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Lower Limb and Ankle Trauma amongst coal miners: Enhancing prevention of injury and improving rehabilitation success

A report to the Joint Coal Board Health and Safety Trust

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Professor Dennis Smith, Professor Ross Harris,
David Harris, George Truman & Natalie Pelham

Rehabilitation Studies Unit
The University of Sydney & Royal Rehabilitation Centre Sydney
PO Box 6
Ryde NSW 1680

Table of Contents

Tables

Executive Summary

This project investigated injury prevention and rehabilitation following lower limb injury. It comprised:

- an exhaustive search of the literature,
- an analysis of a workers' compensation injury database (reported separately),
- a mail-out survey of injured workers,
- a series of face-to-face interviews with seriously injured workers,
- a workshop to list implications of our data for prevention of injury, and
- the develop and trial an audit system for rehabilitation practice.

The literature review revealed that working conditions and experience of the worker were related to injury rates. Also, increased age, accident factors, and injury location and type were related to increased injury severity. Only one published study reporting a successful intervention in rehabilitation practices in the coal industry was found. The reviewed literature was of a relatively low level of evidence when judged by current standards for health research. There are some signposts in the literature for improvements in injury and disability prevention. However, there are serious concerns with the poor quality of evidence presented in the literature, and serious concerns about the quality of data reported in the literature. A dearth of high quality evidence on injuries; their characteristics, prevention and rehabilitation, is particularly disturbing when considering the size and inherent danger of the industry.

A mail-out survey revealed that workers with lower limb injuries frequently had a previous lower limb injury, were aware of the risk of injury and knew a safer way to do things. Furthermore, the main causes/contributing factors included uneven floor/surface, wet/slippery floor, climbing on/off equipment, badly supporting boots, and poor housekeeping. Our analyses revealed that knowledge of risk, and awareness of safer practices do not always prevent injuries, nor does the experience of a previous injury. Causes/contributing factors included some factors which were and are modifiable.

Multivariate analyses of the survey results revealed that injury location and type, awareness of injury risk, educational level of the worker, and some causes/contributing factors influenced the seriousness of the accident. In particular, failure to use standard operating procedures, mining a hazardous geology, lack of job planning, poor light, insufficient space and poor equipment design were related to more severe injuries or greater delays to production. Again, the analyses revealed that some probably significant causes/contributing factors related to serious accidents were modifiable.

The survey also investigated some safety equipment (boots, lamps and modifications for machinery access/egress). In general, injured workers were dissatisfied with boots, especially underground mine workers and those who believed their boots

contributed to their injury. However, two findings are of interest. The first is that no one brand of boot showed up as being more satisfactory than any other. Secondly, the fact that a miner is "happy with his boots" does not prevent serious leg and ankle injuries. Most injured underground mine workers were satisfied with cap lamps, except for a minority who believed that poor light contributed to their injury. Finally, many open cut mine workers report that they jump on or off machinery, despite modifications for access/egress. Attempts to improve safety footwear must continue, however, improvement of lighting in underground mines and machinery access/egress in open cut mines need to be addressed.

The workshop revealed a widespread suspicion of the utility of the JCB's database when used for injury surveillance. Furthermore, effective injury prevention was thought to be hindered by perception of management's lack of commitment to safety, lack of employee ownership of safety strategies, uncertainty regarding responsibility and authority, poor lighting, poor equipment design and modification, and negative attitudes and behaviours of workers. These issues should be considered when attempting to improve health and safety.

Investigation of injury management revealed that half the injuries were assessed at the work site. Workers were satisfied with their assessment especially if the injury was less serious and when the assessment was immediate. About half the injuries were reported immediately. Most reports for serious injuries involved consultation with the injured worker, as did reports made immediately. Reports were generally considered to be accurate especially when consultation was involved. However, few injuries were investigated by management and even then, little feedback was given to the injured worker. These results reveal a great need for improvement in injury assessment, accident reporting, accident investigation and communication of investigations.

Face-to-face interviews with seriously injured workers (ie, those with fractures or more than 4 weeks off work) revealed that they were similar to other injured workers and the cause/contributing factors were also comparable. These interviews showed that, although the workers were performing regular tasks at the time of injured, there were no written procedures for doing the task and they often knew a safer way to do the task. Few of these injured workers were consulted for the report about their injury and little feedback was given. These results again highlight deficiencies in post injury management, and also reveal deficiencies in work planning and procedure documentation.

The trial of the audit for rehabilitation and return to work practice revealed differing process and performance between different mines. No mine earned the minimum score, but no mine performed perfectly. Feedback from staff at the mines suggested that our audit format was acceptable and useful. We conclude that rehabilitation and return to work practices should be audited together with occupational health and safety systems. Rehabilitation process, and return to work practice need to be considered part of occupational health and safety systems in their entirety.

Implementations and recommendations from the study are outlined in the next section and details of the studies are provided in the chapters which follow.

Implications and Recommendations

Future research and development:

- Role of previous injury in lower limb injuries to be investigated and interventions developed and trialed (Chapter 3).
- Interventions or combinations of interventions to reduce known unsafe work practices, ie, to change the 'culture' of coal mining, to be developed and trialed (Chapter 3).
- Interventions or combinations of interventions to reduce exposure to common causes/contributing factors of lower limb injuries to be developed and trialed (Chapter 3).
- Interventions to prevent knee injuries and/or to improve rehabilitation following knee injuries to be developed and trialed (Chapter 4).
- Interventions to address cause/contributing factor of failure to use standard operating practices, to be developed and evaluated (Chapter 4).
- Interventions to address cause/contributing factor of lack of job planning to be developed and evaluated (Chapter 4).
- Interventions to address cause/contributing factor of not enough light to be developed and evaluated (Chapter 4 and Chapter 5).
- Interventions to address cause/contributing factor of mining a hazardous geology to be developed and evaluated (Chapter 4).
- Boots continue to be perceived as problematic. Improvements should continue to be explored (Chapter 5).
- Interventions to improve cap lamps in underground mining to be developed and evaluated (Chapter 5).
- Interventions to address use, or lack of use, of modifications of access/egress for equipment in open cut mining to be developed and evaluated (Chapter 5).
- Interventions to address best practice in purchasing and modification of equipment to be developed and evaluated (Chapter 6).
- Investigate the important issue of why some workers do not get injured, or do not have lost-time injuries (Chapter 6).

