

Tear Gas is a Chemical Weapon: The Toxicology of State Violence

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STEM & Society Lecture Series

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About Me

- Kim (She/Her)
- Graduate Student Researcher, University of Pittsburgh Graduate School of Public Health Dept. of Environmental & Occupational Health
 - Peterson/Pearce lab
- Main study: chemical toxicology of mitochondrial poisons cyanide, phosphine, and azide
- Organizer with Pitt GSOC

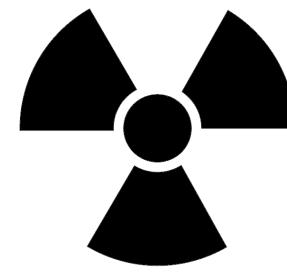


Content warning:

Potentially upsetting information including descriptions of illness, chemical weapons, and violence.

Defining Chemical Weapons (CWs)

- Difficult to define because of toxicological diversity.
- Broadly, a CW is a toxic agent used against another person (or persons) in order to inflict harm through a chemical mechanism.



- Organization for the Prohibition of Chemical Weapons (OPCW) oversees enforcement of the Chemical Weapons Convention (CWC)

Toxicology Principles



“All things are poison, and nothing is without poison, the dosage alone makes it so a thing is not a poison.”

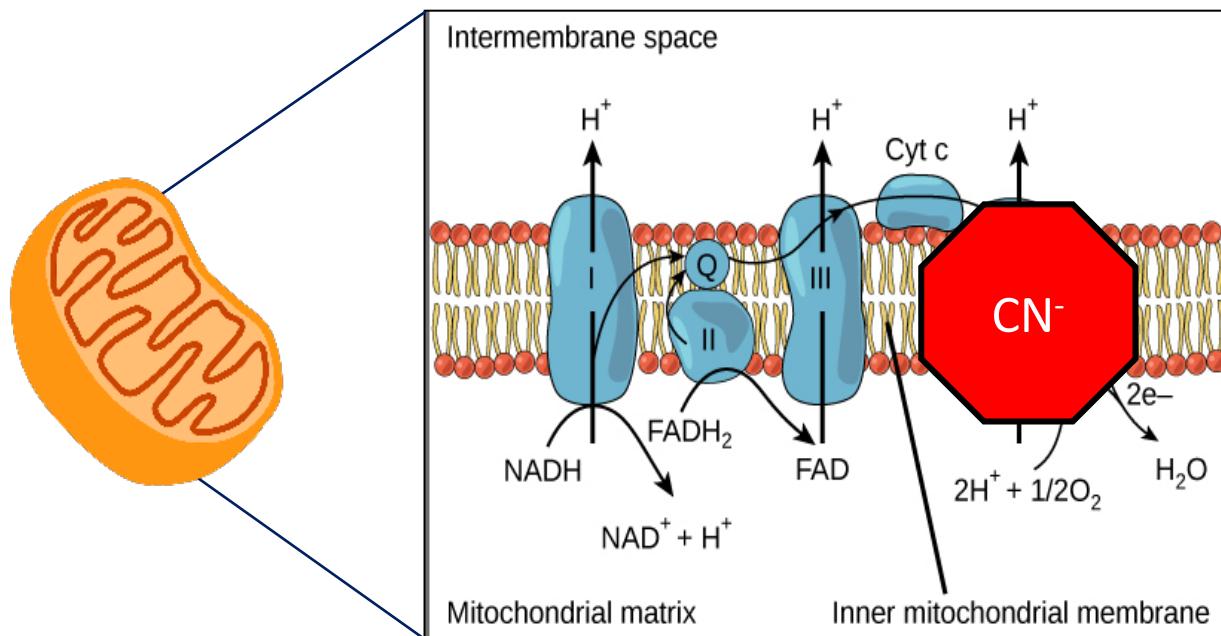
-Phillippus Aureolus Theophrastus Bombastus von Hohenheim (Paracelsus)

Toxicology Principles

- ✓ Dose-response relationships determine toxicity
 - Any chemical has the potential to be a poison.
 - Some chemicals have lower **toxicity thresholds** than others.
 - Effective Dose (ED), Lethal Dose (LD), No Observable Effect Level (NOEL)
- ✓ Exposure routes determine toxicity
 - Toxicants act on **targets**, often specific types of cells or organs. They need to make it to the target to act on it.
 - Inhalation, ingestion, dermal absorption, and direct injection all impose different conditions between a toxicant and a target organ.

