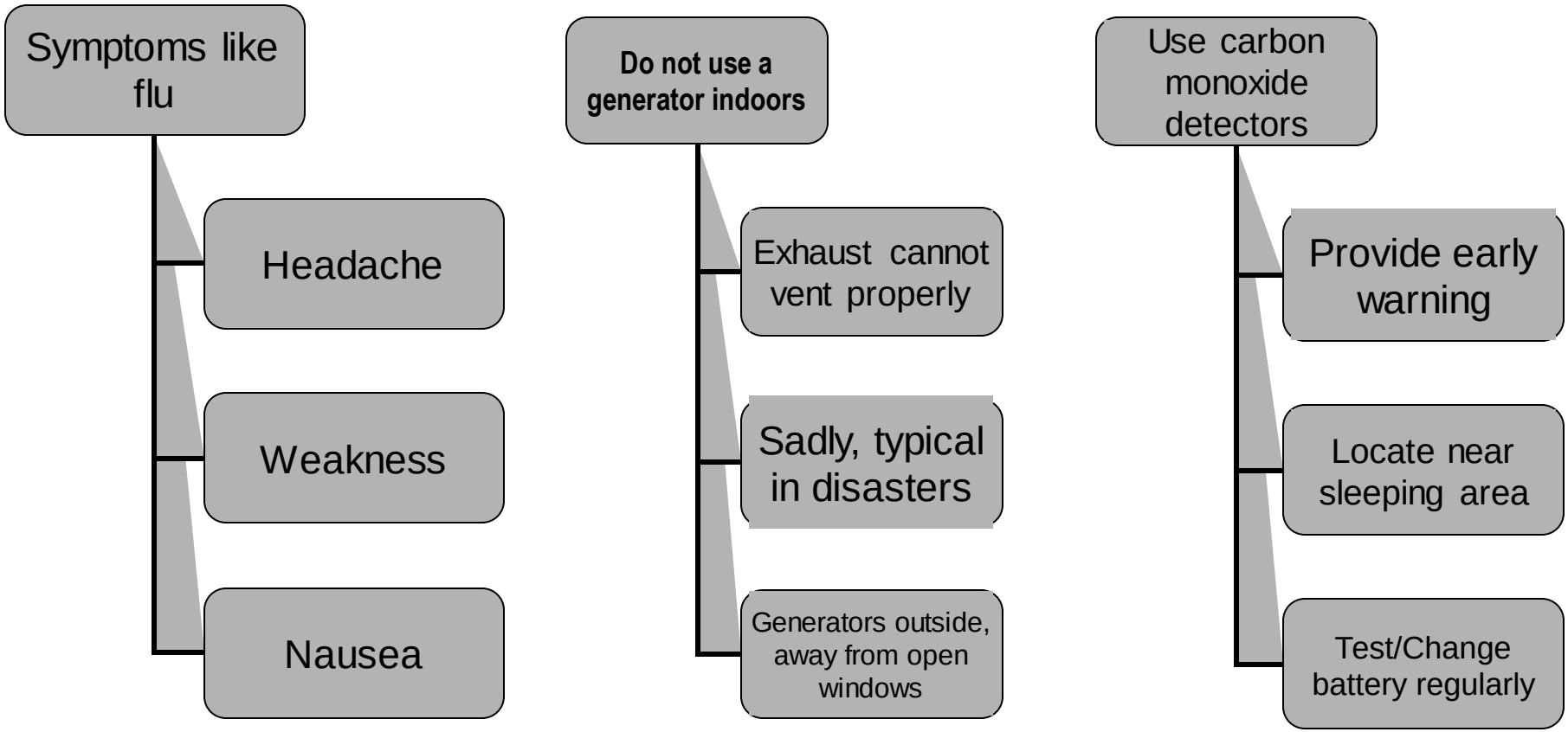
Which of these messages would you include in your statement?

a) Carbon monoxide binds hemoglobin with more affinity than oxygen
b) Thankfully, only 6 people have died
c) If people had not misused the generators, they would still be alive
d) CO causes flu-like symptoms. Don't use a generator indoors. Get and use a CO detector.

Message Map Example



Household Carbon Monoxide Map



Message Mapping Exercise: Three Practice Scenarios

- What is the major issue(s)?
  - Magnitude
  - Urgency
- What are critical data gaps?
  - How would you get them answered quickly?
- What are the key messages?
- What are the supporting statements?
  - Applicability
  - Actionable

Pesticide Release Scenario

- Terrorists steal a crop-dusting plane and release methyl parathion over the downtown area
- There are reports of sick individuals going to hospitals
- You are on-call - media outlets are calling, asking for information

Pesticide Release Scenario

- What questions do you anticipate that you will have to answer?
- What major data gaps do you expect?
- What resources/experts do you have available to help with data gaps?
- What messages do you feel are essential to deliver to inform, calm, and empower the public to respond optimally to this situation?
- For each message, what supporting messages would you use?

