Workplace interventions

with respect to risk management measures & their impact on exposure levels to hazardous substances - literature review

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Background and Aims

- Workplace interventions: Important role in supporting and complementing scientific validation of assessment of effectiveness of risk management measures (RMMs) implemented to reduce occupational exposure to hazardous substances
- Control banding tools (CBT): Easy approach to evaluate worker exposure and to identify RMMs
- Knowledge of how expected reduction factors assumed by CBT compare to effectiveness of specific, implemented RMMs observed in field studies essential to ensure appropriate RMM recommendation by CBT → protection of workers
- We review a collection of published intervention studies comparing observed with CBT-predicted exposure changes.

Methods

Intervention studies published in English from 1999 up to January 2017 were considered for inclusion. The selection was based on a systematic search of Pubmed.

Workplace interventions were defined as programmes aimed at reducing occupational exposure or where reductions occurred as a side effect, e.g. due to changes in the production process.

Where applicable, observed reductions in exposure were compared with predicted or anticipated exposure changes according to reduction factors and their estimated relative effectiveness for RMMs according to a semi-quantitative CBT, the COSHH Essentials e-tool. The work presented here gives an overview of a selection of 11 out of a total of 50 most relevant, published studies included in this review.

	Investigator	Intervention(s)	Study period	Exposure to	Exposure assessment by	Main findings	COSHH Essentials control approach & type	Predicted exposure reduction factor [x-fold]	Observed reduction factor [x-fold]
Metal industry	Thomas *et al.* 2009	Copper-beryllium alloy processing plant, U.S.: Targeted engineering controls etc. btw. 2000 - 2007: (i) 2002: Wire annealing/pickling process enclosed (restricted access zone (RAZ)), put under negative pressure	1995 - 2007	Airborne Be	Survey to identify high-risk processes → 2000-2007 implementation phase	Rod and wire processes: highest air concentrations for all study periods → post-intervention: ↓by ~ 95 % (limited sample size)	2, 3	10-100	~ 20
Welding in construction	Meeker *et al.* 2007	Pipefitters, U.S.: Effectiveness of commercially available portable LEV (experimental and field setting)	2006 (?)	Mn; TPs	Field scenario: full-shift breathing zone samples, 8 days from 2 pipefitters	Field setting: LEV (compared to no LEV): GM ↓53% in Mn exposure; ↓ 10% in TPs	2	10	Mn: 2; TPs: 1.1
					Experimental: semi-enclosed booth at training facility; breathing zone samples outside welding hood	Experimental setting: GM ↓75% in Mn exposure; ↓ 60% in TPs			Mn: 4; TPs: 2.5
	Meeker *et al.* 2010	Chromium-containing steel welders, experimental & field setting (boilermakers & pipefitters), U.S., Canada: Effectiveness of portable LEV	2007 - 2008	Cr(VI)	2 field surveys: full-shift breathing zone samples of welding during power plant overhauls	Field setting: (i)GM for shifts: ↓ 40 % Cr (VI)	2	10	1.67
					Experimental: semienclosed booth at a pipefitter training facility; breathing zone samples outside welding hood	Experimental setting: GM ↓ 55 % Cr (VI)			2.2
	Flynn & Susi 2010	Welders' datasets, U.S., U.K., Canada: Influence of ventilation, degree of confinement, sampler location	1973 - 2008	Metal fumes, including Mn, iron, TPs	Examined data by construction trade : TWI, Center for Construction Research and Training (CPWR), OSHA compliance data	General: ↑ exposure levels associated with ↑ degrees of confinement → work environment a driver of exposure			
						TWI data: LEV (compared to no LEV): mean TPs: ↓35%, iron:↓41%, Mn:↓31%	2	10	TP: 1.5; iron: 1.7; Mn: 1.45
						CPWR data: (i) ironworkers (mechanical vs. natural ventilation):↓ 72% total fume exposure; (ii) pipefitters (mechanical and/or LEV vs. natural): ↓20% TPs & ↓12% Mn; (iii) boilermakers: mixed results	2	10	(i) total fume: 3.6; (ii) TPs: 1.25; MN: 1.14
	Lehnert *et al.* 2014	WELDOX study Germany: Improvements of exhaust ventilation and respiratory protection during flux-cored arc welding of stainless steel	2008 - 2011	Welding fume, Cr, Ni, Mn; BM	243 welders from 23 companies: breathing zone & stationary sampling, post-shift: spot urine & blood	↓respirable particles by ~ 88%	2,4	≥ 10	Particles: 8.3
