

# The Next Step after Detection:

# Removing lead (and other toxic metals) from skin: why soap and water is not enough

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Development of methods to measure, decontaminate skin from Pb

- NIOSH Full Disclosure Colorimetric Sampling Method
- 2. NIOSH Handwipe Method for Removing Lead from Skin
- 3. Research-2-Practice Commercialization, Licensing







## Background and Process

- . <u>Research (Field)</u>: Pb-acid battery plants, trash-to-energy plant dermal exposures
- Invent (think): Hand wipe colorimetric disclosing method for presence of lead
- Research (Iab): Dermal exposures to Pb and skin decontamination
- <u>Research (lab)</u>: Possible formulations, experiments and trials
- Invent (think): Hand wipe removal method for lead and toxic metals



Figure 1 HETA 94-0268 Standard Industries San Antonio, Texas March 27-31, 1995



http://www.cdc.gov/niosh/hhe/reports/pdfs/1994-0268-2618.pdf



# Results: Peri-oral Wipe Samples

9 workers, 3x per day

#### Figure 3

HETA 94-0268 Standard Industries San Antonio, Texas March 27-31, 1995

#### Pb in Skin Wipes Around Mouth

Period 1 = Arrival at Work, 2 = Before Lunch, 3 = End of Work





Figure 5 HETA 94-0268 Standard Industries San Antonio, Texas March 27-31, 1995

#### Distribution of GFAAS Saliva Results by Period and Day



GFAAS= Graphite furnace atomic absorption spectroscopy

HETA 94-0268-2618 Standard Industries

### Results: Hand wipes before & after eating Lead battery plant #1

### Pb (µg)

Pb





# Visualizing 500 $\mu$ g of PbO

## What does 500 µg of PbO look like?

...rubbed onto palmer surfaces?

### Results: Hand wipes before & after eating Lead battery plant #2

## Pb (µg)

Pb



# Results: 30 second hand wipes (lunch)

Waste-to-Energy Plant, PA.

Pb (µg)

Pb





HETA 91-0366-2453 Delaware County Resource Recovery Facility. Esswein, E, Tepper, A.

http://www.cdc.gov/niosh/hhe/re ports/pdfs/1991-0366-2453.pdf

### Worker Number

## Battery plant #1 lead-contaminated inanimate Pb surfaces Steam Table Doorknobs 140 & 320 90-160 $\mu g/ft^2$ $\mu g/ft^2$ Railing 3700 μg **Cafeteria Tables** 140-770 9-130 $\mu_{8}/12^{2}$

**Cutting Boards** 

### Battery plant #1: Pb-contaminated table tops: Paired wipes from 7 tables: µg Pb/ft<sup>2</sup>

Pb (µg)

Pb





Student's t-test, paired wipes: P=0.2 (2-tailed)

## Conceive: Colorimetric Disclosing Method for the Presence of Pb: *Full Disclosure*



Pb



plaque stained teeth



no plaque on teeth



Disclosing tablets

Plaque stained by tablets



NMAM 9106 US Patent 6,248,593 82 **Pb** 204.2

# Need: Hand Wipe Disclosing Method for the Presence of PB

#### NIOSH Alpha Version



Research

### Commercially Licensed Product



**Practice** 

NMAM 9106 US Patent 6,248,593

# Visualizing Contamination

Pb



# **Pb**

# Visualizing Pb contamination from wipe samples

## **Negative control**

### **Positive Sample**

# Removing Toxic Metals from Skin: Hand Washing or Decontamination?

To effectively <u>decontaminate</u> skin from Pb and other toxic metals there is...

- No specific OSHA guidance
- No scientific performance criteria for available products

Need to understand:

Pb

- How metals bind or adhere to skin
- What's required to remove metals from skin



# **Effective Dermal Decontamination** A Systems Approach



# Dissolution of elements in $H_2O$



**Pb** 

# The Takeaway

Pb

Solubility

#### NIOSH formulation optimizes solubility at a similar pH to skin





# Surfaction of elemental cations Pb<sup>+2</sup>

#### Isostearamidopropyl morpholine lactate (ISML)



#### **Desorption of Pb from Soil**

ISML (mole/L)		рН	%Pb
	0.1	3.97	82.0
	0.05	4.0	75.0
	0.025	4.16	72.6
	0.0125	4.42	65.0
	0.00625	4.86	61.0

Pb

By forming water soluble metal citrate complexes, citric acid can effectively extract several elements including Pb.





### Mechanical Removal Engineered cloth

### Engineered cloth provides

- Increased surface area
- Friction
- Makes the wipe easier to handle





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## Stuck on you-size and shape matter



Very small and sharp PbO particles become lodged in the skin making them hard to remove with soap and water.



## Stuck on you-size and shape matter

Pb

Photo of a fingerprint with flurogenic beads shows how lead gets trapped in the topography of skin



### Pb Removal from skin with Different Cleansers Non-blinded

Pb



Cleanser

### Pb Removal by Different Cleansers Non-blinded

Pb



Cleanser

# Beta Version: NIOSH Wipe

Pb

## **Before Using Wipe**





n = 9 2,338 μg Pb effective skin loading



n = 9 2,338 μg Pb effective skin loading



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### NIOSH Design Intent: Hand Wipe Removal Method for Toxic Metals

- ✓ Highly effective
- A system of decontamination
- ✓ No sensitizers (SLS)
- ✓ No abrasives
- ✓ No EDTA





### Licensed and commercialized products

# Summary Points

Pb

- 1. NIOSH 9105: Lead in Dust Wipes (colorimetric method)
- 2. Removal toxic metals: hand washing or decontamination?
- 3. Soap and water: surfaction and mechanical removal
- 4. Don't assume decontamination effectiveness
- 5. pH adjustment, chelation, engineered cloth enhance decontamination
- 6. Evaluate and confirm

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The findings and conclusions in this presentation are those of the author and do not necessarily represent the views of the National Institute for Occupational Safety and Health



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## Questions?

