

Source-specific decision rules to assign historical occupational lead exposure in a population-based case-control study

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Occupation information in population-based studies

- Chemicals, sunlight, shift work, physical activity, noise
- Subject-reported
- **Occupational histories**
 - Job title, employer, tasks
 - Lifetime: Median 6 jobs/subject (U.S.)
- **Exposure-oriented questionnaires (modules)**
 - Tasks, materials, chemicals
 - Systematic capture of within-job, between-subject differences
 - e.g., modules for welders, farmers, health professionals

Decision rule-based exposure assessment

Construction worker module

If: Operated diesel-powered heavy equipment at construction site and task frequency ≥ 20 hr/week and year job started ≥ 1950

Then, diesel exposure estimates:

Probability = High

Intensity = Medium

Frequency = High

■ Transparent

- Link exposure decisions to questionnaire responses
- Others can review
- Can update, sensitivity analyses

■ Reliable, Valid

- Multiple experts
- Anchor with measurements
 - e.g., published data, inspection data

■ Efficient

- Apply in other studies
- Reduce exposure assessment task

Decision rule-based approach vs. IH job-by-job review

- Replicates job-by-job expert review
 - Example: Diesel (Pronk...Friesen, OEM 2012; Friesen et al. AOH 2013)

Comparison group

Weighted kappa

Expert vs. expert

0.5-0.8

Single expert vs. decision rule

0.6-0.8

Expert average vs. decision rule

0.8

Ten categories of lead exposure – identified in literature review



Grinding metal



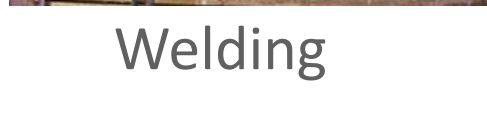
Soldering



Pigments



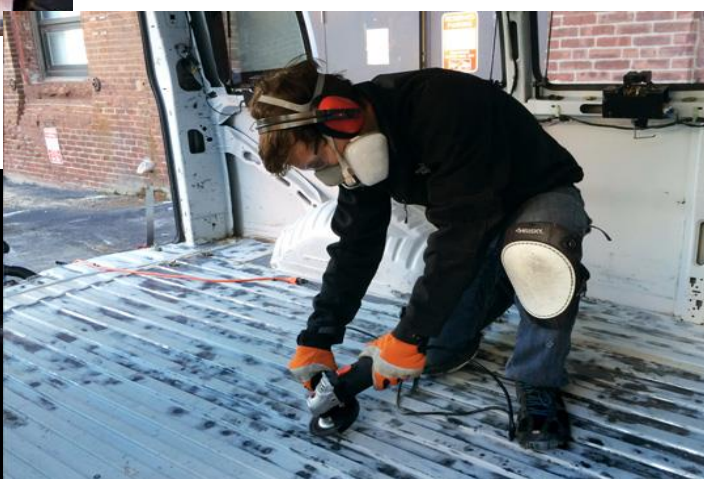
Printing



Welding



Guns/firing range



Paint & Strip paint



Leaded gasoline



Engine repair



Other industry, incl. battery

Lead assessment in the US Renal Cell Carcinoma Study

- 1217 cases and 1235 controls
- Lifetime occupational history (job duration \geq 1 yr)
 - 11,991 jobs, 1939-20074
- 36 job and industry modules
 - Task frequency
 - Max 5 modules per participant
 - Received by 59% of jobs
 - Generic Exposure Module: 40% of jobs

Generic exposure module (40% of all jobs, 4749 jobs)

	% Answered Yes	Hours per week if yes percentile			
		25 th	50 th	75 th	
	(%)	25 th	50 th	75 th	
Chemicals to clean or degrease metal or plastic parts?	12	0.5	2.0	6.0	High sensitivity
Soldering?	4.4	0.3	1.0	4.0	
Welding, burning, or cutting metal?	3.8				Mostly infrequent tasks
Weld or flame cut?	2.5	0.2	1.0	6.0	
Braze?	1.3	0.04	0.5	1.0	
Handling pigments, dyes, colored powders, or dust?	6.7	0.3	2.0	12	
Grinding or machining metal parts?	4.9	0.3	2.0	6.0	
Use a gasoline powered piece of equipment?	4.5	1.0	6.0	24	

Assign source-specific exposure metrics

- Allow multiple sources per job
 - E.g., laborer who paints, welds, uses gasoline-fueled equipment
- Simplify rule building
- Team-based decision rules:
 - Source-specific probability, intensity, frequency
- Aim: Aggregated metrics for 'total lead' metrics

Hierarchical assignment process: Probability & Frequency

1. Subject-specific module information
 - Task frequency information from job/industry modules
 - Used to derive job-group medians
2. Subject-specific occupational history information
 - Tasks identified in occupational history free-text
 - Assigned job-group medians from those with module responses
3. Expert review
 - Industry-specific modules
 - Rare scenarios, heterogeneity, non-specific questions (e.g., pigments)
 - Discordance

Source-specific intensity

- For jobs with medium- or high source-specific probability
- Tasks with frequencies <0.5 hr/week: reduced P_{source} to low
- Blood lead measurements
 1. Meta-regression of welding and painting activities
 2. Unpublished meta-regression, firing range exposures
 3. Weighted arithmetic means from literature review
 4. Expert judgment based on similarities
- Annual source-specific estimates
 - Incorporated time trend (<1975 held at 1975 levels)
 - Subtracted median environmental exposure (NHANES)
 - **Base Intensity * Time Trend Modifier * Frequency of Task**

SOURCE	Probability of exposure, Employed person-years	
	MEDIUM %	HIGH%
Grinding metal	2.3	0.6
Gasoline	2.5	12
Welding	1.6	1.4
Paint	0.8	3.5
Engine repair	2.2	
Solder	0.1	4.1
Guns	0	0.3
Printing	0.1	0.4
Pigments	<0.1	0
“Other”	0.7	0.2
Highest	5.1	19

Medium or high probability:

- One source 16%
- Two sources: 3.7%
- Three sources: 1.3%

Summary

- Transparent, minimized expert review
- Simplified decision rule building process
- Incorporated free-text information efficiently
- Data-driven
 - Job-group medians for frequency
 - Published data for intensity
- Sensitivity analysis possible



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Exposure sources for high probability ($\geq 80\%$)

Source ^a	Task or Job ^c
Paint	Job = Painter and/or Task = Paint, strip paint, use/mix/test paint
Gasoline pre-1995	Job = Police/security, Military occupations, driver, gasoline station attendant, or mechanic and/or Task = Driving, bystander to vehicle exhaust, fill vehicle with fuel, use gasoline-powered equipment
Grinding metal	Task = Grind or machine metal that contained lead
Solder	Task = Solder, or work near others soldering
Welding	Task = Welded leaded steel, brass/bronze
Guns	Job = Military or Police