Identifying Toxicity

- In order to minimize injury, illness, or death from a toxicant after exposure, the poison must first be identified.
- **Toxicdrome:** characteristic symptoms associated with a class of poisons
 - Typically reflect target or chemical mechanism.



Cyanide: inhibits oxygen turnover at mitochondrial complex IV, which leads to a buildup of unused oxygen.

Symptoms: High blood[O₂] with cyanosis, asphyxiation

Characterizing Chemical Weapons

- Chemical weapons are typically classified by target system and identified by toxidrome.
- Nerve agents: inhibit Acetylcholinesterase (AChE), leads to buildup of acetylcholine (ACh)
 - AChE is essential to nerve relaxation – inhibition leads to extended activation of muscles, motor neurons, etc.
 - Symptoms include convulsions, pupil contraction, loss of control of breathing
 - Sarin, VX, Chlorpyrifos
- Respiratory agents: inhibit mitochondrial respiration, leads to asphyxiation & organ damage
 - Symptoms include dizziness, wheezing, increased blood oxygen, cyanosis
 - Cyanide, phosphine, hydrogen sulfide

Characterizing Chemical Weapons

- Blistering agents: react with nucleic acids and proteins to damage tissues
 - Symptoms may be late-onset
 - Mustard gas (SO_2), lewisite
 - Typically non-lethal but can lead to chronic illness and injury
- Irritants & Lacrimators: irritate pain receptors and mucous membranes
 - “Tear gasses”
 - Symptoms include lacrimation, burning, coughing and shortness of breath
 - Typically non-lethal

CWs Throughout History

- Pre-industrial use
- WWI – first mass use
 - Blistering agents
 - Respiratory agents
- 1925 Geneva Protocol
- Second-Gen CWs – Sarin, Tabun
 - Developed but not used extensively
- WWII – Zyklon B (HCN)
- Cold War – stockpiling and development
 - V agents & NOVICHOK
 - Hallucinogens
 - Irritants



Golden poison frog (*P. terribilis*)



CWs Throughout History

- Vietnam War – Agent Orange & Tear Gasses
- 1993 – Convention on the Prohibition of Development, Production, Stockpiling, and Use of Chemical Weapons and their Destruction
 - Effective as of 1997
 - Currently signed by 193 state entities
- 1994-5 Aum Shinrikyo Attack – First non-state terrorist CW attack
 - Multi-instance Sarin release



Current Context

- Focus on risk of international terrorism
- Isolated, individual attacks
- 2013 Damascus, Syria
 - 3,600 patients with neurological impacts visited hospitals within 3 hours of attack
 - >80% biomedical samples from patients tested were positive for sarin and its metabolites
 - Difficult to attribute attack to any specific group but it is highly likely that sarin came from government supply.

“Non-lethal” Chemical Weapons

- Used for control and dispersal of groups and individuals
 - Temporary incapacitation
- Riot Control Agents (RCAs) are prohibited in times of war by the CWC but are permitted for domestic use.
 - RCA stockpiling is allowed and reported to OPCW
 - As of 2011, at least 110 signatories reported stockpiling riot control agents.



Mohamed CJ, CC BY-SA 3.0 via Wikimedia Commons

Tear Gasses

- Designed so that under ideal environmental conditions, effective dose is sub-lethal for an average adult.
- Oleoresin (**OC**) – Cayenne pepper extracts, 1-15% capsaicin TRPV1
 - Synthetic version called PAVA
- Ortho-chlorobenzylidene malonitrile (**CS**):
 - CS2/CX more potent version, rely on environmental persistence
- Dibenzoxazepine (**CR**)
- Chloroacetophenone (**CN**)
- Acute, low-dose exposure leads to lacrimation, eye muscle contraction, burning sensation lasting approximately 30min.