Database:

- Review of database to be conducted with full consultation from industry with view to improving database for injury surveillance purposes (Chapter 6).
- Industry-wide education be provided to inform stakeholders of data reporting and coding procedures (Chapter 6).

Accident investigation and feedback:

- Widespread First Aid certification to be encouraged (Chapter 7).
- Open accident investigation involving both management and labour to be encouraged (Chapter 7). Improvements must also be made with regard to communicating findings to workers (Chapter 7, Chapter 8 and Chapter 9). This is possibly best achieved by development of industry-wide Guidelines.

Auditing of Occupational Health and Safety Practices, including Rehabilitation:

- Auditing of Occupational Health and Safety Practices, including Rehabilitation to be encouraged (Chapter 9).
- Promotion of rehabilitation as part of occupational health and safety needed (Chapter 9).

Lobbying:

- Interventions to address causes/contributing factors of failure to use standard operating practices, mining a hazardous geology, not enough space and equipment poorly designed for using be addressed by industry (Chapter 4).
- Encourage the Joint Safety Review Committee to address specific issues, such as lighting, on an industry-wide basis (Chapter 6).

Recommendations of report to be sent to:

- Minerals Council.
- Coal companies.
- Unions - district boards/central.
- Coal Mines Inspectorate.
- Minerals Resources.

Chapter 1

Lower limb and ankle injuries amongst NSW coal miners: Introduction.

The objective of this chapter is to introduce the lower limb and ankle injury study, and to discuss its evolution. The Joint Coal Board Health and Safety Trust, through an advertisement in the Sydney Morning Herald on 26th March 1994, called for proposals for funding of research to be undertaken into occupational health and safety in coal mines. Following this advertisement, Professor Dennis Smith (Professor of Rehabilitation Medicine, The University of Sydney; now Professor of Rehabilitation Medicine, University of Southampton, UK), and Associate Professor Ross Harris (Head, Department of Public Health, The University of Wollongong; now Professor of Pain Management and Rehabilitation, The University of Sydney) submitted a proposal as joint Principal Researchers. David Harris (Project Director, NH&MRC Workplace Health and Safety Project, The University of Sydney) and George Truman (Research Officer, Rehabilitation Studies Unit, Royal Rehabilitation Centre Sydney & The University of Sydney) were Associate Researchers. The resulting proposal titled *Lower leg and ankle trauma amongst coal miners: Enhancing prevention of injury and improving rehabilitation success* was funded. Although the project was initially concerned with lower leg injuries, it quickly became obvious that the inclusion of knee injuries would be beneficial as it was difficult to define lower leg, and often knee and lower leg injuries resulted from the same causes, required similar rehabilitation techniques and had similar rehabilitation outcomes. The project therefore became *Lower limb and ankle trauma amongst coal miners: Enhancing prevention of injury and improving rehabilitation*

The aim of the study was to provide workers, unions and management with information on lower limb and ankle injuries so that (a) more effective preventive and rehabilitation programs can be developed and (b) costs and time loss associated with rehabilitation from these injuries can be reduced.

Lower limb and ankle injuries are both expensive in terms of financial cost and time lost from work, and are theoretically preventable in the coal mining population. The development of more effective preventive and rehabilitation programs for lower limb and ankle injuries will impact positively, financially and socially on the coal mining industry.

The study had two stages. The first of these was epidemiological and exploratory, the second was a demonstration project with on-site remediation and evaluation. The duration of the study was necessarily prolonged, extending over 3 to 4 years. This was both desirable and necessary in order to ensure the reliability of the data, and that the interventions were both planned and evaluated over a sufficiently long time period

The two co-principal researchers are widely experienced in the conduct of health, safety and rehabilitation research and bring together medical and psychological expertise. The associated researchers bring expertise in workplace health and safety (Harris, D) and data management and analysis (Truman). The project was managed by Professor Harris who established a project committee to meet monthly at the Rehabilitation Studies Unit, The University of Sydney.

Objectives

The objectives of the research study were:

1. Examine and report on the personal, organisational and medical factors associated with lower limb and ankle injuries in all coal mines by retrospective analysis of the 1994/95 cohort.
2. Examine and report on the personal, organisational and medical factors associated with rehabilitation success and failure in the 1994/95 cohort of lower limb and ankle injuries.
3. Specify Health and Safety activities to reduce lower limb and ankle injuries which take into account the personal, organisational and medical factors identified in the study of 1994/95 injuries.
4. Specify the personal, organisational and medical arrangements to accelerate rehabilitation and return to work from lower limb and ankle injuries.
5. In collaboration with unions and management, design demonstration projects incorporating 3 and 4 above for trial and evaluation in 1996-7.
6. Report to companies, unions, Joint Coal Board, Health and Safety Trust on findings to (a) reduce lower limb and ankle injuries and (b) speed rehabilitation of workers suffering from lower limb and ankle injuries.

Expected Outcomes

The outcomes which were to emerge from the project were:

1. Information on factors which speed or retard rehabilitation, including return to work, the limits on optimal restoration of fitness, costs and time loss, in respect of lower limb and ankle injuries industry-wide.
2. Information on personal, organisational and medical factors and their relative importance in return to work following injury.
3. Information relevant to prevention of lower limb and ankle injuries in the workforce, presented in a format for discussion and application by Occupational Health and Safety Officers in educational injury prevention programs.
4. Information on the early outcomes of such educational programs in terms of 1996-7 injuries, in terms of both retention of information and its valid application at the worksite.
5. Industry wide guidelines for injury prevention programs, based on both the balanced and generalised utilization of ergonomic, personal, organisational and medical information found to be

relevant from the study of lower limb and ankle injuries.