Message Map : Airborne Organophosphate Attack… audience critique…

These chemicals mess with normal nerve function

1

- Su F — With enough exposure, fluids leak from everywhere
- Su F — Muscle twitching, weakness, and seizures can occur
- Su F — Early treatment after a serious exposure is very important

If you or a friend were at XX stadium today and feel sick, go to the E.D.

2

- Su F — Go to E.D. if you are having breathing problems
- Su F — Go to E.D. if you have vomiting & diarrhea or a lot of sweating
- Su Fa — Wash your hair and exposed skin with soap/water

Major exposure concern is from breathing in the chemical

- Su P — People who were not near the stadium were not exposed
- Su P — Symptoms should start within minutes – an hour of exposure
- Su P — The stadium is being cleaned as an extra precaution

“Powder Event“ Scenario

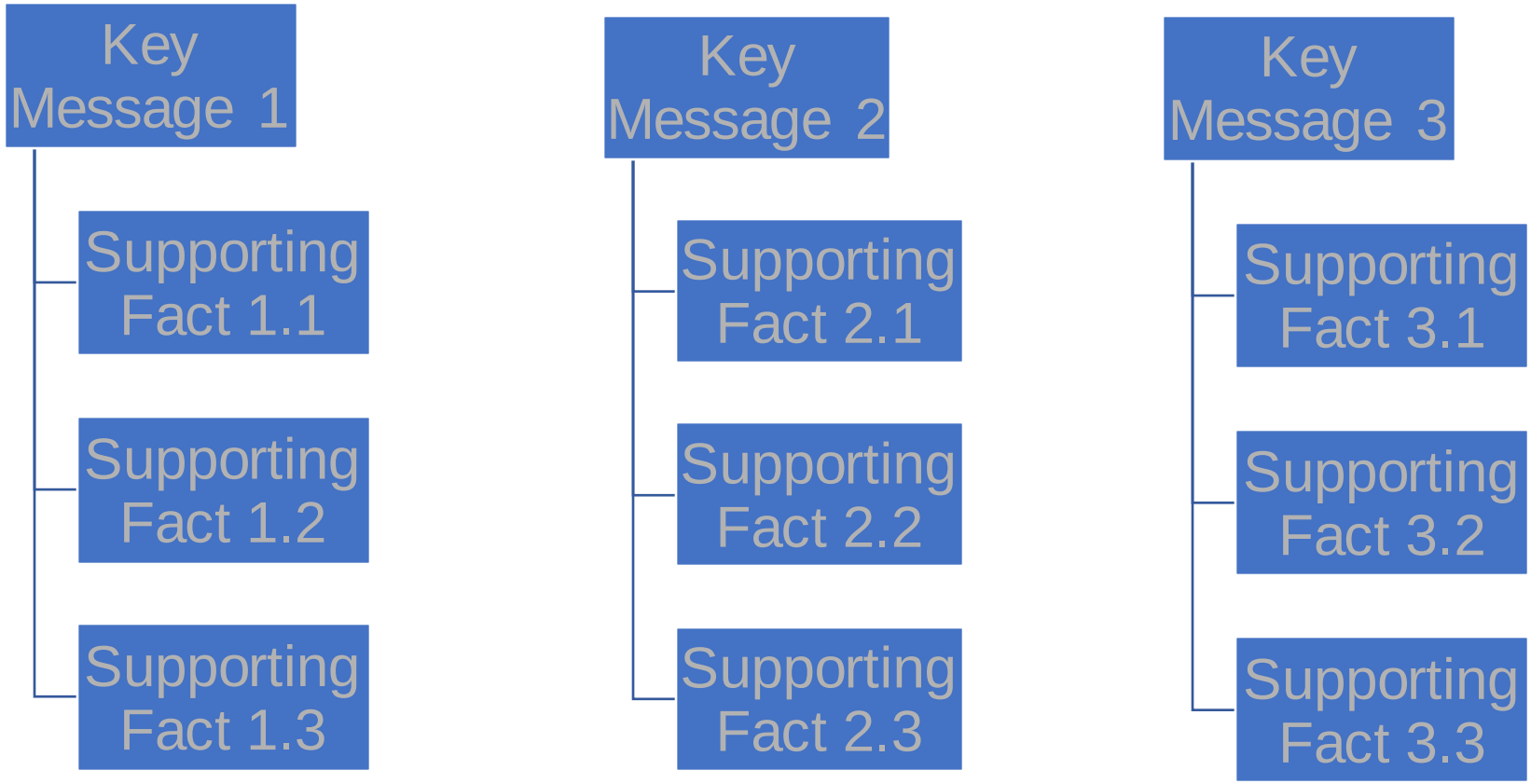
- You are on-call - the Mayor has received a letter, opened by his staff, that contained a white powder
- There is considerable panic and several staff and bystanders are complaining of nausea, vomiting and headache and have gone to local hospitals

- You have been contacted by the local news station for information

Powder Event Scenario

- What questions do you anticipate having to answer?
- What major data gaps do you expect?
- What resources/experts do you have available to help with data gaps?
- What essential messages do the public need to receive to be calmed, informed, and empowered to respond appropriately to this event?
- What supporting messages do you need?

