Science For A Better Life

Risk Assessment And Dermal Protection Today

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Topics To Be Covered

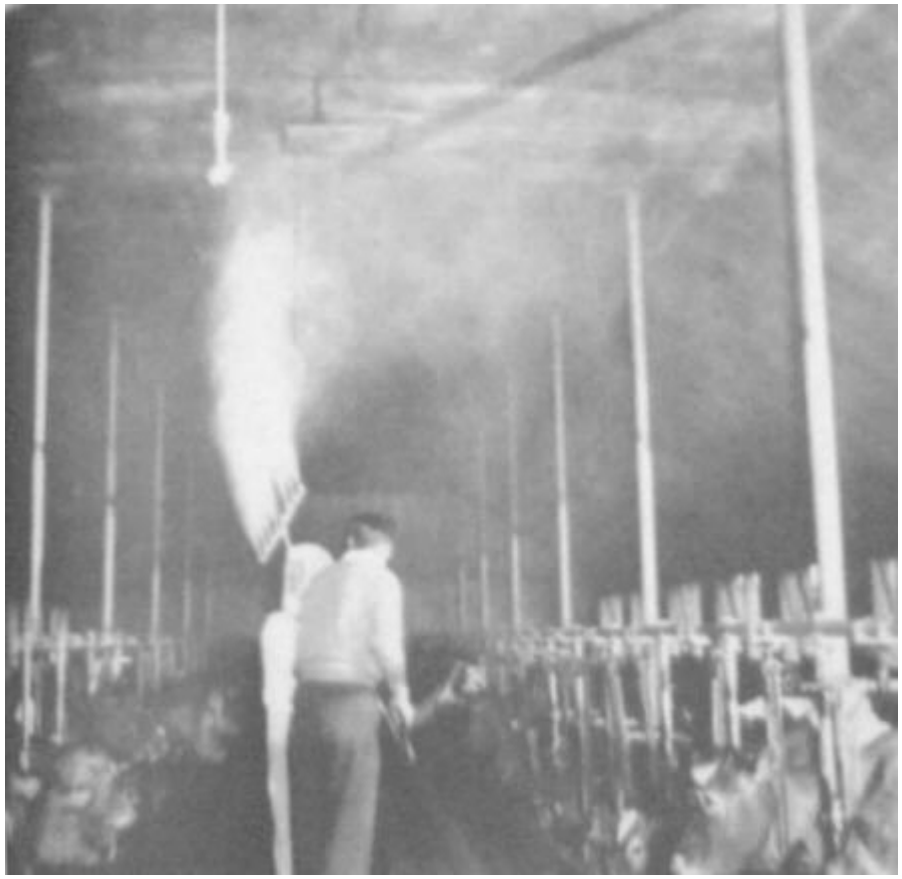
- A Brief History
- Measuring Exposure
- Assessing and Managing Exposure and Risk
- The Good, The Bad, and The Ugly

A Brief History

The First Man-Made Pesticides

Advantages

- The first synthetic pesticides are DDT, Aldrin, Dieldrin, BHC, and 2,4-D
- They all appear to have low mammalian toxicity
- Acute illnesses are rare
- Little concern for exposure



The Organophosphates

- Insect resistance to DDT leads growers to start using the new organophosphate insecticides
  - Ethyl Parathion is registered in the US in 1948
  - Unlike DDT and others these insecticides are acutely toxic
- In the 1950's the rise of worker illness increases awareness of need for controlling exposure
- Durham and Wolfe note a cyclical nature to parathion poisoning among apple sprayers
  - How to measure exposure?

The First Sprayer Exposure Studies

- 1954 sees the first agricultural sprayer exposure study
- Conducted by Batchelor and Walker of the US Public Health Service to determine health hazards of parathion spraying in Washington fruit orchards
- They use cotton gauze patches attached to the workers to capture spray residue and place the gauze in respirators to capture breathable residues

The First Sprayer Exposure Studies

- 1959 sees Durham and Wolfe conduct the first indoor exposure spraying study with DDT
- They use the patch method of Batchelor and Walker
- For the first time the effect of protective clothing is evaluated for the ability to reduce exposure
- Passive dosimetry is the norm today and the exposure studies have been standardized to permit comparisons

