Noise-induced hearing loss milestones: past and future

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Synopsis

A retrospective study was conducted on the Rand Mutual Assurance (RMA) noise-induced hearing loss (NIHL) compensation claims from 1998 to 2008 to determine if the 2008 milestone agreed at the 2003 Mine Health and Safety Summit was achieved. The number and costs of NIHL compensation claims in different commodity sectors and workplaces were collated. A secondary analysis of the ages of employees compensated after 2008 was conducted. A complementary retrospective analysis of audiogram data investigated the percentage loss of hearing (PLH) shift in different homogeneously exposed groups and occupations at two gold mines. The compensation claims analysis indicated a significant decrease in NIHL claims from 1998 to 2008, but the milestone was not achieved. The reason may be either that claims have not been submitted timeously as required by Instruction 171 and that the current submissions are a result of pre-2003 noise exposure, or that employees who were baselined are still developing NIHL owing to ineffective hearing conservation programmes in place in the mining industry. On the basis of best practice for hearing conservation, recommendations are made for leading indicators in hearing conservation programmes and for reducing the risks of NIHL in order to achieve the 2013 milestone.

Keywords
hearing conservation, leading indicators, NIHL milestones.

Introduction

The South African mining industry has committed itself to the Mining Charter, which requires employers to 'implement systems focused on the continuous improvement of the industry's health performance' (DMR, 2010). A well-known call in the mining industry is for 'zero harm' to the health of the mining workforce by identifying risks and implementing prevention strategies for disease and injuries. The hearing health of the workforce and the prevention of noise-induced hearing loss (NIHL) is the focus of this article, and we contend that overexposure to noise and the development of NIHL continue to be widespread and serious health hazards that can be prevented.

Excessive noise exposure can lead to permanent hearing loss and poor verbal communication, and can reduce the ability to recognize warning signals, which can lead to accidents. Noise-induced hearing loss (NIHL) is one of the most prevalent work-related diseases and injuries in the industrialized world, but it is also completely preventable.

At the 2003 Mine Health and Safety Summit, the milestones for elimination of NIHL in the South African mining industry were agreed on. The first milestone, December 2008, has passed and the next one in 2013 is looming. The questions the mining industry needs to ask are: Did we reach the 2008 milestone? What should the industry do now about hearing conservation that will ensure that there is no deterioration in hearing greater than 10 per cent? How can we ensure that the industry achieves the 2013 milestone? What else should the industry aim for to achieve 'zero harm' to workers' hearing?

Milestone One was that, after December 2008, the hearing conservation programmes implemented by the industry must ensure that there is no deterioration in hearing greater than 10 per cent amongst occupationally exposed individuals. In order to evaluate whether the 2008 milestone was reached and what the next step should be, an understanding of 'no deterioration in hearing greater than 10 per cent' is necessary. The 10 per cent refers to percentage loss of hearing (PLH), which is the current metric of hearing loss in the mining industry and determines the eligibility for compensation for an occupational disease.

The history of the use of PLH is that pre-2001 a different method of calculating the eligibility of miners for compensation for hearing loss existed, namely Instruction 168. Under the Instruction 168 legislation only four

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frequencies of the audiogram were used in a formula that arrived at a percentage of permanent damage (PD) to the hearing, and compensation was paid when 2 per cent deterioration in PD occurred. In 2001, Instruction 171 was introduced, and under the new method five frequencies on the audiogram are used with weighted, actuarially-designed tables to calculate the PLH. The introduction of the new legislation allowed employers until December 2003 to 'baseline' all existing employees and to pay all due compensation up to that point. There was therefore a clean slate and from that point forward a deterioration of more than 10 per cent PLH would make an employee eligible for compensation. Not all employers complied with that cut-off date. Non-compliance with the cut-off date meant that the baseline PLH was regarded as zero PLH, regardless of previous noise exposure.

In order to evaluate whether the milestone was achieved, an analysis of the compensation records is necessary. The analysis needs to take into account the abovementioned changes in measurement. The milestone presumed that new or improved methods of hearing conservation would be used to prevent hearing loss, not merely a change in the way in which the hearing loss was reported.

In order to answer the question of what the industry should do now about hearing conservation that will ensure that there is no deterioration in hearing greater than 10 per cent, and what else should the industry aim for to achieve 'zero harm' to workers' hearing, the industry needs to look at what best practice for hearing conservation stipulates.