Message Map


Key Message 1
Supporting Fact 1.1
Supporting Fact 1.2
Supporting Fact 1.3
Key Message 2
Supporting Fact 2.1
Supporting Fact 2.2
Supporting Fact 2.3
Key Message 3
Supporting Fact 3.1
Supporting Fact 3.2
Supporting Fact 3.3

Mercury Spill Scenario

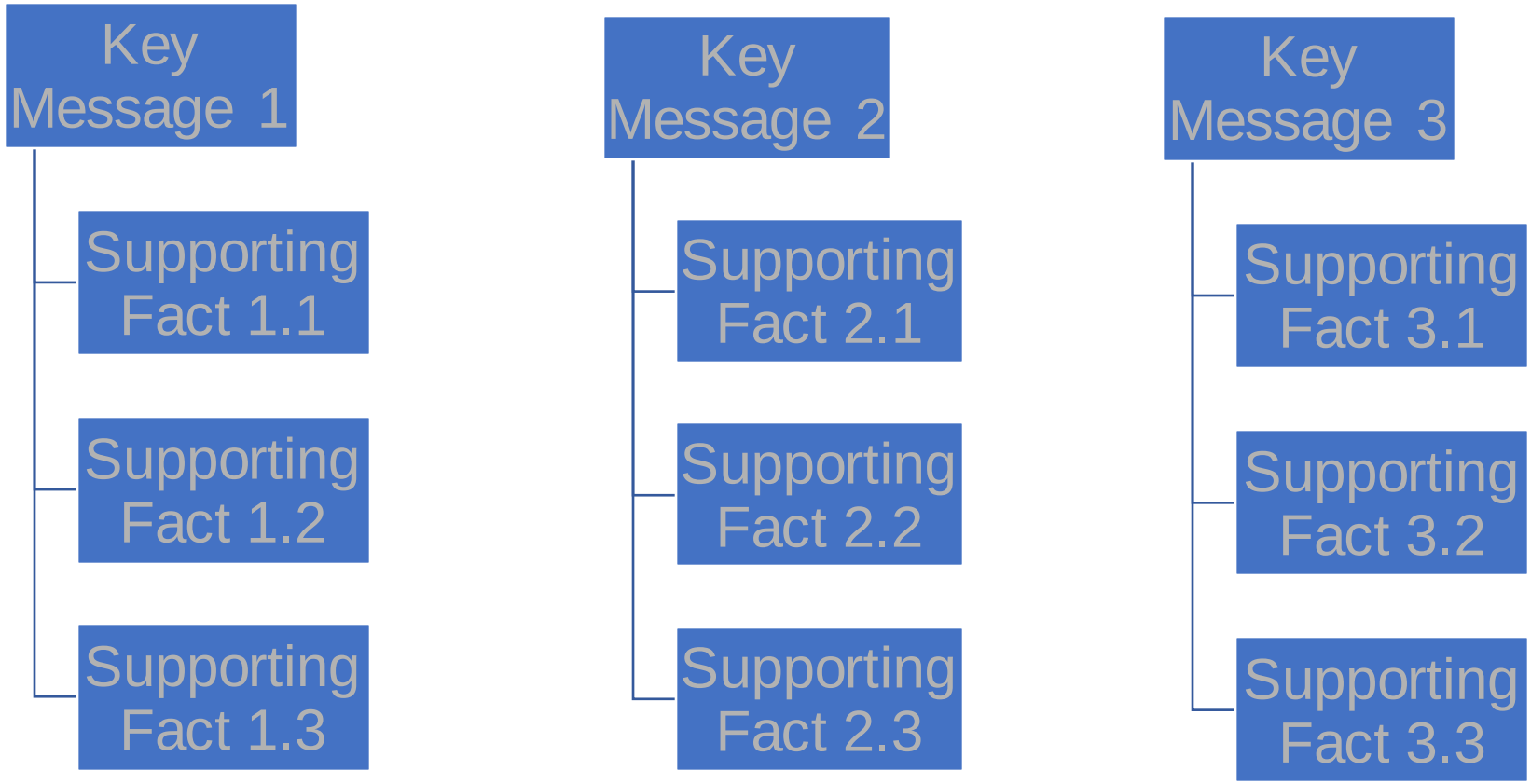
The local school superintendant calls about elemental mercury contamination

- A student whose father is a dentist brought in a jar of mercury from home today
- The kids thought it was cool and poured it on a table in their classroom and moved it around with their hands
- Some spilled on the floor and was tracked around
- The school custodian noticed the mercury at the end of the school day and notified school administration
- The Public Health Dept and Dept. of Environmental Quality have been contacted and are responding
- Calls start to come into the poison center and local health department from the media, healthcare providers and concerned

Mercury Spill Scenario

- What questions do you anticipate being asked?
- What major data gaps do you expect?
- What resources/experts do you have available to help with data gaps?
- What essential messages do you need to convey to school officials, healthcare providers, parents, the media, and the public in order to calm, inform, enable appropriate response to the situation?
- What supporting information would you use for each message?