6. These health and safety guidelines will be presented in a Coal Industry conference and workshop. They will also be presented in an attractive and practical published report.

Methods

Given the broad objectives of the study, several different research methods were used.

A literature review was conducted by identifying relevant published literature with several electronic databases, obtaining copies of the articles, and then critically appraising the articles.

A mail-out survey of a 1-year cohort of miners reporting lower limb injuries was conducted to determine variables associated with injury and injury severity, and subsequent rehabilitation. Questionnaires were mailed to workers recorded on the JCB Injury and Incident database for the 1994/95 financial year.

Face-to-face interviews were conducted with severely injured workers (as defined by reporting a fracture, or having more than 4 weeks off-work) to thoroughly explore variables associated with severe injury and rehabilitation. Invitations to participate in the interviews were sent to all eligible workers reporting injuries in the 1994/95 financial year.

A workshop was conducted to explore issues considered relevant to lower limb injuries in the coal industry. Representatives from Unions, management, workers, OH&S staff, and JCB rehabilitation staff were invited to participate in a one-day workshop. Results from the study were presented and then discussion was directed by a professional facilitator to reveal issues and themes.

A rehabilitation system audit tool was developed and trialed in several underground and open cut mines. The tool was developed using rehabilitation best-practice principles. Acceptability and utility of the tool was assessed with a brief feedback questionnaire.

Consultation with Industry

Full industry consultation was maintained throughout the project. Mr Barry Swan was appointed by the Joint Coal Board Health and Safety Trust as their Project Liaison Officer. As such, Mr Swan acted as communication channel between the project team and the Joint Coal Board Health and Safety Trust. Industry consultation was also maintained through contact with the workers and their representatives, mine management at selected underground and open cut mines, and occupational health and safety staff in the industry. These consultations have ranged in format from informal discussions and feedback sessions to formal reports and seminars.

Chapter 2

Lower limb and ankle injuries amongst NSW coal miners: A review of the literature.

Synopsis

The objective of this chapter is to review published literature to determine the evidence that is available regarding (i) variables associated with injuries, and, in particular, lower limb injuries in coal mine workers, and (ii) variables which are associated with rehabilitation outcomes, particularly following lower limb injuries in coal mine workers.

Introduction

The health service industry is currently undergoing a revolution in terms of increasing the use of the best available evidence in determining practice (eg see Sackett, 1996). This movement, initially known as evidence-based medicine (EBM), has now spread to other areas of health. A fundamental tenet of EBM is that evidence used to decide on practice must be judged according to the strength of the evidence. Often five levels of evidence are identified - Level I - large randomised controlled trials; Level II - small randomised controlled trials; Level III - non-randomised concurrent cohort trials; Level IV - non-randomised historical cohort trials; and Level V - case studies or case series (Sackett, 1996). The US Agency for Health Care Policy and Research (AHCPR) and the Australian National Health and Medical Research Council (NHMRC) identify four levels of evidence - Level I - systematic review of randomised controlled trials; Level II - one or more randomised controlled trials; Level III - well designed non-randomised controlled trials; and Level IV - opinions of experts or descriptive studies (NHMRC, 1995). This literature review will use these two classification systems to judge the strength of evidence regarding the effectiveness of occupational health and safety practices, and rehabilitation practices in the coal mining industry.

Inclusion/exclusion criteria.

Articles were chosen for this review if they were published in English (or had an English translation) in a peer reviewed journal since 1980. These criteria were selected to ensure that only recent reports which had undergone a quality assurance process were considered. Also articles reporting only fatalities, or reporting industrial diseases, such as pneumoconiosis or cancer, were not included in this review.

Variables associated with lower limb injuries in the coal industry.

A thorough literature search to obtain peer-reviewed published research reports was conducted using MEDLINE, CINAHL, NIOSHTIC, HSELINE, CISDOC and MHIDAS by three experienced researchers (George Truman, Natalie Pelham & Dr Thalia Struve-Broughton) using terms including COAL, MINING, INJURIES, and RISK failed to reveal any articles on this topic in international scientific journals.

Variables associated with other injuries in the coal industry.

The need to reduce injuries in the coal mining industry has been asserted since the middle of the nineteenth century (Hodous & Layne, 1993). However much of the early research into the causes of accidents and injuries in the coal mining industry (including up to 1980) has been inconclusive because insufficient numbers of accidents/injuries were studied, or data were not reliably recorded (Bennett & Passmore, 1984a). With this caveat, Bennett and Passmore identified some possible causes or contributing factors associated with injuries in the coal mining industry. Experience and age of the worker, presence/absence of organised labour, the size of the mine, coal extraction technique, safety training, number of shifts and time into shift may be related to accident rates. Bennett and Passmore concluded their review with a call for more extensive and rigorous research into this area. One constant difficulty in epidemiological research is that exposure to a particular variable is not always available, ie either numbers of employees or number of hours worked are not readily available. Therefore true rates cannot be calculated and compared as rate calculation depends upon exposure.

Most recent published research into the causes/contributing factors associated with accidents and injuries in the coal mining industry have relied upon either the administrative records of the Mine Safety and Health Administration (MSHA) from the United States Department of Labour or the Joint Coal Board's (JCB's) Accident and Incident database in New South Wales, Australia. Therefore, the value of much of the recent research into accidents in the coal mining industry depends strongly on the accuracy and integrity of those databases.