Best practice indicates, firstly, that a hearing conservation co-ordinator/manager should be in charge of ensuring that an integrated and continually improving hearing conservation programme exists at a mine (Franz, 2005). Secondly, best practice requires that leading indicators of early NIHL be used to address the impact of poorly fitting hearing protection devices (HPDs) and of non-compliance with wearing HPDs (Schulz, 2011) and of hearing conservation programme success. Thirdly, best practice stipulates that a risk assessment be conducted to prioritize the high-risk workplaces and the employees at risk in these workplaces. Finally, best practice indicates that noise control engineering should be implemented to reduce the risk of noise exposure (Franz, 2005).

The last question, which asks how the industry can ensure that the 2013 milestone is achieved, requires an analysis of the noise sources and a prioritizing of indicators of reduced risks from noise sources as well as an implementation of engineering and other methods that can reduce the noise levels and the risk of NIHL.

The studies outlined in the following methodology were conducted in an attempt to answer these questions.

Methods

A retrospective study was conducted on the Rand Mutual Assurance (RMA) NIHL compensation claims database from 1998 to 2010. The number and costs of NIHL compensation claims in different commodity sectors and workplaces were extracted from the RMA database and analysed per year. The number of claims per 100 000 workers was analysed. An analysis of post-2008 claims was conducted for cost to the industry and the age of compensated workers.

A complementary retrospective analysis of audiogram data from a gold mine investigated the PLH shift in different occupations and different homogenously exposed groups (HEGs) for two mines (CSIR, 2007). The results of the analysis are reported in the following section.

Results and discussion

The compensation claims analysis indicated a decrease in NIHL claims from 1998 to 2001. The claims increased dramatically in 2002, and then began a downward trend to a significant decrease in 2008 (Figure 1). However, the 2008 milestone of 'no deterioration greater than 10 per cent' was not achieved (Figure 2).

The probable reason for the increase in NIHL compensation claims in 2002 is that the 'baseline' process resulted in companies adhering to Instruction 171, which resulted in a flood of submissions. The possible reason for not achieving the milestone may be either that claims were not submitted timeously as required by Instruction 171 and that the current submissions are a result of pre-2003 noise exposure, or that employees who were baselined are still developing NIHL owing to ineffective hearing conservation programmes in place in the mining industry.

The results of the analysis of the costs of NIHL claims at RMA from 1998 to 2007 indicate that the costs were greatest in the platinum and gold industries (Table I). The platinum industry experienced a peak payout in 2005 of almost R90 million in one year. After 2005 there has been a steady decrease in costs. The other commodity sectors did not show any significant changes in the costs of NIHL claims between 1997 and 2007.

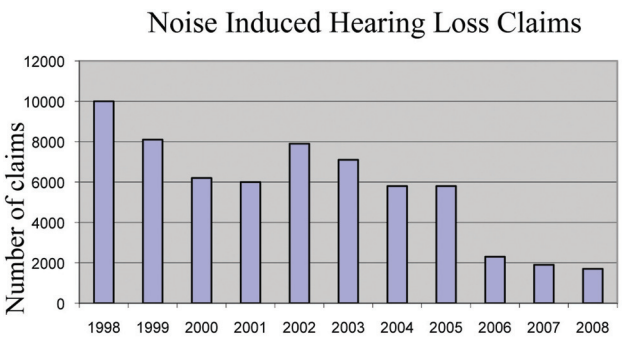

Figure 1—Noise-induced hearing loss claims registered with RMA from 1998 to 2008

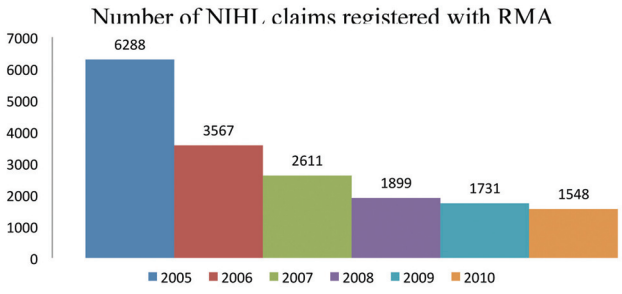

Figure 2—Noise-induced hearing loss claims registered with RMA from 2005 to 2010

Table I

Costs of noise-induced hearing loss compensation claims in industry, by commodity sector

