The cost effectiveness of occupational health interventions: prevention of silicosis

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Record Status
This is a critical abstract of an economic evaluation that meets the criteria for inclusion on NHS EED. Each abstract contains a brief summary of the methods, the results and conclusions followed by a detailed critical assessment on the reliability of the study and the conclusions drawn.

Health technology
The study compared alternative methods for preventing occupational-induced silicosis. The following interventions were compared:

- Engineering controls (ECs) including wet methods, local exhaust ventilation (LEV) or vacuuming, and total plant ventilation (TPV); and
- Worker training and four variants of personal protective equipment (PPE), namely comfort masks (CM), dust masks with filters (DMF), and full- and half-face respirators (FRs).

Type of intervention
Primary prevention of occupational health-related problems.

Economic study type
Cost-effectiveness analysis.

Study population
The study population comprised individuals living in AMROA (Canada, USA) and WPROB1 (China, Korea, Mongolia) who were exposed to silica during the conduct of the study. These two regions were selected as they were deemed to be representative of the wider community of developed and developing regions. Individuals aged 15 years and younger were not included in the study. The authors did not report any further inclusion or exclusion criteria.

Setting
The setting was the community, in particular the construction and mineral processing industry. The economic study was carried out in the two sub-regions of AMROA (developed) and WPROB1 (developing).

Dates to which data relate
The effectiveness data were derived from studies published between 1993 and 2005. The cost data were derived from sources published between 1996 and 2000, while some cost estimates were based on personal communications made in 2001. The price year was not explicitly reported.

Source of effectiveness data
The effectiveness data were derived from a review and synthesis of completed studies, augmented by expert opinion where necessary.

Modelling
The authors used previously constructed models to estimate the cost-effectiveness of interventions for the prevention of
occupationally-induced silicosis. Details are given in other studies (Murray 2000; WHO 2002; Lauer et al. 2003; see 'Other Publications of Related Interest' below for bibliographic details). It was reported that the effectiveness of the interventions were analysed using the population model POPMOD Version 1.1.4 Visual C++. All the interventions were compared with a "null" scenario where no intervention was used. The time horizon of the population model (accounting for the effectiveness of the interventions) was 100 years. The model had three states, diseased, susceptible and mortal.

Outcomes assessed in the review
The authors reported that a systematic review was carried out. The following parameters were used in the model:

the prevalence rate of silicosis,

the incidence rate of silicosis,

the case-fatality rates,

the background mortality rates, and

the reduction in silica exposure when using selected interventions (wet method, LEV, TPV, and training and PPE).

Study designs and other criteria for inclusion in the review
No study designs and further criteria were reported in the review. The authors reported only that they had used data from published and unpublished literature.

Sources searched to identify primary studies
Not reported.

Criteria used to ensure the validity of primary studies
Not reported.

Methods used to judge relevance and validity, and for extracting data
Not reported.

Number of primary studies included
Overall, 18 publications provided effectiveness data.

Methods of combining primary studies
Not reported.

Investigation of differences between primary studies
It was unclear whether the authors investigated differences between the primary studies.

Results of the review
For the construction industry, the estimated reduction in silica exposure was 86% with the wet method, 85% with the LEV method, and 20% with the training and PPE method.

For the minerals processing industry, the reduction in silica exposure was 79% with the LEV method, 70% with the TPV method, and 50% with the training and PPE method.
For the manufacturing industry (iron and steel foundries, glass, pottery), the estimated reduction in silica exposure was 80% with the wet method, 70% with the LEV method, and 40% with the training and PPE method.

The proportions of American and Chinese populations with current exposure to silica were reported by age group and gender.

**Methods used to derive estimates of effectiveness**

Some estimates of effectiveness were not derived from the literature. These were based on assumptions and expert opinion, derived through personal communication with individuals.

**Estimates of effectiveness and key assumptions**

Normal or current exposure to silica (measured as time-weighted average concentrations for an 8-hour period) was estimated to be 2.4 mg/m³ for the task of dry cutting masonry with a portable "chop saw". The exposure was reduced to 0.055 mg/m³ when wet cutting masonry with a stationary wet saw. Thus, the intervention resulted in a 98% reduction in silica exposure.

Normal or current exposure to silica was estimated to be 2.84 mg/m³ for the task of mortar grinding. The exposure was reduced to 0.059 mg/m³ when using LEV. Thus, the intervention resulted in a 98% reduction in silica exposure.

Both estimates were derived through personal communication with an individual at the Center for the Protection of Workers’ Rights.

Owing to the lack of appropriate data, the analysis was also based on authors' assumption that interventions (e.g. wet method, LEV, and training and PPE) that are mainly functional in the construction and mineral processing industries would also be suitable for the manufacturing sector, thus producing similar results.

It was also assumed that within a given economic sub-sector, male and female employees are subject to the same probability of exposure, as are young and old employees.

With regards to the training and PPE intervention, it was assumed that there was full compliance with training instructions on behalf of the workers.