Bennett and Passmore (1984b) investigated the relationship between variables and duration of work time lost following injury in 82,705 incidents recorded in the MSHA database from 1975 to 1981. In a larger study of the same and some additional MSHA data, Bennett and Passmore (1985) analysed variables associated with severity of 91,404 injuries reported in underground coal mines from 1975 to 1982. Severity was measured by six categories: death; permanent total or partial disability; requiring days off work only, but not permanent disability; requiring days off work and modified work activity; modified work activity only; and injury so minor that it is not in any other category (ie, no consequences). Their analyses revealed that accident type, miner's age, use of powered tools, location in mine of accident, mining system, geographical region, and year of injury were associated with severity of injury. In summary, some of their results showed: all accident types were more likely to result in death, disability, or modified work rather than no consequences; injuries of older miners were more likely to produce disability or modified work than no consequences when compared to younger workers; accidents involving powered tools were more likely to produce disability or modified work than no consequences when compared to accidents involving manual processes; and accidents at the coal face were more likely to produce severe disability than no consequences when compared to accidents at other locations in the mine. Injury severity was not associated with experience. This study has a major flaw in that it is unclear how many 'no consequence' accidents are reported, and in fact, Lee and colleagues (1993) chose to exclude this group of workers because of questions of completeness of data collection. However, Bennett and Passmore highlighted the fact that injuries, including those resulting in severe disability, can occur throughout the mine and are not restricted to the coal face. This study would be considered Level III EBM classification, and a Level III AHCPR/NHMRC classification.

Watson and White (1984) investigated the relationship between variables and severity of injury for 1,431 female coal miners reported in the MSHA database from 1978 to 1980. They found that injury severity was related to mine type, cause and nature of injury, age and body part injured. They also reported that female coal miners had a lower rate of lost time injury, fewer days off work, and a lower rate of fatalities than male coal miners in the same time period. It was not clear how much of this difference was due to females being less likely to undertake higher risk tasks, given their relative inexperience in the coal mining industry. Close examination of some accident reports by Watson and White revealed that some accidents were due to poorly fitted safety equipment. They argued that smaller sized safety equipment must be manufactured to ensure that women can work safely as coal miners. This study would be considered Level III EBM classification, and a Level III AHCPR/NHMRC classification.

Butani (1988) investigated the relationship between variables and rates of injury in coal mine workers. They used information from the 1986 cohort of injured workers from the MSHA database. Information for exposure was obtained from a random sample of mines and miners. They found that experience at the present company is more important than age in determining injury rates. Workers with less than one-years experience had a higher than average risk whereas workers with more than fifteen-years experience had lower than average risk of injury. This study would be considered Level II EBM classification, and a Level II AHCPR/NHMRC classification.

Leigh and colleagues (1990) investigated the relationship between personal and environmental factors and lost-time injury in 16,700 non-fatal accidents recorded in the JCB database from 1986 to 1988. They found that underground mine workers had the highest rate of injury, followed by underground mine surface workers and then open cut mine workers. They also found that age, experience, occupation, nature of injury, body part, type of accident, task, shift type and time into shift were associated with lost-time injury. However, while they were able to report frequencies of accidents, they were unable to compare rates for different levels of these factors as exposure was not obtainable. They concluded that while their findings highlighted factors associated with high frequency accidents, more precise recording of exposure is needed to determine risk of injury and to evaluate specific intervention designed to reduce injury. This study would be considered Level III EBM classification, and a Level III AHCPR/NHMRC classification.

Leigh and colleagues (1991) also investigated the relationship between variables and back or non-back lost-time injuries for 14,956 strain/sprain injuries recorded in the JCB database from 1986 to 1988. They found that back strain/sprain injuries frequently recurred, and resulted in more days off work than non-back strain/sprains. Back strain/sprains often resulted from overexertion and involved mining equipment. They suggested that preventative strategies designed to stop workers from overexertion could be implemented to reduce injuries. This study would be considered Level II EBM classification, and a Level II AHCPR/NHMRC classification.

Lee and colleagues (1993) investigated variables associated with rates of significant traumatic injuries of male underground coal miners using MHSA data from 1986. Rates were calculated using numbers, and age and experience statistics of coal miners from the US Department of Interior. Workers with 2 to 3 years experience in the mine or over 10 years experience in their current job had higher injury rates than other workers. Additionally, younger workers were found to have a higher injury rate than older workers, however, Lee and colleagues concluded that experience in their current job and experience in the particular mine was more important than age per se. Lee and colleagues also investigated variables associated with severity of injuries. Two injury severity groups were defined; fewer than 5 days off work, and 5 days or more off work (including death). Logistic regression revealed that experience in the mine has a protective effect in that the chance of a more serious injury is reduced by 10% after 5 years experience in the mine, while experience in their current job has an adverse effect in that the chance of a more serious injury is increased by 20% after 5 years experience in their current job. In conclusion, Lee and colleagues reiterated their caveat of interpretation of incomplete data sets, but also reinforced the importance of conducting research in this area given the size of the industry, the high injury rate associated with it, and the inherent danger associated with coal mining. This study would be considered Level IV EBM classification, and a Level III AHCPR/NHMRC classification.

Hunting and Weeks (1993) analysed MHSA data to determine the characteristics of mines with high rates of transport-related injuries. They found that most mines with high transport-related injuries were small, have a disproportionate number of injuries of young and inexperienced workers and had a disproportionate number of more severe injuries. They concluded that these results were due to smaller mines on average having less experienced workers. They suggested that injury rates could be reduced by improving training which targets newly hired workers. This study would be considered Level IV EBM classification, and a Level III AHCPR/NHMRC classification.

Summary of results.

The following factors were reported to be associated with increased risk of injuries: underground work, lack of experience in a mine, increased experience in current job, younger workers, and small mines. The following factors were reported to be associated with more severe injuries: older workers, use of powered tools, accidents at the coal face, back strain/sprains, lack of experience in a particular mine, increased experience in current job, and male mine workers. Several of these factors are highly correlated, for example, age and experience, and it is therefore difficult to determine whether both factors are important or which factor is more important than the other.

Variables associated with rehabilitation outcomes following lower limb injuries in the coal industry.

A thorough literature search to obtain peer-reviewed published research reports were conducted using MEDLINE, CINAHL, NIOSHTIC, HSELINE, CISDOC and MHIDAS by three experienced researchers (George Truman, Natalie Pelham & Dr Thalia Struve-Broughton) using terms including COAL, MINING, INJURIES, and REHABILITATION failed to reveal any articles on this topic in international scientific journals.