Year	Gold	Platinum	Coal opencast	Coal underground	Diamonds	Mineral mines	Shaft sinking
1998	R66 013 380	R37 586 797	R193 206	R1 986 753	R425 818	R693 176	R3 870 573
1999	R37 363 965	R38 938 335	R577 623	R2 389 042	R1 098 751	R875 814	R2 994 070
2000	R21 721 472	R46 306 795	R543 587	R2 436 636	R515 843	R574 371	R3 112 409
2001	R27 972 900	R41 628 991	R721 502	R2 192 371	R870 179	R751 174	R2 815 290
2002	R32 147 036	R31 449 581	R1 388 294	R2 806 369	R941 572	R606 407	R4 118 758
2003	R29 548 065	R26 183 423	R961 432	R1 056 322	R1 391 844	R771 367	R2 056 055
2004	R38 860 654	R49 821 153	R949 875	R1 114 459	R2 419 865	R3 900 348	R4 029 768
2005	R42 980 468	R86 852 705	R2 235 102	R1 672 145	R1 120 150	R2 927 401	R5 316C248
2006	R17 086 000	R47 419 729	R1 944 756	R2 453 315	R2 743 072	R1 112 546	R5 188 111
2007	R20 868 763	R25 228 727	R1 906 988	R1 298 746	R801 168	R1 563 173	R4 375 532

Table II

Noise-induced hearing loss claims per 100 000 employees in various workplaces

NIHL claims per 100 000 employees	2005	2006	2007	2008	2009	2010
Underground (gold)	1287	641	611	661	582	524
Underground (other)	2214	1309	800	315	361	268
Opencast	323	259	212	110	144	263

The workplace with the highest NIHL claims per 100 000 employees is underground mines that are not gold mines (Table II). This confirms the results in the costs analysis, that the platinum mines were the most severely affected by NIHL claims in 2005 and have had dramatic reductions in the number of claims per 100 000 employees since then. The probable reason for very high numbers of claims in the platinum industry in 2005 is the slump in the gold industry and peak in the platinum industry that took place in that year and which resulted in a large number of former gold miners moving to the platinum mining industry in that period. It can be argued that the platinum industry inherited the hearing losses. It is also possible that the system that Instruction 171 envisages, where a worker will only have one 'baseline' for his whole working life and all hearing loss changes will be compared to the baseline, was not successfully implemented when workers changed commodity sectors. The lack of detailed information in the NIHL claims database made it difficult to determine the exact reason for this finding.

Since the 2008 milestone, there are claimants for NIHL compensation under 40 years of age in all of the main commodity sectors (Table III). Also, in the age categories where miners have longer service, the number of claims is considerably higher. These miners have hearing loss far beyond what would be expected for their age as a result of the normal age-related degeneration of their senses. The reason for these claims may be that the years when little or no hearing conservation practices were implemented have left a legacy of hearing loss. Additionally, the hearing conservation programmes in operation today are not effective enough to prevent all hearing loss.

The analysis of the claims and cost of claims since 2008 indicates that the gold mining industry is where most victims of NIHL work (Table IV).

Table III

Age categories of noise-induced hearing loss claimants since 2008

Commodity	Age				
	<30 years	30–39 years	40–49 years	50–59 years	>60 years
Gold	5	70	453	594	57
Platinum	0	22	129	212	33
Coal	0	6	42	63	24

Table IV

Costs of noise-induced hearing loss claims since 2008

Post-2008 NIHL compensation costs		
	Rands (millions)	Number of claims
Gold	42 653 722	1179
Platinum	20 397 867	396
Coal	9 061 924	135

Table V

Homogenously exposed groups at a gold mine

HEGs at a gold mine
HEG 1 Shafts and Services
HEG 2 Haulages
HEG 3 Development
HEG 4 Stoping
HEG 5 Roving

Prediction of time to compensation

A parallel analysis of hearing levels at a gold mine was conducted to determine the average rate of PLH shift that would facilitate a prediction of the time period for miners from baseline to compensation. The analysis used the categories of homogeneously exposed groups (HEGs) in use at the mine, as outlined in Table V.

The analysis showed that the rate of average PLH shift differed between HEGs (Figure 3).

Figure 3—Average PLH for various HEGs from 2003 (baseline – BL) to 2006

Table VI

Comparison of two mines for the average PLH shift in one year for various occupations

PLH shift in 1 year	Mine 1	Mine 2
Drillers	2.2%	2.1%
Locomotive operators	0.9%	1.4%
Winch operators	1.3%	1.2%
Stopers	1.1%	1.5%

The results indicated that average PLH shifts in one year differ from mine to mine and across various occupations (Table VI). The average deterioration in PLH in one year at the two gold mines was worst for drillers (2.2 per cent and 2.1 per cent respectively). The stopers at mine 2 were the next most at risk for deterioration in PLH, followed by locomotive drivers at mine 2 (1.4 per cent). The results indicate that each mine needs a customized hearing conservation programme for each occupation type, and that if effective hearing conservation programmes are not in place the mine in question can expect that between five and seven years from baseline the compensation claims will again begin to increase in number.

