Effective health surveillance in mining: Blood lead levels in open and underground mines.

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Abstract

Background: Biological monitoring of lead exposed workers in lead mines is mandatory in Queensland. This study reviewed and compared biological monitoring results from an open and an underground lead mine.

Objective: To determine whether a) there is evidence of lead accumulation in lead mine workers and b) if there is a significant difference in accumulation between workers in the open and underground mines.

Methodology: During a calendar month all blood lead samples from each of the mines were compared with the workers' baseline levels. The level of absolute change from baseline was used as the primary outcome measure.

Results: Data was analysed for 1333 worker-years from the open cut mine (n=194, median 6.09 years between baseline and study samples) and 704 worker-years (n=120, median 5.38 years) for the underground. The mean change in lead level was -0.0104µmol/L for the open mine (95% CI -0.237 to 0.030) and 0.0032 µmol/L (95% CI -0.0173 to 0.0109) for underground. Neither was statistically or clinically significant. With lead charted against duration time, there was a statistically but not clinically significant regression for the open-cut mine (-7.89×10^{-3} µmol/L per year). For the underground mine, total and subset analysis of surface and underground workers showed no statistically significant regression or correlation.

Discussion: This study shows that a) lead mining does not seem to result in significant lead accumulation in workers and b) there is no statistically significant difference in accumulation between the open and underground mines studied. This suggests that risk assessments and control measures are effective in the mines studied.

Lead is a well understood occupational hazard. It has clear health risks proportional to body burden, well known methods of bodily absorption, known methods of control and can be relatively easily measured. These factors, combined with statutory mandates, result in excess lead absorption in lead mine workers being a rare occurrence.

Not all occupational health hazards are as well controlled, and many, despite well-meaning efforts, remain stubbornly uncontrolled. Fatigue, for example is a vexing occupational health issue. In contrast to lead, it is difficult to clearly define, difficult to measure and has multiple contributing factors.

The following will discuss some of the key issues that need to be addressed when considering intervention for potential occupational health risks.

1: Clarify the issues, understand the motivation for change
2: Examine options
3: Communicate with stakeholders and develop a plan
4: Enact, monitor, (enforce?)
5: Review

1: Clarify the issues:

Understand what the issue is and what motivates the organisation to control the risk.

The easiest cases are when there is a legislative mandate to address an issue. Whether or not the workplace agrees, there is a requirement for action. Under these circumstances there are usually clearly identifiable means of surveillance and control.

Otherwise issues may arise because:

- There have been injuries/incidents
- It is a known health/safety risk that has been identified prospectively
- Your management has said it is an issue
- Workers/unions have raised it
- A salesman has said it is an issue.

Ideally, all risk will be treated with maximal respect and effective controls enacted at all times. In reality, budgets, staffing, motivation (of management, health and safety staff, workers and unions), and political and community attitudes will result in some hazards being elevated above others.

Understanding why an issue is important to your business at that particular time will aid in prioritising (or deprioritising) its status.

Quantify the problem. Develop a sense of urgency/priority

Record keeping is vitally important, and keeping data in a form that can be statistically analysed is incredibly helpful when attempting to quantify risk. This can include injury statistics, incident reports, complaints, biological monitoring levels and environmental sampling data.

Quantification of risk is important for two main reasons.

As previously stated, maximal effort cannot be practically exerted on all potential hazards. Diligent risk assessment can help focus resources into areas where effort will be best rewarded.
Secondarily, review of the effectiveness of the intervention process is not meaningfully possible if there is no baseline assessment. Allocating resources to well-intentioned, but ineffective intervention is usually pointless, and it is certainly possible that well-meaning intervention can create more problems than it solves. Without assessments of baseline injury/illness/exposure rates, it is near impossible to determine whether your intervention is worth continuing.

It is also vitally important to be clear on what outcome you are measuring. In particular, are you measuring the actual hazard or a proxy? For example, lead monitoring is relatively easy as it can be measured directly, both environmentally (with some limitations) and biologically.
Conversely fatigue monitoring is a more vexing issue as the aim of fatigue management is ostensibly to reduce the risk of sudden incapacitation (falling asleep) during safety critical work. Measurement of frequency of falling asleep is not likely an acceptable means of risk assessment. Technological measures such as eye monitoring cameras that measure speed of lid opening may be effective in alerting operators and supervisors who are at risk of falling asleep. These are expensive, may be prone to false alarms, and are not widely available, so a proxy is often used. Sleepiness scales are used as a proxy for fatigue, but in an occupational setting are highly questionable.