Variables associated with rehabilitation outcomes following other injuries in the coal industry.

A prospective study was conducted in two Queensland coal mines to evaluate the effectiveness of a 'back school' and early rehabilitation program to prevent chronic back pain (Ryan et al., 1995). A newly established mine acted as the experimental mine while an established mine acted as a control. While the results of this study suggest that this program reduced the number of claims, and the average cost of claims, the authors acknowledge that differences in psychosocial factors between the workers of the two mines may be responsible for the results, and not the program per se. Psychosocial factors are well known to affect chronicity of back pain (Bigos et al., 1991). This study would be considered Level III EBM classification, and a Level III or Level IV AHCPR/NHMRC classification.

Summary of results.

Interventions, including early rehabilitation, can potentially improve rehabilitation outcomes.

Conclusion

Evidence identifying factors associated with increased risk of injury or increased risk of more severe injury in coal mine workers is relatively scarce in the published literature and of a low level of strength. Also, evidence of interventions to improve outcomes following injury in coal miners is scarce and of low level of strength. Evidence of interventions to eliminate or reduce the effect of factors associated with increased risk of injury or increased risk of more severe injury in coal mine workers is non-existent in published peer-reviewed literature.

It is unclear why there is such a scarcity of good meaningful research on coal mining injuries published in peer reviewed journals. There are at least two (the MHSA and JCB's) databases which can be used for analyses. Furthermore, as Lee and colleagues (1993) point out, it is important to conduct research in this area given the size of the industry, the high injury rate associated with it, and the inherent danger associated with coal mining. However, there do appear to be some difficulties in conducting research in the area. First, while some factors important for injury prevention have been identified through various studies, these studies have relied upon databases with uncertain integrity. Before good reliable epidemiological analyses can be conducted into these factors, the accuracy and integrity of the databases needs to be guaranteed. Second, the coal mining industries in Australia and in the US are very competitive, and given current environmental pressures, they are becoming more competitive. This may hinder research as any company which finds a financial advantage through reduction of the costs of workplace injuries would be reluctant to convey this information to a competitor. Added to this is the problem of needing moderate to large numbers of observations to conduct research. This means that companies would need to co-operate and share information which may lead to their competitors gaining a financial advantage. These are not mutually exclusive difficulties, nor are they the only difficulties facing conducting and publishing research in this area.

Chapter 3

Factors contributing to lower limb and ankle injuries in coal miners in NSW: Univariate analyses of a survey of injured workers.

Synopsis

The objective of this chapter is to investigate causes/contributing factors of lower limb injuries in the NSW coal industry. All workers reporting a lower limb injury in 1994/95 financial year were surveyed to identify (i) variables which were frequently reported as contributing to a lower limb injury, and (ii) variables which had different frequencies for the three different workplace groups.

Introduction

Coal mining has one of the highest rates of workplace injuries in NSW and internationally. This is especially the case for underground coal mining. Despite the significance of coal mining in occupational injuries, there is little published research into the causes and possible prevention of injuries in coal mining. Early research into the causes of coal mine accidents/injuries was often inconclusive and often relied upon inadequate data bases (Bennett & Passmore, 1984a). Because of these problems Bennett and Passmore identified age and experience as *possible* predictive factors, but concluded that more rigour in conducting research in this area was needed to obtain valid results.

While age appears to be related to injury rate, it is likely that experience working with the present company may be a better predictor of injury (Butani, 1988). Employees with less than 1 year experience with a company had a higher than average chance of injury whereas employees with over 15 years experience had a lower than average chance of injury. Lee and colleagues (1993) also concluded that, when injury severity is considered, experience in current job is more important than age in determining rate and severity of injury. However they found an opposing effect between experience in a mine and experience in the worker's current job. While experience in a mine has a protective effect of chances of serious injury, experience in current job increases the likelihood of an injury being a severe injury.

Leigh and colleagues (1990) retrospectively analysed 16,700 non-fatal lost-time accidental injuries recorded for NSW coal mines between July 1986 and December 1988. They found that underground workers had a higher rate of injury per 1000 employees than open cut workers. They also found that younger age, strain/sprains, trunk/upper limbs/lower limbs, involvement of equipment, activity undertaken at the time of accident, shift type and time into shift were associated with accidental lost-time injuries. Leigh and colleagues recognised that a lack of information regarding exposure resulted in uncertainty in the interpretation of their results. No attempt was made to compare risk factors with levels of severity. In a second study of the same data, Leigh and colleagues (1991) compared back sprains/strains with non-back sprains/strains. Although factors were identified which were associated with back sprains/strains, but not other non-back sprains/strains, it was not clear whether the difference between back and non-back sprains/strains was one of injury severity or of anatomical location.

The current study investigated factors associated with injury and injury severity in coal miners in NSW for injuries in a strict anatomical location, namely lower limb injuries. Lower limb injuries account for approximately one quarter of all injuries in the coal mining industry (Leigh et al., 1990). The study aimed to explore recent accidents resulting in lower limb and ankle injuries in coalminers in NSW by surveying all lower limb injuries reported in 1994/95. Respondents were given the opportunity to endorse more than one cause/contributing factor, and they were given the opportunity to estimate the severity of the accident allowing a better investigation of prevalence of cause/contributing factors in accidents resulting in lower limb and ankle injuries. Due to the differing nature of the working environments, injured workers were divided into workplace groups of underground mine workers, open cut mine workers and other coal industry workers, including contract workers and coal preparation plants.

Method

A questionnaire was developed by the research team with consultation from industry. A copy was mailed out to all miners completing an Accident and Incident report form for the JCB with an injury location recorded as below the hip in the financial year 1994/95. A total of 1604 individuals were identified from 2078 reports of lower limb injuries. A second copy of the questionnaire was mailed out 8 weeks later and a reminder letter was also sent. To improve participation, a lottery was held for a small cash prize for a randomly selected respondent. Seven hundred and seventeen questionnaires were returned (45%). Of these, 128 respondents stated that they did not recall their injury, leaving 589 completed questionnaires.