Things May Change But They Stay The Same

1873 Johnson Sprayer

Modern Groundboom Sprayer

Equipment May Have Improved

But The Principles Of Exposure Remain The Same

Measuring Exposure

Exposure Is Where It Is At

- A risk assessment evaluates BOTH the hazard and exposure – Risk = Hazard X Exposure
- Knowing the toxicology of a product is important BUT YOU CANNOT CHANGE IT – Only refine it
- Exposure is the part of the risk equation that we can control
- Formulation, methods of application, application rates, protective clothing and equipment all affect exposure potential
- Exposure assessment is where the action is with the regulatory agencies

Occupational Exposure

- Occupational exposure assessment involves estimating the exposure that occurs during job-related activities with pesticides
  - Handlers who mix, load, and apply pesticides
  - Workers who re-enter treated fields to weed, thin, prune, pick the crops, etc.
- The dermal and inhalation routes of exposure are important – not oral

Occupational Handlers

- Three major inputs
  - Application rate (lb a.i./acre) usually obtained from the label (maximum application rate) or sometimes from survey information
  - Area treated (acres/day) obtained from agricultural census data and dependent on the method of application and also the crop
  - Unit exposure (µg/lb a.i. handled) obtained from exposure studies and appropriate generic exposure databases developed from multiple studies

Handlers Exposure Concept

- Handler exposure is less dependent on chemical structure, more dependent on the physical processes of mixing and loading, the type of formulation, Personal Protective Equipment (PPE), packaging, application equipment, etc.
- This permits the development of generic databases such as the Pesticide Handlers Exposure Database (PHED) or the Agricultural Handlers Exposure Task Force (AHETF) data

So How Do We Measure Exposure?

- Remember Batchelor and Walker or Durham and Wolfe?
- Since the early 1950's exposure studies have been conducted
- The methodology is pretty much standardized globally
- And the methodology is?

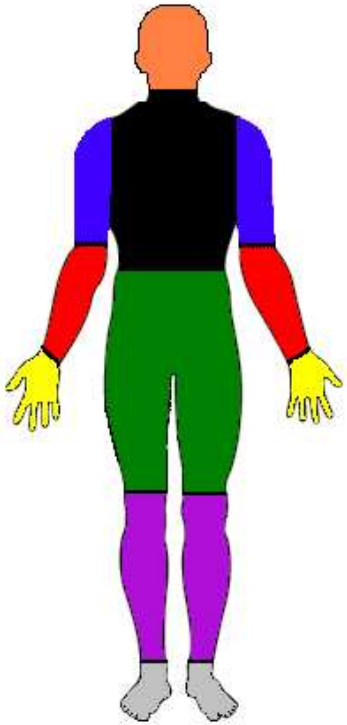
Conduct of Exposure Studies

- Dermal Exposure:
  - Outer work clothing – usually not analyzed in NA
  - Inner full-body dosimeter – exposure under clothes
  - Hand washes
  - Face/neck wipes
  - Measuring the residues of the inner dosimeters under clothing or PPE lets us know the exposure under actual use conditions
- Inhalation Exposure:
  - Inhalation cartridge: filter and resin

Passive Dosimetry

Whole body dosimeter (WBD) is divided into 6 sections

Typically worn under the clothing



Front torso	Upper arm	Upper leg
Rear torso	Lower arm	Lower leg

100% cotton

Laundered prior to use

Passive Dosimetry

Hand wash samples are collected after PPE and outer clothing are removed by the worker using a total of 500 mL of a 0.01% Aerosol® OT solution. Done before removing WBD to avoid contamination.

Hand washes are conducted prior to each break.

The worker scrubs their own hands for a minimum of 30 seconds.

Passive Dosimetry

Face and neck wipes are conducted with gauze pads moistened with approximately 4 mL of a 0.01% Aerosol® OT solution.

The workers face/neck (front & back) is wiped with the sponge for a total of two dermal wipes per sample.

Inhalation Exposure Monitoring

Inhalation exposure monitoring is conducted with OSHA Versatile Samplers powered by air sampling pumps calibrated at approximately 2 lpm.

Exposure period = pump time

Examples of Studies – Open Pour

Tank residues can lead to increased front of body exposure

Soil Incorporation With Open Cab

Yellow Clothing

After 8 hours

Assessing and Managing Exposure and Risk

So What Do We Do With The Data?

