Macro- and micro-management of hearing conservation in the South African mining

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1.1.1 *ABSTRACT*

Noise-induced hearing loss (NIHL) can be prevented, but only by incorporating more proactive and innovative measures into our NIHL-prevention programmes. At present, direct and indirect costs to the mining industry resulting from occupational noise are unacceptable and, more importantly, mineworkers' quality of life is being eroded.

Researchers at the CSIR Laboratory for Mining Innovation (LMI) propose that the use of the large databases of audiometric results available at mines be analysed in ways that will provide information to prevent NIHL by early identification and by proactive intervention in areas of the mine where trends in hearing loss indicate at risk groups and workplaces. The management of hearing loss prevention is therefore at a macro level.

The method also proposes a hearing-loss-risk matrix as a tool for collating information about each worker into a format that can be used for counseling and for education and training for NIHL prevention, so that "case- or micro-management" measures can be applied. This matrix, together with audiometric database analysis (ADA) to monitor NIHL risks across the workforce, would enable a two-tiered or macro- and micro-management approach that could contribute to finally eradicating NIHL in the South African mining industry.

1.1.2 **Introduction**

NIHL costs the SA mining industry millions of rands per year (Hermanus, 2006). More importantly, NIHL continues to rob employees in the industry of their quality of life. Research has shown that even the mildest degree of NIHL results in a significant degree of hearing handicap (Vermaas, Edwards, & Soer, 2007).

Occupational audiologists report that the most common complaint of noise-exposed clients is that, although they can hear when they are in a one-to-one listening situation, they have great difficulty coping when there is background noise because they can hear that people are talking but they cannot understand what they are saying. That is the nature of NIHL; it reduces speech discrimination ability because areas of the cochlear that receive the most important signals for speech discrimination are damaged by the noise exposure.

The essential point is that NIHL is completely preventable. If we are going to win the battle against NIHL in the mining industry, all the stakeholders involved need to be committed to finding ways that will prevent the disability. The methods used thus far, do not seem to have been successful. We know that the industry lives with the legacy of the past where, because very little attention was given to hearing conservation programmes in the pre-1994 era, a large percentage of the workforce has significant hearing loss. However, even 15 years after hearing conservation became a legislated process, employees are still losing their hearing and with it their quality of life, and the industry is paying huge compensation claims when the money could be used to prevent the disability effectively. This paper suggests that in the future NIHL prevention will have to be characterised by innovative management.

1.1.3 **Innovative management**

Large amounts of information on the hearing levels of the workforce are available in the mining industry. This information results from both annual medical surveillance records and noise dosimetry measurements as required by occupational health and hygiene legislation (DME, 1996; DME, 2003). Research and international practice indicate that best practice for NIHL prevention should be driven by the use of such information by means of audiometric database analysis (ADA) that informs the hearing

conservation programme (HCP) of each mine. Legislation also stipulates that occupational hygiene information should be integrated with occupational medical information(DME, 2003).

The individual susceptibility of employees to the development of NIHL as well as the reports in the literature of the synergetic impact of medical and life-style factors would require that, if the information already available on the mine was used in a useful way, data would need to be well managed. Factors that are known to impact on NIHL development are HIV/AIDS, TB, diabetes, hypertension, heat and exercise, smoking, and alcohol(Chen, Dai, Sun, Lin, & Juang, 2007; Prasher, Morata, Campo, Fetcher, & Johnson, 2002). Innovative management of all these factors requires that a great deal of information about a specific employee be integrated into a database but more importantly that the information is analysed in a useful way so that prevention actions can be implemented in a practical way.

1.1.4 **Macro- and micro-management of NIHL**

Research at the CSIR aimed at integrated management tools for occupational health, proposes a model for macro- and micro-management of NIHL(CSIR, 2008). The abovementioned theoretical and practical issues are embedded in the suggested methods.

Macro-management

Macro-management of NIHL requires in-depth audiometric database analysis (ADA) and is based on the identification of trends in the hearing levels of groups of workers. The hearing levels are measured in percentage loss of hearing (PLH), which is the legislated unit of measurement for compensation for NIHL. The workers are divided into homogeneously exposed groups (HEGs) as specified by the occupational hygiene legislation (SAMOHP, 2002). The noise exposure measured by the occupational hygiene procedures can easily be integrated into the analysis.

The method has the advantage that the new legislation governing NIHL compensation gave the industry a clean slate in 2003 when all previous hearing loss should have been compensated (Begley, 2004; DME, 2003). The process of "baselining" all employees meant that a standardised testing procedure using two audiograms ensured that the starting point was accurate and reliable. If the company now uses the averaged baseline results for each HEG as a starting point and annually compares the hearing levels for that group, trends can be identified and hopefully changes can be made to the noise exposure of groups where hearing levels are deteriorating.