Respondents were divided into 3 groups - underground mine workers, open cut mine workers and other coal industry workers (including contractors and coal preparation plants). The majority of respondents were from underground coal mines (78%), and two-thirds of the remaining injured workers were from open cut mines (13% of total). This proportion of workplace groups was similar to that of questionnaires mailed out (underground mine workers = 77%; open cut mine workers = 12%). Where possible, postcode of a respondent was recorded and comparison with postcodes of questionnaires mailed out revealed that the sample was representative in terms of geographical area.

Approximately one-half of the injured workers had achieved their High School Certificate or Leaving Certificate or a higher qualification (54%). There was no significant difference between the three workplace groups for educational level achieved ($X^2 = 0.43$, $p > 0.05$)

Results

In general, injured workers were experienced in the industry (see Table

3.1). There was a significant difference between the three groups for experience ($X^2 = 40.43$, $p < 0.001$). Over one-third of the underground mine workers and other coal industry workers had more than 20 years experience (40% and 42.6% respectively), whereas less than one in ten open cut mine workers had more than 20 years experience (6.1%).

Table 3.1: Experience of injured workers (percentages).

	Underground mine workers	Open cut mine workers	Other coal industry workers
< 5 years	1.3	7.6	0.0
5 - 10 years	9.2	16.7	9.3
10 - 20 years	49.5	69.7	48.1
20 - 30 years	32.5	6.1	37.0
30 or more years	7.5	0.0	5.6

There was a significant difference between the three groups on the issue as to whether the injured worker had a previous lower limb injury or not ($X^2 = 17.11$, $p < 0.001$). About one-half of the injured underground mine workers had a previous lower limb injury (50.6%), slightly less than one-half of the other coal industry workers (39.6%), and about one-quarter of the open cut mine workers had a previous lower limb injury (24.2%).

Tables 3.2 and 3.3 show the location of lower limb and ankle injuries and the type of lower limb and ankle injuries respectively. The main location of injury in all groups was the knee (49.2% in underground mine workers, 40.9% in open cut mine workers and 51.9% in other coal industry workers) and ankle (36.5% in underground mine workers, 36.4% in open cut mine workers and 40.7% in other coal industry workers). The main types of injury in all groups were sprain/torn ligaments (48.8% in underground mine workers, 45.5% in open cut mine workers and 53.7% in other coal industry workers), bruise (31.4% in underground mine workers, 19.7% in open cut mine workers and 22.2% in other coal industry workers), and strain/torn muscle (23.1% in underground mine workers, 16.7% in open cut mine workers and 25.9% in other coal industry workers). The only significant difference between the three groups on location or type of lower limb and ankle injuries was for foot injuries ($X^2 = 6.27$, $p = 0.04$). About one fifth of injuries were to the feet in underground mine workers and other coal industry workers (20.4%), while less than one tenth of open cut workers had foot injuries (7.6%).

There was no significant difference between the three groups and awareness of the risk of injury ($X^2 = 4.73$, $p > 0.05$) nor knowing a safer way to do the job ($X^2 = 0.54$, $p > 0.05$). Just over one-half of the workers were aware of the risk of injury; 62.5% of underground mine workers, 56.1% of open cut mine workers and 48.1% of other coal industry workers were aware of the risk. Furthermore, about one-quarter of the workers were aware of a safer way to do the job (25.2% of underground mine workers, 25.8% of open cut mine workers and 20.8% of other coal industry workers).

Table 3.2: Location of lower limb and ankle injuries (percentages).

Note: Totals do not add to 100% as more than one location of injury can be reported per accident.

	Underground mine workers	Open cut mine workers	Other coal industry workers
Knees	49.2	40.9	51.9
Ankle	36.5	36.4	40.7
Foot	20.4	7.6	20.4
Shin	8.8	13.6	1.9
Calf	8.6	12.1	3.7
Toes	5.3	3.0	0.0

Table 3.3: Type of lower limb and ankle injuries (percentages).

Note: Totals do not add to 100% as more than one type of injury can be reported per accident.

Type of injury	Underground mine workers	Open cut mine workers	Other coal industry workers
Sprain/torn ligament	48.8	45.5	53.7
Strain/torn muscle	23.1	16.7	25.9
Bruise	31.4	19.7	22.2
Cuts/laceration	13.4	15.2	3.7
Fracture	7.7	4.5	5.6
Crush	7.3	1.5	9.3
Abrasions	11.2	3.0	9.3

Table 3.4 shows the perceived cause/contributing factors which resulted in lower limb and ankle injuries. The major perceived cause/contributing factors for underground mine workers were uneven floor/surface (67.3%), wet/slippery floor conditions (47.7%), climbing on/off equipment (37.8%), badly supporting boots (37.4%) and poor housekeeping/untidy work area (34.7%). The major perceived cause/contributing factors for open cut mine workers were uneven floor/surface (56.1%) and climbing on/off equipment (54.5%). The major perceived cause/contributing factors for other coal industry workers were uneven floor/surface (51.9%), poor housekeeping/untidy work area (38.9%) climbing on/off equipment (38.9%) and wet/slippery floor conditions (37.0%). We consider that these findings are of fundamental importance in determining how to prevent injury, by the application of better practice. This would reduce the injury rate, which at present appears unacceptable compared to other industries.

There were significant differences between the three groups on the involvement of equipment poorly designed for use as a contributing factor in their injury (X^2 = 7.00, p = 0.03), involvement of not enough space to work in (X^2 = 8.64, p = 0.01), involvement of badly supporting boots (X^2 = 24.13, p < 0.01), mining a hazardous geology (X^2 = 20.45, p < 0.01), involvement of wet/slippery floors (X^2 = 17.49, p < 0.01), involvement of uneven floor/surface (X^2 = 7.33, p = 0.03), and involvement of climbing on/off equipment (X^2 = 6.76, p = 0.03). All the above are more commonly reported for underground mine workers, except for equipment poorly designed for use and climbing on/off equipment.