- The data from the dermal and inhalation exposure studies are used to estimate unit exposure for handlers
- Use information is combined with the exposure data to get daily exposure estimates
- Exposure = Unit Exposure x AR x Area Treated ÷ BW
- µg/kg bw/day = µg/lb a.i. x lb a.i./A x A/day ÷ kg bw

The unit exposure comes from exposure studies and generic data bases

The AR or Application Rate comes from the product label

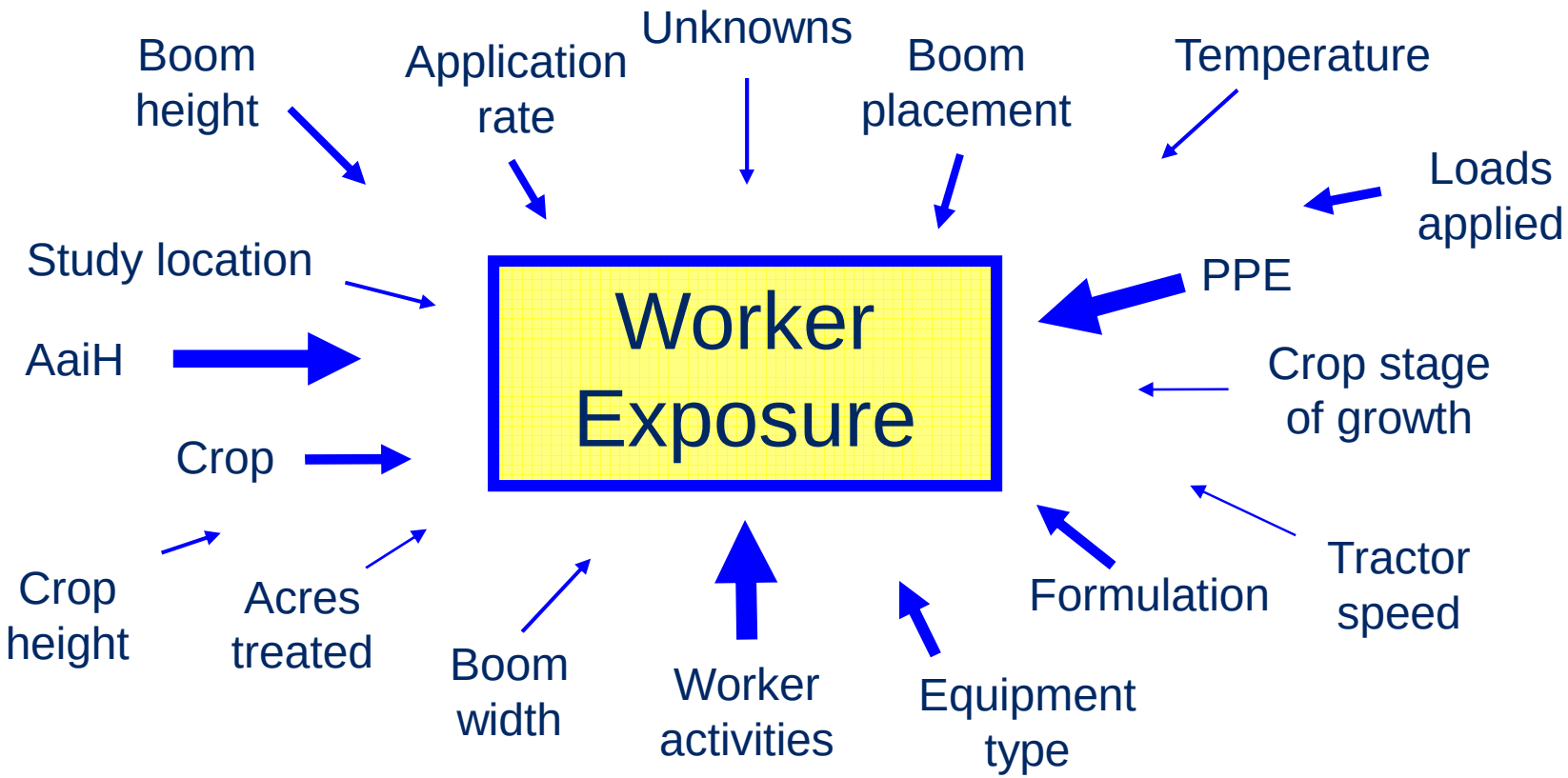
The area treated/day comes from surveys or regulatory agency defaults

The body weight comes from survey data and is an agreed default

Handler Exposure Is Variable

- Understanding the **large variability** in how much exposure can occur is **essential** to understanding **potential risk**
- Open cab airblast applicator example (15 replicates)
  - Mean exposure = 2,700 µg/kg a.i. handled
  - Minimum measured exposure = 8 µg/kg a.i. handled
  - Maximum measured exposure = 20,600 µg/kg a.i. handled
  - The exposure is skewed (lognormal distribution)
- Why so much variability?