TRPA1

“Ideal Conditions”

Designed so that under ideal environmental conditions, effective dose is sub-lethal for an average adult.

Below LD
Hopefully LOEL
No NOEL identified
Population variation
Determined by environment

150lb
Male
18 or older
No underlying conditions

70°F
Low humidity
High ventilation
Distanced from individuals
Single administration

Philadelphia protesters gassed on I-676. leading to ‘pandemonium’ as t

by Justine McDaniel, Ellie Rushing, Sean Collin

Police gassed students on second-floor patio of residence hall during G-20

By Lindsay Carroll
OCTOBER 20, 2009

Acute Exposure

- High dose, sub-lethal: coughing, sneezing, vocal cord spasm, chest tightness, vomiting, corneal burns, swelling, first, second, and third degree burns, bronchospasm, asthma exacerbation, miscarriage
- High dose, lethal: Pulmonary edema
- Canister-related injuries
- Opportunistic respiratory infections

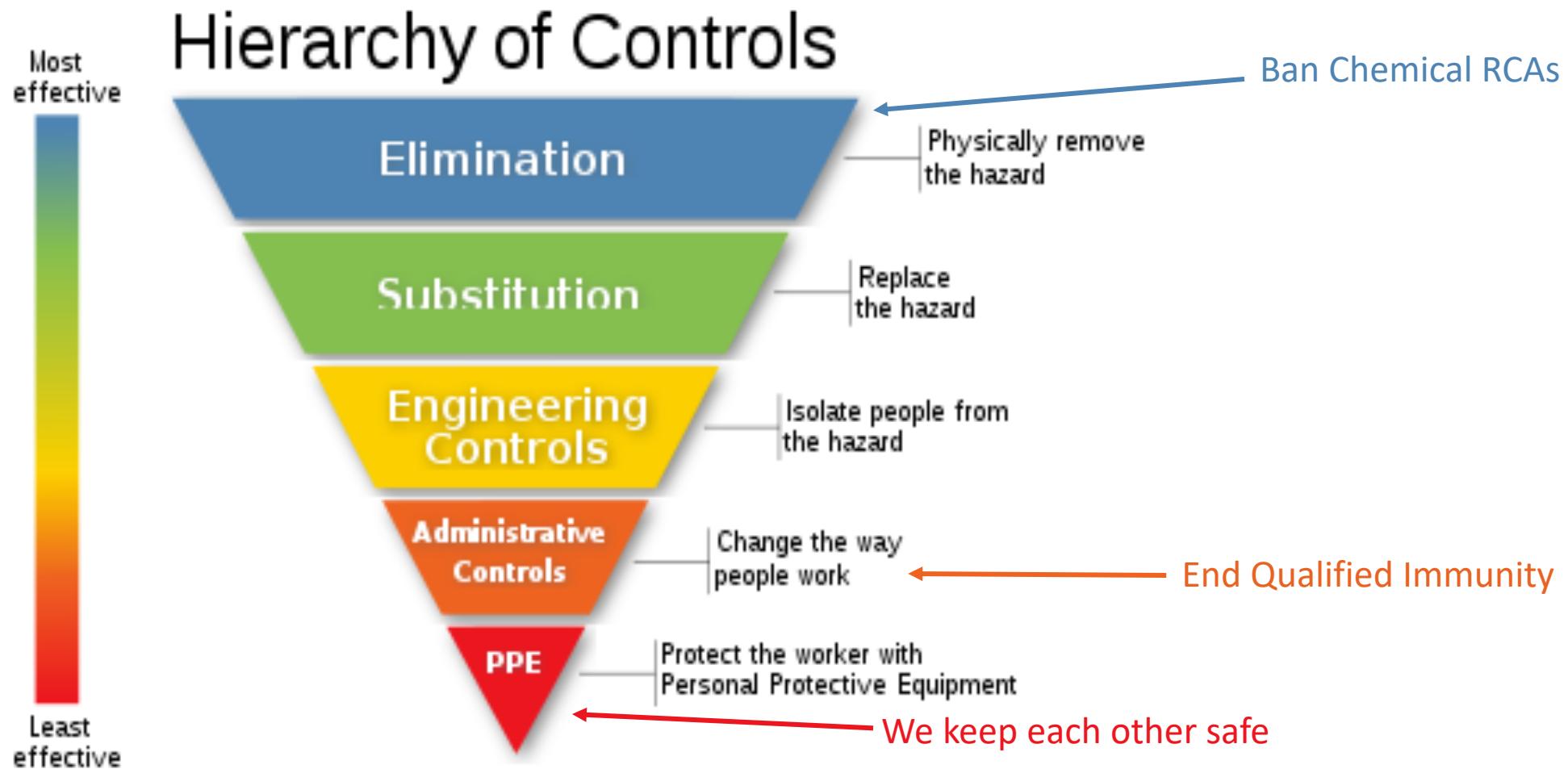


We don't know that tear gas is safe.

There is a concerning lack of research into the safety of lacrimator RCAs.

- Limited to animal research and retrospective human studies
 - Case reports
- Right now, estimates are the best we can do.
- Outdated research often informs municipal regulations
 - Himsworth Report, 1971
 - Beswick et al., 1972
- How might tear gas exposure interact with other respiratory illness?
COVID-19?

Minimizing and Eliminating Risk



Treating Tear Gas Exposure

1. Call for a street medic.
2. Distance yourself from the exposure site
 - Get to higher ground if possible
3. Remove as many layers of clothes as possible
4. Flush the eyes repeatedly with water, preferably from a pressurized source for up to 15 minutes.

~~Baking Soda~~

~~Milk~~

~~Lemons~~

~~Shampoo~~



Treating Tear Gas Exposure Cont...

5. When able, wash skin with soap and water.
6. Launder clothes, potentially multiple times.