Table 3.4: Perceived cause/contributing factors which resulted in lower limb and ankle injuries (percentages).

Note: Totals do not add to 100% as more than one perceived cause/contributing factor can be reported per accident.

Perceived cause/contributing factor	Underground mine workers	Open cut mine workers	Other coal industry workers
Uneven floor/surface	67.3	56.1	51.9
Wet/slippery floor conditions	47.7	21.2	37.0
Climbing on/off equipment	37.8	54.5	38.9
Badly supporting boots	37.4	10.6	18.5
Poor housekeeping/untidy work area	34.7	28.8	38.9
Not enough space to work in	28.8	13.6	18.5
Mining a hazardous geology	28.1	9.1	7.4
Not enough light/lighting a problem	18.9	18.2	24.1
In a hurry/short on time	16.7	13.6	16.7
Not enough manpower	15.2	6.1	13.0
Equipment poorly designed for use	14.3	22.7	25.9
Emphasis on production, not safety	12.1	12.1	9.3
Lack of job planning	8.4	13.6	7.4
Recommended equipment not available	8.1	9.1	5.6
Standard operating procedures not in use	7.7	1.5	3.7
Poorly maintained equipment	5.5	12.1	7.4
Poorly guarded equipment	2.6	0.0	0.0
Lack of training	2.2	1.5	1.9

Table 3.5: Potential severity of injury (percentages).

	Underground mine workers	Open cut mine workers	Other coal industry workers
Fatality or permanent disability	9.8	6.2	5.7
Serious lost-time injury	33.3	26.2	32.1
Moderate lost-time injury	42.7	33.8	37.7
Minor lost-time injury	12.9	29.2	24.5
No lost-time injury	1.3	4.6	0.0

Injured workers also rated the potential seriousness of their accident by rating how severe their injury could have been, and how much production time could have been lost because of their injury (see Tables 3.5 and 3.6). Most injured workers rated their injury as having the potential to be a moderate lost-time injury. There was a significant difference between the three groups on their rating of the potential severity of injury ($X^2 = 20.84$, df = 8, p = 0.008). Underground mine workers and other coal industry workers tended to rate their injuries as being potentially more severe than open cut mine workers.

Most injured workers rated their injury as having the potential to result in less than 1 hour loss of production. There was also a significant difference between the three groups in terms of the rating of the potential delay in production ($X^2 = 37.42$, df = 8, $p < 0.001$). Just over one quarter of the open cut mine workers (29.7%) rated a potential loss of one day's production from their injury, whereas less than one in 10 underground mine workers (9.6%) and other coal industry workers

(9.8%) rated a potential loss of one day's production from their injury.

possible to determine whether more experienced workers suffer a greater number of lower limb injuries than other workers. It is also not possible to determine whether inexperienced workers have a higher risk of injury. Good routine collection of variables such as age and experience in the industry, will allow the comparisons of relative risk, and thereby identify possible interventions to reduce injury risk.

Table 3.6: Potential delay in production (percentages).

	Underground mine workers	Open cut mine workers	Other coal industry workers
More than 1 day	9.6	29.7	9.8
One shift to 1 day	3.1	1.6	5.9
One shift	3.3	1.6	5.9
One hour to one shift	33.8	12.5	13.7
Less than 1 hour	50.2	54.7	64.7

Summary of results

Injured workers were experienced in the industry, and about one-half had previous lower limb injuries. The knee was most commonly injured, and injury was most likely to be sprain/torn ligament. Workers were aware of the risk of injury and one quarter of the injured workers knew of a safer way to do the job. Uneven floor/surface, wet/slippery floor, climbing on/off equipment, badly supporting boots and poor housekeeping were major causes/contributing factors for lower limb injuries. Workers rated their injury to have the potential to be a moderate lost-time injury, but resulting in less than one hour delay to production. Underground mine workers rated the potential for severe injury greater than open cut mine workers, whereas open cut mine workers rated the potential for delay in production greater than underground mine workers.

Discussion

This study found that even experienced workers suffer lower limb injuries. However, the lack of information regarding the experience levels of coal industry workers means that it is not possible to determine whether more experienced workers suffer a greater number of lower limb injuries than other workers.

About one-half of the injured workers had a previous lower limb injury. There are several possible explanations for this observation which are not mutually exclusive. First, workers may be aggravating injuries which have not recovered due to inadequate recovery time or mismanagement of the original injury. Second, some workers may be more prone to lower limb injuries because of their physical condition, occupational role or behaviour. Finally, this observation may be due to random occurrences of a frequent event (ie, a lower limb injury) in an individual. Although there is a difference between previous injuries in the three workplace groups, it is not possible to identify the relative importance of the explanations from the data in our survey, nor the role of other explanations. The issue of repeated injury needs further investigation.

Our finding that the knee was the lower limb part most often injured supports injury database analyses (eg, JCB, 1994). However, in our survey we found a greater proportion of workers reporting ankle injuries than in other analyses (eg, we found the proportion of ankle to knee injuries was about 2 to 3, whereas in the 1994 JCB report the proportion of ankle to knee injuries it was 1 to 2). This is most likely due to the fact that workers could report more than one injury location in our survey, but are restricted to reporting only one injury location in the JCB database. While *Lower Limb, multiple* is a coding option for the JCB database, which can be used for cases where both ankle and knee injuries occur, this classification includes numerous combinations of multiple injury sites, thereby making it a heterogeneous collection of injury sites. The issue of multiple injury locations is significant and may be very important. Injuries involving both the knee and ankle are more likely to be serious than an injury involving only the knee or the ankle. The implications of this for rehabilitation, and for the cost of the injury are not trivial, and therefore injury location must be better recorded if the JCB database is to be used for injury surveillance. Our finding that workers often record more than one injury type when permitted to do so has similar implications.