Message Map


Key Message 1
Supporting Fact 1.1
Supporting Fact 1.2
Supporting Fact 1.3
Key Message 2
Supporting Fact 2.1
Supporting Fact 2.2
Supporting Fact 2.3
Key Message 3
Supporting Fact 3.1
Supporting Fact 3.2
Supporting Fact 3.3

Summary

- Risk communication is vital
  - Particularly in stressful environments
    - Communications with media or public about perceived toxicologic threats
    - Response to true toxicologic disasters
- Effective risk communication is based on science
  - Delivery of a scientifically valid message in a comprehensible fashion, recognizing that the message will not be heard or heeded by many
- Effective risk communication includes:
  - Preparation of key messages
  - Anticipation of follow-up questions
- Risk communication requires practice

Parting Thoughts

- Risk Characterization is critical for Risk Communication
- Don’t forget to characterize the “outrage” factor
- It is OK to “not know” – it is not OK to “never know”
- “3 key messages with 3 supporting statements”
- Statements: accurate, understandable, positive, and quotable
- Be first, right, credible; show respect and empathy; promote action

Pediatric Considerations in a Chemical Emergency

Webinar #4: Pediatric Considerations in a Chemical Emergency & After Event Monitoring

Fred M. Henretig, MD, MSHP, FAAP, FACMT
Children's Hospital of Philadelphia
Philadelphia, PA

Disclosures

- **I have no financial disclosures -**
  other than a long career working in academic pediatric emergency medicine , medical toxicology and as a former poison control center medical director!

Objectives

- Describe special *pediatric vulnerabilities to exposure and effects* of chemical emergencies
- Highlight *significant differences in the management* of chemical exposures in children
  - *decontamination* issues
  - *antidotal treatment* issues
- Indicate *potential for worsened long-term consequences* of chemical exposures in childen

Chemical Injuries:
Pediatric Vulnerabilities to Exposures and Effects

- physiologic
- developmental
- psychologic
- EMS deficiencies re pediatric mass casualties

Quick toxicology review: Dose-response principal

- For most toxic exposures (eg, ingestions, injections, nasal insufflation), toxicity correlates with *total dose (mg/kg) absorbed*

- For *gases and dermal exposures*, toxicity also correlates with total dose absorbed , but this is related to both *concentration and exposure time (mg-m^3/min)*

Physiologic Factors - Respiratory

- Many hazardous gases are heaver than air, and young children are "closer to the ground", so exposed to higher concentration

- Higher basal metabolic rate, increased relative minute ventilation
  (eg, children vs adults exposed to CO)

- ***Both result in Higher Dose***

- Also- smaller airways:

increased susceptibility to respiratory irritants

Physiologic Factors - Dermal

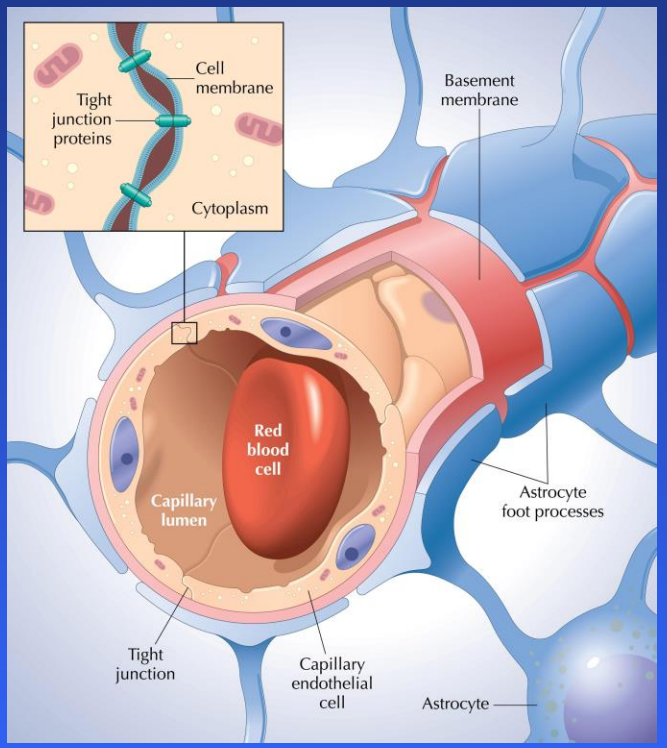
- thinner, more permeable skin (especially young infants)
  - 30% less horn cell layer
  - Less hydrolipid film
- increased BSA / mass ratio =