Usually, the more directly a risk can be measured, the easier it is to control. Where the hazard is directly measurable, a reduction in level corresponds to a reduction in risk. Where a proxy is measured, a reduction in level *may* correspond to a reduction in risk, but other unmeasured contributing factors may mean that the overall risk is not diminished. Proxies can be useful, but it

must be remembered that control of the proxy is not equal to control of the risk.

Identify contributing causes, highlight the modifiable ones.

This will be significantly different based upon the issue in question.
For substance related hazards, the substance is obviously the cause, but routes of exposure, control mechanisms and potential failure points require consideration.

For injuries, databases of reported injuries can help identify work locations, tasks, similar exposure groups (SEGs) or equipment that may be contributors. This relies heavily on diligence on behalf of safety staff as injury clusters can be missed easily.

Some issues are particularly complex with multiple contributing factors, and identification of the issue is vital.
Again using lead and fatigue as examples, sources of exposure for lead are readily identifiable as are routes of ingestion. Consequently the main points of exposure risk can be targeted in order to reduce risk.
Fatigue however is a more complicated issue with multiple potential causes. Obstructive sleep apnoea is a frequently discussed risk factor for fatigue and “daytime” sleepiness, but is far from the only one. As a result, using medical screening tools for sleep apnoea is an incomplete and potentially falsely reassuring means of targeting fatigue. Overall health, caffeine, alcohol and other drugs, sleep patterns, exercise, night-time activities, task oriented issues (including repetition and monotony), lighting, medications, stress, isolation, shiftwork and many other factors contribute to sleep disturbance. Trying to control risk by targeting a single facet is likely to be ineffective. Again, identification and control of a proxy does not necessarily equate to control of a risk.

2: Examine Options:

The commonly used hierarchy of control is a handy guide for developing control plans:

1. Elimination
2. Substitution
3. Engineering controls
4. Administrative controls
5. Personal protective equipment

Where possible, do not have hazardous substances or processes in the workplace. Alternatively where that is inherently impossible, substitute for less hazardous substances, formulations or processes.
Where that is not possible, provide engineering controls suc as remote handling, isolation, exhaust, lockout mechanisms, deadman switches etc.
Administrative controls include shift length, supervision, task rotation and training and certification.
Finally when all else fails ask the worker to look after themselves.

What is available?

There are a couple of important questions to be addressed:

1. Is there anything that can be done to control risk?
2. Is there anything that can be legally and ethically be done to control risk?
3. Can the risk be controlled in a manner that is acceptable?

The first question is the crux of risk control. Is there a known method of risk control? If there is, is it backed up by evidence or is it a process that occurs widely without any clear evidence for benefit?
If a risk is identified for that has no clearly known method of effective control, or where control measures are dubious in validity, a pilot study is a good means of determining whether to proceed with a control measure prior to enacting widespread and potentially expensive change.
Again baseline then follow-up quantification of the exposure and potential health outcomes is vital.

The second question can be where well-meaning risk control comes badly unstuck.
As an extreme example there is often concern (rightly or wrongly) about the aging workforce and injury rates.

Question 1: Is there anything that can be done to control risk?

Yes. Hire only workers under 30 and force retirement at age 45.

Question 2: Is there anything that can be legally and ethically be done to control risk?

Well, maybe, but not that option.

It is important to be cognisant of federal and state laws relating to disability and discrimination, privacy and equal opportunities. Potential problems occur when companies develop policy that contravenes these laws.
Common examples include pre-employment screening and policies of selecting against workers with pre-existing conditions. The Disability and

Discrimination act requires that unless a worker is unable to perform the substantive duties of their proposed employment that there is no lawful grounds to deny them employment. An increased risk of possible future injury is not a justifiable reason to deny employment. From a common sense view, exclusion of workers with symptomatic arthritis is highly likely to reduce the incidence of injury claims, but it is likely to invite legal problems.