Conclusions and recommendations

To answer the question regarding what the industry should do now about hearing conservation to ensure that there is no deterioration in hearing greater than 10 per cent, the results clearly indicate that hearing conservation programmes need to be commodity-specific, mine-specific, and occupation-specific. Particularly in large mines, the management and continued improvement of hearing conservation programmes requires a great deal of specialized attention and confirmation of the best-practice call for a hearing conservation co-ordinator/manager at every operation.

The answer to the question: 'What else should the industry aim for to achieve "zero harm" to workers' hearing?' must be found in the known best practice for hearing conservation, namely the use of leading indicators of early NIHL that can address the impact of exposure to high levels of noise and of poorly-fitting hearing protection devices (HPDs), and/or of non-compliance with wearing HPDs. These measures are clearly not widely implemented in the industry, as shown by the compliance figures with best practice reported in recent research conducted by the Safety in Mining Research Advisory Committee (SIMRAC) (Dekker, Franz, van Dyk, and Edwards, 2009). Leading indicators can assist to evaluate hearing conservation programme success (Schulz, 2011).

Such leading indicators need to be customizsed for the operation concerned, but some of the better known indicators are known to be measures such as:

- The percentage of exposed workers with threshold shifts per year
- A 15 dB shift from baseline in at least one frequency 1–6 kilohertz (kHz)
- The number of work areas with excessive noise levels
- The number of workers who work in those areas
- The number of workers with a 5 dB shift in at least two of the frequencies 2, 3, and 4 kHz
- The number of HPDs bought per annum
- The number of HPDs used per section.

Other improvements to current hearing conservation programmes that will improve prevention strategies and allow for monitoring the success of interventions are, firstly, implementing risk-based examinations of the ear to ensure that the variations in gender, age, hearing loss, ear canal size, and susceptibility to hearing loss are taken into account and then followed up by providing an HPD choice for workers. Another strategy that best practice suggests is the use of earplug fit testing in order to ensure that the required attenuation is achieved from the HPDs. The use of the noise reduction rating (NRR) as found on the specifications of HPDs is known to be inaccurate, and real-world verification of HPD attenuation is essential. There are some commercially available methods of checking the attenuation, and the methods all need to be investigated for the South African mining industry (Franz, 2005).

The measurement of temporary threshold shift (TTS) after a working shift, if measured correctly, has the potential to be a powerful indicator for hearing conservation co-ordinators of the effectiveness of HPDs being used and of the compliance of workers with regulations concerning wear of HPDs (Schulz, 2011).

Another measure that the mining industry can implement to ensure that no deterioration in hearing occurs is to use current technology such as otoacoustic emissions, which can indicate inner-ear damage before the damage is evident on the audiogram. This can be used in motivating workers to protect their hearing and in the training of workers on the risks of noise for the development of NIHL.

Another method to further improve hearing conservation programmes would be to include the hearing threshold levels of workers in the risk assessment. In this way the impact of noise would become a priority, and the individual unique response to noise would also be taken into account.

Finally, best practice indicates that noise control engineering must be implemented to reduce the risk of noise exposure (Franz, 2005). The last question addressed in this research, of how the industry can ensure that the 2013 milestone is achieved, requires that all noise sources are ranked according to the level of risk they pose to the human ear. Some work on noise control engineering has been conducted on rock drills (Harper, 2008), but there are many

sources of high levels of noise in the mining industry, and all occupations (including those with slightly lower noise exposure levels) must be identified and addressed. For example, the baseline project conducted by the Safety in Mines Research Advisory Committee (SIMRAC) has clearly ranked a number of at-risk occupations in the industry, and these should be systematically addressed for noise reduction (Edwards, Dekker, Franz, van Dyk, and Banyini, 2011).

International initiatives for noise reduction, such as those at the US National Institute for Occupational Safety and Health (NIOSH), should be taken note of and applied to the South African situation. The NIOSH initiative is called 'Prevention through Design' (PTD), and this initiative has reduced noise exposures of continuous mining machine operators by 3 dB(A) through the four functional areas of PTD: Practice, Policy, Research, and Education (Kovalchik, Matetic, Smith, and Bealko, 2008). More emphasis needs to be given to the engineering controls recommended by best practice, such as sourcing quiet equipment, and using vibration pads, enclosures, barriers, and isolation methods. Again, customized programmes are required, and a hearing conservation co-ordinator needs to manage all these aspects of both noise control engineering and hearing loss.

If there is enough commitment from industry to prevent the deterioration in quality of life that is caused by NIHL, it is possible to achieve the second milestone of reducing the noise exposures from machinery in the industry to below 110 dBA by 2013.

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