						↓airborne metal compounds: Mn: 98%			Mn: 50
						↓Cr: 97%			Cr: 33
						↓Ni: 96%;			Ni: 25
						most striking ↓ inside helmets with purified air supply; ↓urinary metal & mean Mn blood concentration			
Dust in construction	Nij *et al.* 2002	Construction industry, Netherlands: Control measures to ↓ quartz dust exposure : LEV, wet suppression, PPE	1998 - 1999	Respirable dust & quartz dust	Full-shift (n = 61) & short-term measurements & questionnaire (n=1335 workers) → mixed effect model	Short-term% dust reduction: wet dust suppression or LEV: >70% to >99%	2, 4	≥ 10	Short-term: LEV or wet suppression: 3.3 - >90
						Controls not very strongly associated with full-shift estimates; +ve association btw. some controls and exposure levels			Full-shift: (i) natural ventilation: dust: 1.5; quartz: 1.4
									(ii) LEV in tunnel(not significant): dust: 0.8
									(iii) P3 respirator: dust: no association; quartz: 0.2
	Flanagan *et al.* 2003	9 large construction sites, U.S.: Control measures on silica dust exposure on 8 dust-producing construction tasks	2000 - 2001	Respirable dust	Task with vs. task without controls; 42 on-site days per site	Surface grinding inside (GM): (i) Box fan: ↓ 57%; (ii) Vacuum/shroud: ↓ 71%	2	10	(i) Box fan: 2.3; (ii) Vacuum/shroud: 3.4
						Floor sanding inside: (i) Box fan: ↓ 50%;			2
						Demolition inside: (i) Ducted fan dilution:↑ 6%			0.94
						Clean-up inside: (i) Sweeping: ↑ 25%, (ii) Box fan: ↑ 17%; (iii) Ducted fan dilution: ↑ 73%			(i) Sweeping: 0.8; (ii) Box fan: 0.85; (iii) Ducted fan: 0.57
						Surface grinding outside (GM): (i) LEV: ↓70%			3.3
	Croteau *et al.* 2004	6 commercial construction sites, Seattle, WA: Commercially available LEV system (ventilation shroud) during concrete surface grinding by cement masons	2001 - 2002	Respirable dust & crystalline silica	28 paired personal samples (with & without LEV)	LEV: ↓ GM respirable dust exposure of 92%;	2	10	Dust: 12.5
						crystalline silica of 86.4%			Silica: 7.4
	Deurssen *et al.* 2015	8 construction companies, Netherlands: Multidimensional intervention to ↓quartz exposure (engineering: LEV and/or water suppression techniques), organisational, behavioural)	2011 - 2012	Quartz	Randomized controlled trial (4 control, 4 intervention group); Bayesian hierarchical models	Substantial overall ↓ in quartz exposure baseline vs. follow-up: 73% in intervention vs. 40% in control group; Intervention group:	2	10	3.7
						(i) Concrete driller: ↓55%			2.2
						(ii) Demolisher: ↓83%			5.9
						(iii) Tuck pointer: ↓80%			5
Wood dust	Lazovich *et al.* 2002	Minnesota Wood Dust Study, U.S.: 48 small woodworking businesses: Multidimensional intervention(engineering: LEV and/or other dust controls), organisational, behavioural)	1997 - 1999	Wood dust	Baseline vs. follow-up (1 yr later), intervention vs. control group: Work practices survey, personal sampling & task recording; Mixed effects models	Overall median ↓ dust concentrations intervention group: ↓ 19.8%; controls: ↓ 10.4%	2, 4	≥ 10	1.25
Chicken production	Williams Ischer *et al.* 2017	2 broiler chicken production houses, Mississippi State, U.S. (House 1: sprinkler cooling system to deliver water mist; house 2: untreated control)	Winter of 2015 (Jan to March)	Inhalable dust; ammonia	Daily stationary measurements (1 production cycle of flock of chickens (63 days))	GM dust and ammonia: intervention house not statistically different to control; intervention house: dust ↓ 11%; both houses conc. above recommended limits → still need for RPE	2	10	1.12

Discussion

- Methods and findings varied considerably → limit scope to directly compare
  (i) results from different studies and
  (ii) effectiveness of different interventions
- Overall: Majority of interventions successful at reducing exposure levels
- BUT: Preliminary results of comparison of observed vs. CBT predicted changes indicate: Across different sectors assumed CBT reduction factors overestimate efficacy of individual control approaches and associated classes of RMMs.

Conclusions

- Decreases in workplace exposure levels followed a variety of interventions in a variety of industries → benefits of implementing RMMs
- BUT at this point:
  - (i) no clear tendency regarding best choice of (classes of) RMMs
  - (ii) no specific recommendations for workplace risk assessment possible
- Preliminary results indicate: Efficacy of classes of RMMs called into question

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