Beyond the legal, ethics can be easily overlooked in the short-term. Just because an option may be legal, does not make it right. In the longer term, dubious ethical practices undermine the value of companies.

Finally question 3: Can the risk be controlled in a manner that is acceptable?

Drug and alcohol screening is an identifiable example here. Drug and alcohol intoxication has clearly negative effects on workplace safety.
Alcohol testing is relatively straight forward as there is a simple, cheap, easy means of testing (breath alcohol) and there are numerous studies that link breath alcohol and current performance impacts.
Drug testing however is far more problematic, as there is no test for current effect, only tests for past exposure. This is an example of measurement by proxy.
Consequently it is of little surprise that there is great debate regarding this with various workplaces having no testing, urine testing or saliva testing.
There is further debate as to when to test - pre-employment, routine, random or incident only.

There are effective means of monitoring use, they are legally available and arguably monitoring is ethical (even if not to the tested individual, then to the wider population).
There is frequently however, concerns among those being tested about the frequency and method of testing, as well as consequences of positive tests. Should positive tests mean instant dismissal, an arbitrary number of strikes, or referral for treatment and continued employment in non-safety critical areas?

Ultimately this is an issue for discussion between management, health and safety staff, unions and workers, bearing in mind community concerns and expectations.
Frequently there is no right solution, but only one that is a compromise between groups.

3: Communicate with stakeholders and develop a plan:

This follows from question 3 above regarding acceptability of plans.

Once the issues have been identified and one or more potential plans have been identified, the relevant stakeholders need to be identified and engaged. These may include among others:

- Management - ultimate safety responsibility as well as controlling funding and allocation of resources.
- Regulatory bodies.
- Unions and/or worker representative.
- Health and safety staff.
- Community leaders if the hazard or controls may impact on the surround.

Depending on the magnitude of the issue and the scale of the intervention, the consultation period may be relatively brief or require prolonged negotiation.

It is during this stage that consequences must be discussed if applicable. This is important in the previous example of drug and alcohol use, but also other areas such as weight management. A well-meaning ‘healthy lifestyle’ program is a good general measure, are there to be any consequences for workers who do not participate? If workers are assessed as high risk and placed on weight management programs, is there any action against them if they gain further weight? If so, is this legal, ethical or acceptable to the workers?
It is vital that consequences of actions are agreed in advance and then consistently applied.

4: Enact, monitor, (enforce?):

Once a plan has been developed and agreement reached, it obviously needs to be implemented. This requires communication, education and training and enough lead time for those affected to prepare for a new system.

When a novel intervention is planned or the outcome of intervention is uncertain, a pilot study may be beneficial. This can allow a graduated roll-out while comparing outcomes between the status quo and the intervention group. It also potentially allows identification of unforseen negative consequences.

Where there is some level of penalty for workers, a period of grace may be appropriate. It is unreasonable to assume all workers will immediately assimilate to a new regime, and immediate enforcement of policy is likely to result in significant unrest and potential industrial relations problems.

Again, monitoring is essential in order to gauge the effect of the intervention. Good data recording allows accurate statistical analysis.

5: Review:

Ultimately it must be remembered that the whole purpose of the program was to reduce risk.

Where the anticipated risk reduction has not been achieved, consider whether it was a result of:

1. an ineffective plan
2. an effective plan that was poorly implemented
3. a potentially effective plan that had unforseen effects that increased other risks.

It is highly unlikely that the first iteration of any program will be the best possible. Areas for improvement should be noted and considered in review with stakeholders.

Summary:

It is vital when attempting to implement new health policy to consider the following:

1. Without clearly defining the problem, it is likely to be impossible to tailor an effective solution.
2. Plans must be considered in the context of relevant legislation and ethical standards.
3. Policy enacted without consultation is a potential recipe for both failure of the plan and an industrial relations fiasco.
4. Before and after studies of health effects are valuable in assessing the effectiveness of implemented plans. It is vital to have some form of objective measure of outcome in order to assess the value of the policy.
5. It is unreasonable to expect perfection immediately. Honest assessment of the effectiveness of policy is vital as is a willingness to modify or abandon implemented plans if necessary.