7. Document symptoms
 1. What symptom
 2. When did it start?
 3. How long did it last?
8. See a medical professional if symptoms persist longer than a few days, you have extended shortness of breath, or other symptoms of respiratory illness.
9. Check in with others.

Conclusions

- Tear gasses are chemical weapons
- It is broadly accepted that chemical weapons are unethical to use.
- Tear gasses have not been proven to be safe.

What can I do?

- ✓ Support local initiatives to ban chemical RCAs and “less lethal” weapons
- ✓ Share evidence-based information about how to treat tear gas exposure
- ✓ Continue to demand justice for victims of police violence



www.blacklivesmatter.com

Pittsburgh Coalition to End the Deadly Exchange
www.deadlyexchange.org

Dr. Juniper L. Simonis – ecotoxicology researcher
[@JuniperLSimonis](https://twitter.com/JuniperLSimonis)

Tear Gas From the Battlefields of World War I to the Streets of Today
By Anna Feigenbaum, 2017
www.versobooks.com



Riot Ethics:
PROTEST, PROPERTY, AND THE POLITICS OF NON-VIOLENCE

This summer's uprisings against police brutality have reignited the perennial debate regarding the ethics of protest, property destruction, and looting within non-violent political movements. What can we learn ethically from the ongoing social movements against police violence?

October 21, 2020 | 6 p.m.-7:30 p.m. via Zoom

Registration for this event is required.
Sign up at bit.ly/riotethics

SPEAKERS

DR. AMARYAH SHAYE ARMSTRONG
Assistant Professor of Race in American Religion and Culture at Virginia Tech

DR. BENJAMIN S. CASE
Independent scholar, Jews Organizing for Liberation and Transformation [JOLT]

DR. HATEM M. HASSAN
Independent researcher, writer, and educator

CARLOW UNIVERSITY *the* **ATKINS CENTER FOR ETHICS**

Thank you!

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