



Identification of beryllium exposure in primary metal industries and aeronautics plants operating a foundry : the Quebec experience

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Study collaborators (report)

- Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSST)
- Ministère de la santé et des services sociaux (MSSS)
- Centres locaux de services communautaires (CLSC)
- Directions régionales de santé publique (DRSP)



Background

- Multiple partners agreed on a *Concerted Action Program* aimed at reducing beryllium exposure in the workplace (ASP, CLSC, CSST, DRSP, INSPQ, IRSST, MSSS)
- Multifaceted stepwise program focussing on one economic sector at a time
- Program started with plants operating a non ferrous foundry or smelter

Study objectives



- Identification of workplaces where beryllium *is* or *was* used
- Estimation of workers' exposure levels in order to plan for appropriate preventive measures

(report:subset of Concerted Action Program activities)



Methods - 1

- Local public health teams (39 CLSCs) : visits from October 2001 to April 2003
- Activities:
 - Information gathering in 123 plants (standardized questionnaire + MSDS): industrial processes & Be sources
 - Dust wipes or settled dust samples to confirm presence of the metal
 - When dust wipes $\geq 0.2 \mu\text{g}/100 \text{ cm}^2$ of Be (8%) or settled dust samples $\geq 10 \text{ ppm}$ (21%) \rightarrow personal air sampling



Methods - 2

- Dust wipes (n=1,958)
 - Delineated surfaces (10 x 10 cm²), wet cellulose filter (derived from NIOSH 9100 method for Pb dusts)
- Settled dust samples (n=276)
 - Sealed plastic bags, at least 1.5 m (5 feet) above ground
- Personal air sampling (n=710)
 - Mixed cellulose ester filter, 1.5L/min flow rate
- Analysis (by IRSST)
 - Graphite furnace atomic absorption spectrometry after acid digestion (air & wipe samples; LD = 0.001 μg/filter)
 - Flame atomic absorption spectrometry (settled dust samples; LD ≈ 3 ppm)



Methods - 3

- Plants categorized according to beryllium use (exposure):
 - No use (past or present)
 - Past use
 - Present use
 - Present use of sources < 10 ppm (0.001%)
 - Insufficient information
- In plants with present use, workers' exposure estimated from personal air samples



Results - 1

- 123 plants visited, ~ 23,270 workers
 - 105 plants operating a foundry (83% non-ferrous)
 - 18 plants without a foundry, but with workers exposed because of nearby foundry operations
 - Various sizes:
 - 27.6% with 1-20 workers
 - 30.1% with more than 150 workers



Results - 2

- Various economic sectors involved
 - Primary metal ind. (n=94)
 - Transportation equipment ind. (n=9)
 - Metal products ind. (n=5)
 - Trade ind. (incl. metal waste recycling) (n=5)
 - Mines, Machinery ind. & Diverse manufacturing ind. (n=2 of each)
 - Construction, Chemical ind., Service ind. & Electrical products ind. (n=1 of each)



Results - 3

- Main non-ferrous alloys used :
 - aluminum (80% of plants)
 - copper (49%)
 - zinc (35%)
 - magnesium (32%)
 - manganese (22%)
 - nickel (21%)
- Type of casting (n=82/105 foundries)
 - sand casting (24% of plants)
 - squeeze casting (16%)
 - wax casting (7%)

Results - 4

| | Presence of beryllium (=use) | | | | | Total |
|--------------------------|------------------------------|------------|------------------------------|-----------------|-------------------|-----------------|
| | Absence | Past use | Present use | Source < 10 ppm | Insufficient data | |
| Plants n % | 65 52.8 | 4 3.3 | 44 35.8 | 6 4.8 | 4 3.3 | 123 100.0 |
| Workers n % | 7,715 33.1 | 111 0.5 | 13,080 56.2 | 1,977 8.5 | 387 1.7 | 23,270 100.0 |



Results - 5

- Among 44 plants with ***present use***:
 - Non-ferrous metal rolling, casting and extruding, incl. Al & Cu (n=13; 12.0% of workers)
 - First aluminum smelting (n=12; 61.4% of workers)
 - Aircraft and aircraft parts industries (n=6; 4.2% of workers)
 - Other primary smelting & refining of non-ferrous metal ind. (n=3; 7.1% of workers)
 - Metal & waste materials recycling wholesale (n=2; 2.2% of workers)
 - Other machinery & equipment ind. (n=2; 0.2% of workers)
 - Others (n=6, 1 of each sector; 12.9% of workers)

Results - 6

| | Total with present use | Exposure categories | | | |
|------------------------------|------------------------|------------------------------|--|--|-------------------------------------|
| | | > 5 $\mu\text{g}/\text{m}^3$ | 5 $\mu\text{g}/\text{m}^3$ to > 2 $\mu\text{g}/\text{m}^3$ | 2 $\mu\text{g}/\text{m}^3$ to > 0,2 $\mu\text{g}/\text{m}^3$ | $\leq 0,2$ $\mu\text{g}/\text{m}^3$ |
| Number of plants* (%) | 44 (100.0%) | 1 (2.3%) | 2 (4.5%) | 18 (40.9%) | 43 (97.7%) |
| Number of workers (%) | 13,074** (100.0%) | 7 (0.05%) | 21 (0.2%) | 478 (3.7%) | 12,568 (96.1%) |

* Number of plants with at least 1 worker in a given category

** Exposure information missing for 6 workers from 1 plant



Results - 7

- In 18 plants (40.9%) : exposure estimates $> 0.2 \mu\text{g}/\text{m}^3$, and in 3 plants (6.8%) : exposure estimates $> 2 \mu\text{g}/\text{m}^3$
- Activities associated with exposures exceeding the Quebec standard ($2 \mu\text{g}/\text{m}^3$)
 - Machining squeeze casting plungers containing from 4,500 to 20,000 ppm Be (Cu-Be alloy)
 - Upkeep of electrolytic baths in primary aluminum industry



Results - 8

- Housekeeping procedures and work clothes handling
 - Work clothes washed at home in 21 plants/44 (47.7 %) – incl. 2 plants > standard
 - Double changing rooms with showers in 10 plants/44 (22.7 %) – incl. 1 plant > standard
 - Regular housekeeping using compressed air to clean work areas in 14 plants/44 (31.8%) & HEPA aspiration in 12 plants/44 (27.3 %)
 - Previous decontamination of work areas in 6 plants/44 (13.6%)



Results - 9

- Among the 3 plants with workers exposed above standard
 - None restricted access to more exposed zones & 1 plant partially confined process
 - 14 workers (1 plant) had no access to adequate ventilation systems or protective personal equipment (PPE)
 - 14 workers (2 other plants) had access to adequate PPE; 1 plant had full at source vacuum extraction and the other had some workstations with adequate ventilation



Conclusions

- Limitations:
 - Worst case scenario sampling & exposure estimates
 - Not exhaustive for **all** plants operating a foundry, but representative of the primary metal industry in Quebec
- Descriptive study confirmed actual use of Be in 36% of plants (57% of workers), in several economic sectors associated to primary metal industries
- Inadequate working methods and preventive measures noted in a sizeable proportion of plants
- Estimates of workers' exposure identified activities associated with exposures exceeding standard



Recommendations

- Rapid corrective and preventive interventions in plants (*keep exposure as low as possible*)
- Environmental surveillance recommended for all Be-using industries
- Continue the *Concerted Action Program* in other industrial sectors suspected of uncontrolled Be exposure, incl. Aeronautics, Waste & residues management ind., Machining ind.



Merci de votre attention!

Questions?