  Higher Dose
- *Greater potential heat loss*
- *More susceptible to caustic injury*

Physiologic factors – Immunologic / Anatomic

- **immunologic immaturity,**
- **more permeable blood-brain barrier =**

higher brain dose, enhanced neurotoxicity



From Perkins J, Rochester Institute of Technology, 2011. available at: https://www.rit.edu/spotlights/blood-brain-barrier

Developmental Factors

less capacity to escape

(without adult help)

potentially resulting in more prolonged exposure time, and thus: *higher dose*

Psychologic Factors

Likely *less coping skills with personal or witnessed injuries*
(probably somewhat dependent on premorbid factors, physical injury, parental injury or death, etc)

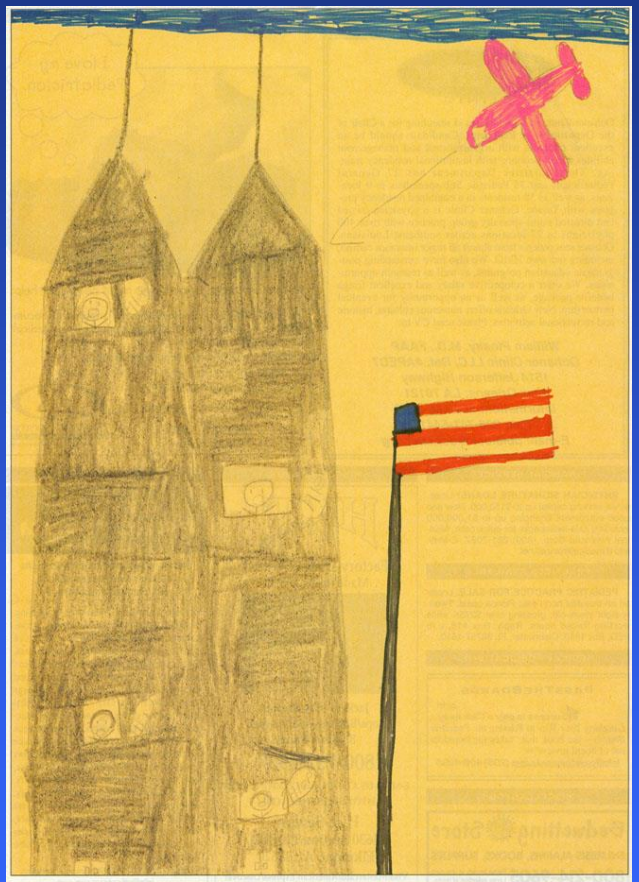


Illustration by SHANNON MURFREE, a third-grade student at Central Valley Elementary School, Central Valley, N.Y.

EMS Factors

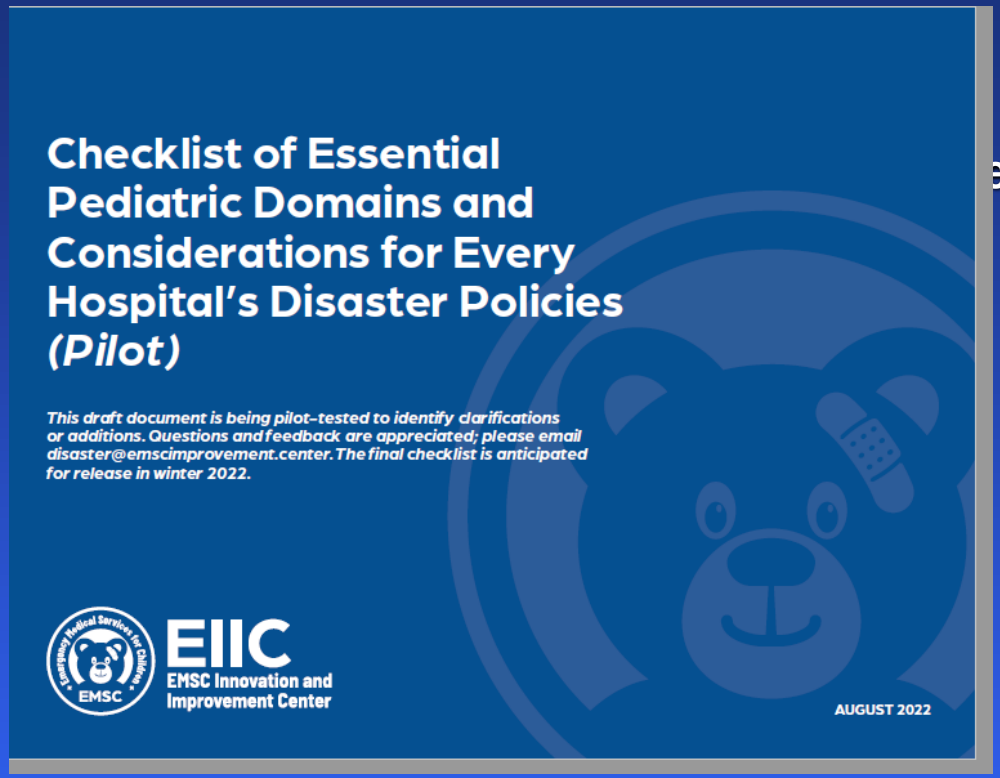
- ***procedural challenges*, esp garbed in PPE**
- ***less surge capacity* for critically ill children**
  - **routine *transfer less available***
  - ***limited pediatric bed expansion capability***