The analysis can be further refined by dividing each HEG into occupations, and, potentially, if a system is well developed and maintained, subdividing the occupations into gangs of workers. In this way, the risk manager can identify which occupations show changes in hearing levels. The manager will be able to identify which source of noise is the culprit when a gang shows deterioration in its members' hearing levels. The information will be useful as the leader of the gang can be informed for improved motivation to use hearing protection devices (HPDs), the gang members can be targeted for retraining, improved HPD fitting can occur, and the noise source can be targeted for improved maintenance or engineering options.

The actions for the HCP will depend on the amount of averaged PLH change noted in the hearing levels. In Table 1 below the categories used are: "none/little change", "some change", or "significant change". The three categories of change noted have been colour coded for easy prioritising of actions. This type of analysis would require that the hearing level be tracked for the same employee throughout the analysis to ensure that averaging of information does not result in incorrect assumptions about the hearing levels. When the employee is tracked year-on-year, the number of employees in an HEG can also be noted in the analysis and the risk manager will then have an indication of the number of employees affected.

Table 1. Comparison of HEGs and occupations for averaged PLH over a three-year period, using colour coding for categories of change noted

Insert Table 1

Other formats of analysis can also be used for macro-management of NIHL. One example is to categorise the hearing levels into normal (0-2% PLH), mild hearing loss (3-5% PLH), and severe hearing loss (>5% PLH). The ultimate goal of the HCP would be to have all employees in the normal hearing category. If the average PLH for a HEG or an occupation increases over time, the risk manager has a basis for an investigation into the reasons for this. The manager can also use the analysis to iden-

tify high-risk areas, predict compensation costs, and budget for HCP costs. As with the other format of analysis, colour coding can be used and any changes in category will alert the manager to a need for HCP action.

Table 2. Comparison of HEGs and occupations for averaged PLH over a three-year period, using colour coding for categories of hearing levels

Insert Table 2

Insert Figure 1

Figure 1. Comparison of the averaged PLH for the drillers from Business Unit 1 over a six-year period.

Insert figure 2

Figure 2. Comparison of the averaged PLH between business units from baseline (BL) for three consecutive years.

The use of hearing levels as a basis for managing NIHL as suggested by this macro-management system will not only provide useful information for comparisons between gangs, occupations and HEGs, but comparisons between sections and between business units too. The graphs in figure 1 and figure 2 give examples of the type of analysis that can be used in this form of NIHL management.

If the mining industry is to use this form of NIHL management, managers will need to put systems in place that result in improved ADA methods and programmes. The ideal would be for standardisation across the industry so that progress on the targets can be easily tracked and that comparisons on national level can be facilitated.

An industry-wide initiative would be ideal. The initiative would be feasible as some of the ground work has already been done by projects such as the baseline repository and this CSIR project (Begley, 2006). The aim of such an initiative would be to create standard reporting systems with a range of report templates and picklists of what items should be represented in a report, allowing for improved comparisons. The systems should include automatic triggers; for example, those warning of deteriorating hearing levels that notify the responsible persons and result in action such as counseling, discipline, management reports, etc.

Micro-management

The macro-management of NIHL cannot be successful without the co-existence of a micro-management system. The micro-management of NIHL is based on the individual susceptibility of employees to noise exposure. Anecdotal reports from occupational audiologists show that a driller who has worked for 40 years might have only a very mild NIHL, while a relatively new employee of two years might have already developed a severe hearing loss. This is because certain individuals' ears are more susceptible to noise exposure than others. The reasons for susceptibility have been found to be influenced by genetic factors as well as life-style factors such as smoking and alcohol. Other synergetic factors affecting the development of NIHL are medical factors such as ototoxic medication, immune diseases such as HIV/AIDS, and other diseases such as TB, diabetes and hypertension (Fuente & McPherson, 2006; Mizoue, Miyamoto, & Shimizu, 2003; Toppila, Pyykkö, & Starck, 2001; Zhu, Sakakibara, & Yamada, 1997).

For the above reasons the prevention of NIHL must not only take into account the trends within a population but must individually assess the impact of the occupational noise on an employee.

The proposed micro-management model makes use of a hearing-loss-risk matrix that includes all the abovementioned factors. The matrix uses four dimensions to arrive at a score for NIHL risk. The four dimensions that are taken into account are:

- Noise-exposure factors;
- Medical factors;
- Hearing conservation factors; and
- Audiological factors.