The exposure observed for worker is a combination of all of the factors during the exposure period.



Managing Risk

- We manage risk by managing exposure
- Label Based Mitigation to Reduce Dermal Exposure
  - Requiring **feasible** protective clothing
  - Engineering controls such as enclosed cab tractors
  - Reducing application rates if efficacy remains
- Product Stewardship and Training
  - The exposure studies provide insight to where dermal exposure occurs and work practices that are not the best
  - Incorporate our information into training

What Do The Data Tell Us?

- The data from the exposure studies tell us which methods of application have the greatest exposure potential
  - Airblast > Groundboom > Aerial
- The data inform us about which body areas receive the bulk of the exposure for different methods of application
  - Head for open cab airblast or back for backpack sprayers
  - Permits focused use of PPE to reduce exposure
- The study data permit comparison of observed work practices with resultant exposure
  - We have observed some eye openers
  - Useful information for training programs

Liquid Formulation Mixing/Loading Example

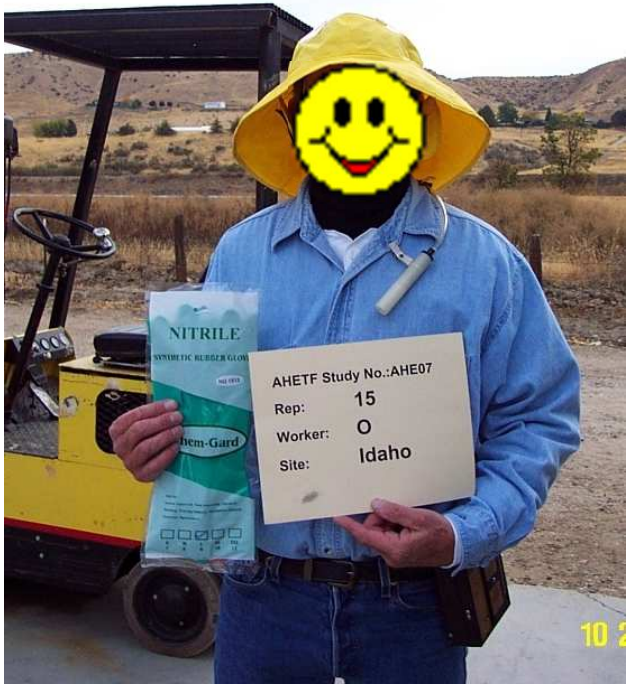
- Open pour mixing loading with long-sleeved shirt, long pants, and NO protective gloves has an average dermal exposure of 220 µg/lb a.i.
- The use of protective gloves reduces the average dermal exposure to 37.6 µg/lb a.i.
- Closed loading systems reduces this exposure further to an average dermal exposure of 1.44 µg/lb a.i. for returnable containers and 1.15 µg/lb a.i. for non-returnable containers
- The risk assessment informs what level of protection is necessary

The Good, The Bad And The Ugly

The Good – Simple PPE

Majority of exposure during open cab airblast exposure is to the head.