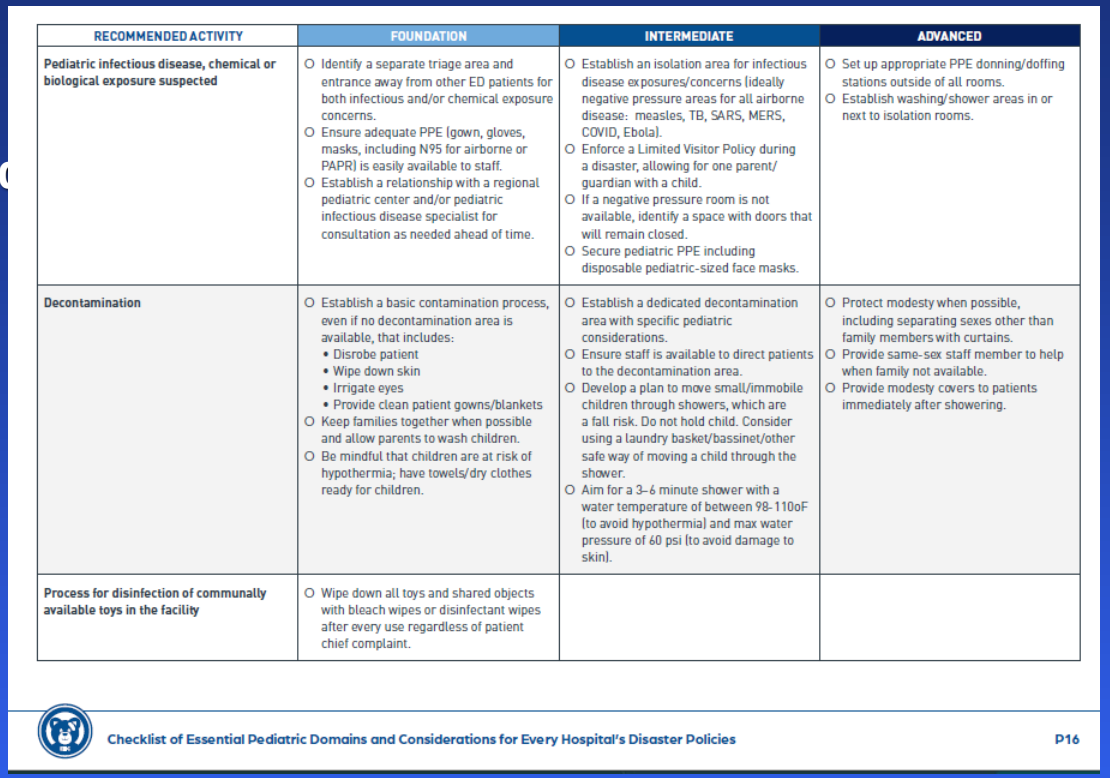
Imagine...***multiple*** pediatric patients
presenting ***simultaneously***,
requiring ***immediate*** treatment,
with ***unfamiliar*** medications,
by first responders in ***PPE***
for ***rarely encountered*** conditions