**Measure of benefits used in the economic analysis**

The authors used healthy life-years gained as the measure of benefit. This was based on World Health Organization's definition of Healthy Years Equivalent (i.e. "indicator of the time lived with a disability and the time lost due to premature mortality"). Premature mortality was estimated using standard expected years of life lost derived from model life tables. Loss of physical capacity was estimated using disability weights derived from the literature.

**Direct costs**

EC intervention costs were included in the analysis and were reported as summary costs. The authors reported that such costs were estimated by taking the weighted average of the different elements of EC costs (e.g. wet cutting equipment for construction workers, TPV, dust control equipment and so on for mineral processing workers). In terms of the EC costs, all aspects of costs related to equipment and capital costs. Further costs included in the analysis were for PPE (i.e. half-FR, full-FR, DMF and CM). Twenty per cent of these costs 20% were assigned to wage costs and 80% comprised equipment or capital costs. Although some unit costs of some cost components were reported, the costs and the quantities were not reported separately as the costs were reported as summary costs. All costs were reported for the two sub-regions (AMROA and WPROB1). The time horizon of the economic analysis was 10 years and all costs were appropriately discounted. The price year was not explicitly reported.

**Statistical analysis of costs**

The costs were treated deterministically.
Indirect Costs
The indirect costs were not included in the analysis.

Currency
US dollars ($). Currency conversions were not reported.

Sensitivity analysis
No sensitivity analysis was carried out.

Estimated benefits used in the economic analysis
In the AMROA sub-region, 2,880,119 healthy life-years were gained when using ECs, 1,654,601 when using CM, 2,880,119 when using DMF, 2,880,119 when using half-FR, and 3,495,298 when using full-FR.

In the WPROB1 sub-region, 1,184,154 healthy life-years were gained when using ECs, 585,740 when using CM, 1,184,154 when using DMF, 1,184,154 when using half-FR, and 1,498,169 when using full-FR.

Cost results
In the AMROA sub-region, the total costs amounted to $304,988,924 for ECs, $183,726,737 for CM, $551,183,877 for DMF, $863,523,627 for half-FR, and $10,656,25716 for full-FR.

In the WPROB1 sub-region, the total costs amounted to $129,483,316 for ECs, $68,641,179 for CM, $205,925,160 for DMF, $32,261,6913 for half-FR, and $398,123,664 for full-FR.

Synthesis of costs and benefits
In the AMROA sub-region, the average cost per healthy year gained was $105.89 when using ECs, $111.04 when using CM, $191.38 when using DMF, $299.82 when using half-FR, and $304.87 when using full-FR.

In the WPROB1 sub-region, the average cost per healthy year gained was $109.35 when using ECs, $117.19 when using CM, $173.90 when using DMF, $272.45 when using half-FR, and $265.74 when using full-FR.

Authors' conclusions
The authors concluded "to the extent that this analysis can be generalised across other sub-regions, it suggests that engineering control (EC) programmes would be cost-effective in both developed and developing countries”.

CRD COMMENTARY - Selection of comparators
All the comparators were described in great detail and a justification for them was provided. You should decide if these represent widely used technologies in your own setting.

Validity of estimate of measure of effectiveness
A systematic review was undertaken to derive the estimates of effectiveness. However, the methodology and the conduct of the review were not described, and it was not explicitly reported whether the authors investigated differences between the studied identified. Some estimates of effectiveness were based on assumptions, but no justification for the choice of assumptions was given. For estimates of effectiveness that were derived through personal communication with individuals, the authors did not comment on how these individuals were chosen. In addition, the robustness of the estimates was not investigated in sensitivity analyses. Given these facts, it is difficult to ascertain if the best available evidence has been used in the analysis.
Validity of estimate of measure of benefit
The authors used healthy life-years gained as the measure of benefit in the economic analysis. These were based on data from the literature and were derived from the model. The results were presented as average cost-effectiveness ratios.

Validity of estimate of costs
Although the perspective adopted in the economic analysis was not explicitly reported, it was not societal since the indirect costs were not included. Given that the analysis looked at preventing occupationally-induced silicosis, productivity losses might have been a useful extension to the analysis. The unit costs and the quantities of resources used were not described separately as the authors mainly reported summary costs. It is therefore not possible to know which aspects of costs were included. In addition, this would not allow the analysis to be easily reworked for other settings. The costs were treated deterministically and no sensitivity analysis was conducted to assess the robustness of the estimates used, which may introduce possible uncertainty into the results. Appropriate currency conversions and a price year were not reported.

Other issues
The authors did not compare their findings with those from other studies, so it is not known how far their results agree with other published results. The issue of generalisability of the results to other settings was not directly addressed, although the authors seem to have been suggesting that their findings may be generalisable to other developed and developing regions. The authors do not appear to have presented their results selectively. The study enrolled workers who were exposed to silica and this was reflected in the authors’ conclusions. The authors only reported one limitation to their study, the restricted data available in the literature on silicosis prevention interventions in developing countries. Consequently, the authors made assumptions based on the evidence available on developed countries.

Implications of the study
The authors did not make explicit recommendations for changes in policy or practice. However, they called for further research in developing countries in order to acquire robust estimates on silicosis prevention interventions.

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Other publications of related interest


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