Each of the four dimensions has subdivisions that are relevant to that specific aspect of the matrix and that are scored. The aim of the scoring is to obtain a zero score or a zero risk of NIHL development in the individual. Despite the need for studies to quantify the exact impact of each factor and the interaction of

the factors in the risk matrix, the initial phase of such a matrix has been specified. The scoring in the matrix is based either on the absence or presence of the factor or on a known or suspected impact. The subdivisions are allocated a score of 0, 1 or 2. In a worst-case scenario the individual would score the highest score on the risk matrix of 32. If all risk factors are reduced to a minimum, then the risk of NIHL for an individual would be zero.

The hearing-loss-risk matrix is proposed as a tool to be used on an individual basis in a counseling session at an annual medical surveillance interview. The employee would have the contributing factors explained and his individual risk profile analysed. The matrix should be further developed to be an electronically calculated score based on information in the integrated management of NIHL prevention in the company. The automatic triggers mentioned in the macro-management of NIHL would alert the occupational health nurse counseling the individual to high risk identified by the matrix and the need for more intense hearing conservation measures such as 6 monthly monitoring, change of job, HPD evaluation, re-training. The risk profiles of individuals in a gang or in an HEG could be analysed together and would further inform the company risk profile for NIHL.

If the use of this matrix was standardised and the matrix became a tool used throughout the industry, the possibility of comparisons between commodities and operations could be facilitated.

Table 3. Hearing loss risk matrix

Insert table 3

1.1.5 **Conclusion**

The prevention of NIHL is possible. If the industry manages its prevention strategies proactively and with innovation, the workers' right to a healthy and safe environment will be maintained (Hermanus, 2007). The costs to the industry will be greatly reduced and the quality of life of workers and their families will be enhanced. The use of micro- and macro-management of NIHL prevention could become an industry-wide initiative to prevent NIHL in the mining sector.

1.1.6 **References**

Begley, A. (2004). *Processing noise induced hearing loss cliams at rand mutual assurance.* No. NIHL repository skills transfer workshop.). Orkney, South Africa: Rand Mutual Association.

Begley, A. (2006). Development of internet-based mining industry database for audiograms. *Safety in Mines Research Advisory Council*,

Chen, C., Dai, Y., Sun, Y., Lin, Y., & Juang, Y. (2007). Evaluation of auditory fatigue in combined noise, heat and workload exposure. *Industrial Health, 45*, 527-534.

CSIR. (2008). *Optimal miner: Holistic management of risks associated with occupational health stressors* (Technical report No. Project Number YMP0033). Pretoria: CSIR.

Mine Health and Safety Act, of 1996. 29, (1996).

DME. (2003). *Guidelines for the compilation of a mandatory code of practice for an occuaptional helath programme for noise.* Retrieved 30/5/2008, 2008,from http://www.dme.gov.za/mhs/documents.stm

Fuente, A., & McPherson, B. (2006). Organic solvents and hearing loss: The challenge for audiology. *International Journal of Audiology, 45*(7), 367.

Hermanus, M. (2006). OHS milestones: Achieving the milestones-time for change. *SA Mine Ventilation Society, Colliery Branch Workshop.*

Hermanus, M. (2007). Occupational health and safety in mining-status, new developments, and concerns. *The Journal of the South African Institute of Mining and Metallurgy, 107*(August), 531-538.

Mizoue, T., Miyamoto, T., & Shimizu, T. (2003). Combined effect of smoking and occupational exposure to noise on hearing loss in steel factory workers. *Occupational and Environmental Medicine, 60*(1), 56-59.

Prasher, D., Morata, T., Campo, P., Fetcher, L., & Johnson, C. (2002). Noisechem: An european commission research project on the effects of exposure to noise and industrial chemicals on hearing and balance. *International Journal of Occupational Medicine and Environmental Health, 15*(1,), 5-11.

South African Mines Occupational Hygiene Programme Code Book. (2002).

Toppila, E., Pyykkö, I., & Starck, J. (2001). Age and noise-induced hearing loss. *Scandinavian Audiology, 30*(4), 236-244.

Vermaas, R. L., Edwards, A. L., & Soer, M. M. (2007). Noise exposure in gold miners:Utilizing audiogram congfiguration to determine hearing handicap. *Occupational Health SA, 13*(5), 16-19.

Zhu, S., Sakakibara, H., & Yamada, S. (1997). Combined effects of hand-arm vibration and noise on temporary threshold shifts of hearing in healthy subjects. *International Archives of Occupational and Environmental Health, 69*(6), 433-436.