Pediatric management considerations

- Decontamination- a few pediatric issues
- Antidotal treatment considerations

Pediatric decontamination highlights - 1





RECOMMENDED ACTIVITY	FOUNDATION	INTERMEDIATE	ADVANCED
Pediatric infectious disease, chemical or biological exposure suspected	○ Identify a separate triage area and entrance away from other ED patients for both infectious and/or chemical exposure concerns. ○ Ensure adequate PPE (gown, gloves, masks, including N95 for airborne or PAPR) is easily available to staff. ○ Establish a relationship with a regional pediatric center and/or pediatric infectious disease specialist for consultation as needed ahead of time.	○ Establish an isolation area for infectious disease exposures/concerns (ideally negative pressure areas for all airborne disease: measles, TB, SARS, MERS, COVID, Ebola). ○ Enforce a Limited Visitor Policy during a disaster, allowing for one parent/guardian with a child. ○ If a negative pressure room is not available, identify a space with doors that will remain closed. ○ Secure pediatric PPE including disposable pediatric-sized face masks.	○ Set up appropriate PPE donning/doffing stations outside of all rooms. ○ Establish washing/shower areas in or next to isolation rooms.
Decontamination	○ Establish a basic contamination process, even if no decontamination area is available, that includes: • Disrobe patient • Wipe down skin • Irrigate eyes • Provide clean patient gowns/blankets ○ Keep families together when possible and allow parents to wash children. ○ Be mindful that children are at risk of hypothermia; have towels/dry clothes ready for children.	○ Establish a dedicated decontamination area with specific pediatric considerations. ○ Ensure staff is available to direct patients to the decontamination area. ○ Develop a plan to move small/immobile children through showers, which are a fall risk. Do not hold child. Consider using a laundry basket/bassinet/other safe way of moving a child through the shower. ○ Aim for a 3–6 minute shower with a water temperature of between 98-110oF (to avoid hypothermia) and max water pressure of 60 psi (to avoid damage to skin).	○ Protect modesty when possible, including separating sexes other than family members with curtains. ○ Provide same-sex staff member to help when family not available. ○ Provide modesty covers to patients immediately after showering.
Process for disinfection of communally available toys in the facility	○ Wipe down all toys and shared objects with bleach wipes or disinfectant wipes after every use regardless of patient chief complaint.		

Checklist of Essential Pediatric Domains and Considerations for Every Hospital's Disaster Policies P16

- **Available at: https://media.emscimprovement.center/documents/EIICDisasterChecklist_2022.04.11.pdf**

Pediatric decontamination highlights - 2

- All the usual (eg, Kazzi, Webinar 2) re location, timing, PPE, disrobement, bagging clothes, dry vs wet, shower technique, duration
- For showers: warm water (~ 100 F), low pressure (~ 60 psi); avoid hypothermia with warm blankets, heat lamps etc
- Handle infants carefully- very slippery! Use laundry basket, modified infant car seat, etc
- Try to keep parents nearby and involved, same sex lines for older ambulatory pts

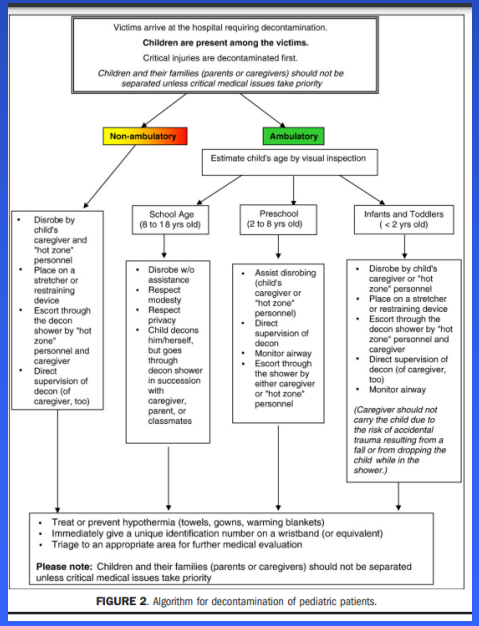
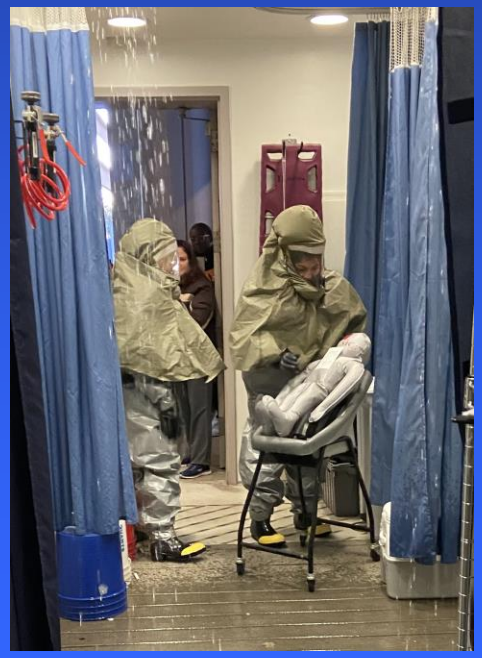


FIGURE 2. Algorithm for decontamination of pediatric patients.



From Heon and Foltin, Clin Ped Emerg Med 2009 (https://downloads.aap.org/AAP/PDF/Principles_of_pediatric_decontamination.pdf)

Antidote considerations-1

Similar to peds / em practice in general: pediatric size-based dosing, eg, cyanide and nerve agents, from NEJM, 2019

Table 3. Cyanide Antidotes.