Rain hat reduces dermal exposure 7-fold and the rainsuit 11-fold



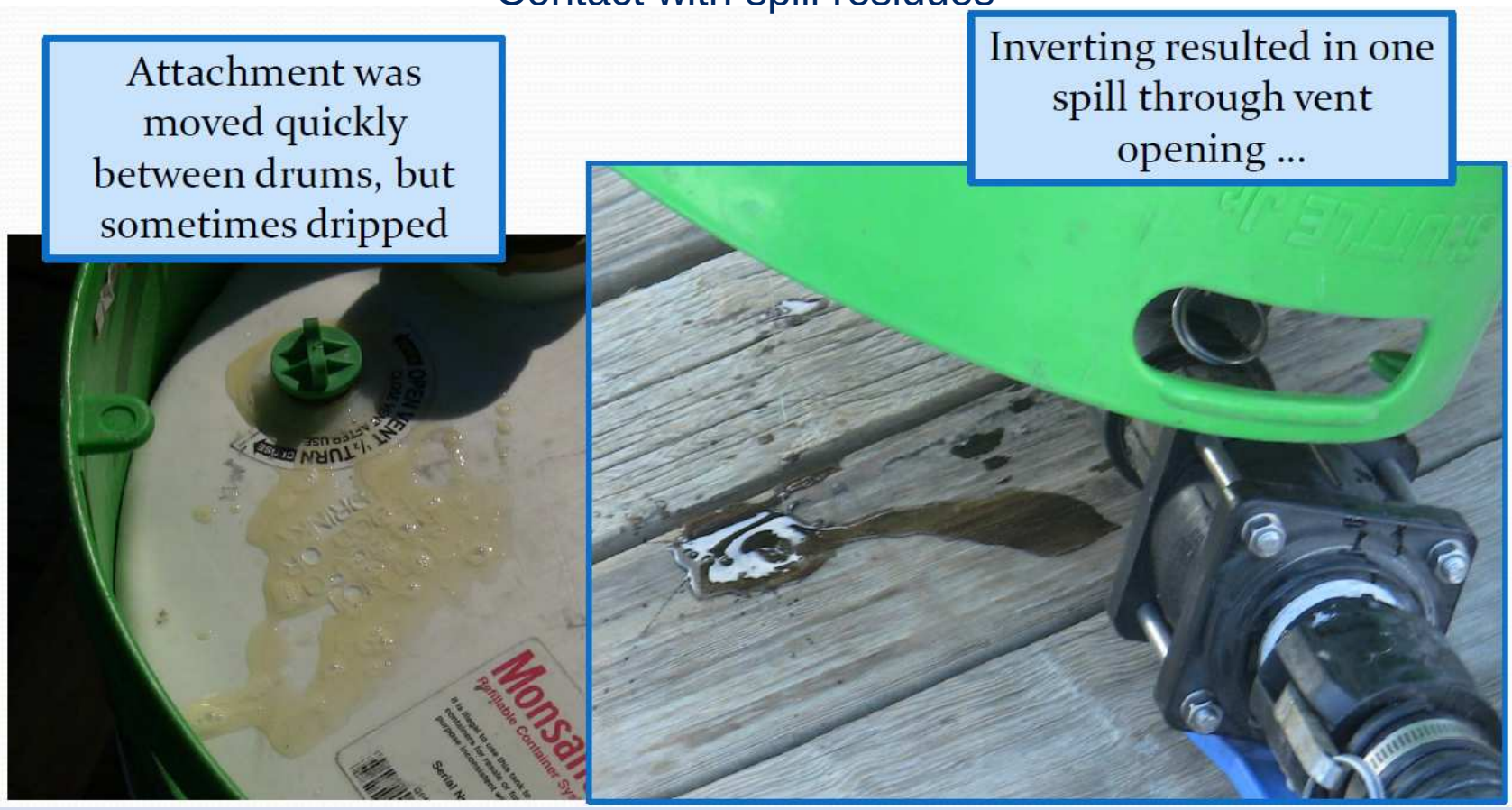
The Good - Technology

Reduction of drift and exposure potential

The Bad – Work Practices

This led to measurable increase in dermal exposure

Contact with spill residues



The Ugly – Negation of Engineering Controls

Dermal exposure was greater than pouring from a bag

Downright Ugly – Puff The Powder

However, the placement of the WSP in baskets at the opening to the spray tank was observed for some orchard applications in the Northeast.

Analyzed dosimeters for two mixer/loaders confirmed high exposure potential.

Summary

1. Agricultural exposure and risk assessment developed from the need to address pesticide illnesses observed in the 1950's
2. Dermal exposure is generic and has permitted the development of robust exposure databases that provide a focused understanding of exposure potential
3. Exposure mitigation can be achieved through regulatory means by placing PPE, engineering controls, or rate limitations on the label
4. Observations of work practices and effect on dermal exposure can be incorporated into product stewardship and training to improve work practices and reduce exposure

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Thank you!