Indication	Supportive Laboratory Findings	Medication	Adult Dose	Pediatric Dose	Comment
Smoke inhalation from house fire, with prehospital cardiorespiratory arrest or coma, hypotension	High-anion-gap metabolic acidosis, lactate level >10 mmol/liter (elevated carboxyhemoglobin level alone not typically associated with lactate level >10 mmol/liter)	Hydroxocobalamin* (sodium thiosulfate [25%]† if hydroxocobalamin not available)	5 g	70 mg/kg; maximum, 5 g	IV infusion over a 15-min period; repeat the same dose as needed in severe cases
Injury from occupational or hazmat exposure, nitroprusside, self-harm, or CWA; or suggestive toxidrome and severely ill patient	High-anion-gap metabolic acidosis, lactate level >8 mmol/liter; narrow arteriovenous oxygen saturation gap	Hydroxocobalamin* (sodium thiosulfate [25%]† plus sodium nitrite [3%]‡ if hydroxocobalamin not available)	5 g	70 mg/kg; maximum, 5 g	IV infusion over a 15-min period; repeat the same dose as needed in severe cases

The NEW ENGLAND JOURNAL of MEDICINE

Table 4. Antidotes to Cholinergic Agents.*

Antidote	Adult Dose	Pediatric Dose	Comments
Prehospital, moderate-to-severe toxic injury			
Atropine	2 or 3 autoinjectors (2 mg each; total, 4–6 mg)	Age <3 yr: 0.05–0.10 mg/kg (IM) or use autoinjector† Age 3–7 yr: 1 autoinjector (total, 1–2 mg) Age 8–13 yr: 1 or 2 autoinjectors (2 mg each; total, 2–4 mg) Age >13 yr: 2 or 3 autoinjectors (2 mg each; total, 4–6 mg)	Repeat every 2–10 min as needed to achieve rapid atropinization, then as needed for maintenance‡
Pralidoxime	2 or 3 autoinjectors (600 mg each; total, 1200–1800 mg)	Age 3–7 yr: 1 autoinjector Age 8–13 yr: 2 autoinjectors Age >13 yr: 3 autoinjectors	Repeat every hr two more times in severe cases (if logistically possible, use weight-based dosing for children <3 yr of age)†

Antidote considerations - 2

- Pre-hospital and/or MCI scenario for nerve agents
- Little experience- recommendations based on consensus guidelines
- Pediatric sized atropens, 0.5 and 1 mg for child

  (eg, ~ 0.05-0.1 mg/kg for < 2 yrs, 1-2 mg for 2-10 yrs)
- Pralidoxime- not yet- can consider use of adult AI as follows (Table made for Mark 1 kit, likely ok for Duodote):

  – age 2-7 (13 -25 kg): 1 autoinjector
  – age 8-14 (26-50 kg): 2 autoinjectors
  – Age 15 or > (>50kg): 3 autoinjectors

- What about young infants?

Weight-based dosing from multi-dose vials, or
AI discharged into sterile vial, and redrawn for IM injection
(but if no alternative, AI better than nothing)

Ann Emerg Med, Oct 2002

Long term effects and childhood toxic exposures

- Genetic factors (actual DNA sequence)
- Epigenetic factors (modification of DNA to turn genes on and off)
  - both: may be modified by toxic exposures, but latter far more likely
- Neurodevelopmental factors- eg, lead impact on childhood brain synaptic pruning and microarchitecture
- Longer life span
  - Possible increased risk of carcinogenicity
  - Reproductive effects, esp in context of endocrine disruption
  - Diseases of aging: longer exposure to toxins

References

1. Henretig FM, Cieslak TJ, Eitzen EM Jr. Biological and chemical terrorism. J Pediatr 2002; 141:311-326.
2. Chyung S, Baum CR, Nyquist A-C. Chemical–biological terrorism and its impact on children. Pediatrics 2020; 145 (2):e20193750
3. Checklist of essential pediatric domains and considerations for every hospital's disaster policies.(Pilot). EMSC Innovation and Improvement Center. https://media.emscimprovement.center/documents/EllCDisasterChecklist_2022.04.11.pdf
4. Heon D, Foltin GL. Principals of pediatric decontamination. Clin Ped Emerg Med 2009; 10: 186-194.
5. Henretig FM, Kirk MA, McKay CA Jr. Hazardous chemical emergencies and poisonings. N Engl J Med 2019; 380: 1638-55.
6. Henretig FM, Mechem C, Jew R. Potential use of autoinjector-packaged antidotes for treatment of pediatric nerve agent toxicity. Ann Emerg Med 2002; 40:405-8.
7. CHEMM website. Available at: chemm.hhs.gov/index.html
8. Bellinger DC. An overview of environmental chemical exposures and neurodevelopmental impairments in children. Ped Med 2018;http://dx.doi.org/10.21037/pm.2018.11.03