It was of importance to find that one-half of the injured workers were aware of the risk of injury, and one quarter of the injured workers knew of a safer way to do the job. Therefore, workers know that they are likely to be injured, and also of how to do the job more safely, but they persevere with unsafe practices and then get injured. While it is tempting to dismiss this observation as a consequence of worker attitudes and the unmodifiable 'culture' of coal mining, the observation highlights a serious problem that needs to be addressed. It is likely that the solution to this problem will not be a single intervention, but a series of interventions, targeting various levels of the coal mining industry, from the individual worker up to senior management, and involving individual-centred interventions as well as organisational changes. Trials of possible interventions and combinations of interventions should be a priority. Our finding, in part, provides validation for ongoing OH&S education of workers. Furthermore, it raises the question of the impact of changing worksite management activities, including productivity targets, on worker behaviour.

The finding that the most commonly reported causes or contributing factors to lower limb injuries are uneven floor/surface, wet/slippery floor, climbing on/off equipment, badly supporting boots and poor housekeeping is not surprising. Coal industry employees work in a hostile environment (uneven floor/surface, wet/slippery floors and poor housekeeping), perform difficult tasks (climbing on/off equipment), with sub-optimal personal protective equipment (badly supporting boots). Again it is tempting to dismiss this finding as a consequence of worker attitudes and the 'culture' of coal mining. However, exposure to these causes/contributing factors can be reduced. Methods of providing dry floors should be found. These may include the installation of manufactured walkways or improved housekeeping activities. Methods of reducing the difficulty of tasks also need to be found. These may include better access/egress routes, increased lighting and improved training in performing the tasks. Finally, methods of providing optimal personal protective equipment must be found. Efforts at achieving this are currently underway, however, the widespread dissemination of information regarding this issue is important to ensure that full value is obtained from these efforts. As with awareness of risk and safer methods, the solution to the problem of common cause/contributing factors will not be a single intervention, but a series of multi-targeted interventions involving individual- and organisation-centred interventions. Trials of possible interventions and combinations of interventions should be a priority.

Finally, coal industry workers report that the accidents that occur are potentially serious, in terms of severity of injury (for all workplace groups) and delay to production (for open cut mine workers). This suggests a possible motivation for injury prevention programs.

Chapter 4

Relationship between causes/contributing factors and the seriousness of lower limb and ankle injuries in coal miners in NSW: Multivariate analyses of a survey of injured workers.

Synopsis

The objective of this chapter is to investigate the relationship between causes/contributing factors and the seriousness of lower limb injuries in the NSW coal industry. All workers reporting a lower limb injury in 1994/95 financial year were surveyed to identify (i) variables which predict more severe injury, and (ii) variables which predict greater delays to productivity.

Introduction.

Research into coal mine injuries has typically identified factors which are related to injury occurrence (eg, Butani, 1988; Lee et al., 1993; Leigh et al., 1990, 1991; Chapter 3). In some studies exposure is included in analyses allowing a comparison of relative risk of injury (eg, Butani, 1988). All of these studies however do not consider the issue of severity of injury or the seriousness of the accident. No distinction is made between an injury, for example, which results in two days off work compared with an injury which, for example, results in two months off work. In a thorough review of the literature on the factors associated with injuries in coal mining, Bennett and Passmore (1984a) concluded that more research was required to investigate variables which have an impact on the severity of injury. In a recent study, Hull (1994) used number of days off work as a dependent variable in a regression study to identify predictors of severity of injury. This study however relied on the use of lost-time injury, which is subject to possible bias, and data which is routinely collected in a workers' compensation database, which may also be subject to bias.

Our study aimed to rectify these two problems by using a questionnaire to explore recent accidents resulting in lower limb and ankle injury in coalminers in NSW. Respondents rated the seriousness of their accident in terms of potential severity of injury and potential delay to production. Injured workers were also given the opportunity to endorse more than one cause/contributing factor for their accident, and more than one type and location for their injury. The relationship between these cause/contributing factors and accident seriousness in the coal mining industry in NSW was then investigated using model building with logistic regression.

Method

The data for this chapter are from the survey reported in Chapter 3. Separate regressions were performed for the three groups (ie, underground mine workers, open cut mine workers and other coal industry workers). The forward stepwise model building method for logistic regression was used. Although stepwise methods for regression are no longer as popular as they have been, Hosmer and Lemeshow (1989) recommend this method in new research areas where predictors are not known and the association between predictors and the dependent variable is not well understood (p 106).

Perceived causes/contributing factors, worker variables (ie, years working in the coal mining industry and education level), injury variables (ie, location and type of injury), and worker knowledge variables (ie, awareness of risk and knowledge of safer way to do work) were tested in the models.

Two different dependent variables were used in the models: severity of injury (potentially serious or fatal versus potentially moderate or less severe), and delay to production (more than 1 hour delay versus delay of 1 hour or less). Among underground mine workers, 43.1% of workers rated their injury as potentially serious or fatal and 56.9% as potentially moderate or less severe. For open cut mine workers, 32.3% of workers rated their injury as potentially serious or fatal and 67.7% as potentially moderate or less severe. For other coal industry workers, 37.7% of workers rated their injury as potentially serious or fatal and 62.3% as potentially moderate or less severe. With regard to delay to production, for underground mine workers 49.8% of workers rated their accident as potentially causing more than 1 hour delay to production and 50.2% as potentially causing 1 hour or less delay to production, for open cut mine workers 45.3% of workers rated their accident as potentially causing more than 1 hour delay to production and 54.7% as potentially causing 1 hour or less delay to production, and for other coal industry workers 35.3% of workers rated their accident as potentially causing more than 1 hour delay to production and 64.7% as potentially causing 1 hour or less delay to production.

Table 4.1: Significant predictors for severity of injury for underground mine workers.

Variable	B (SE of B)	Wald	p	Exp(B)	95% CI Exp(B)
Education	-0.38 (0.11)	12.07	<0.01	0.68	0.55 - 0.85
Cuts/lacerations	0.38 (0.19)	4.08	0.04	1.47	1.01 - 2.13
Fracture	0.51 (0.23)	4.91	0.03	1.66	1.06 - 2.61
Crush	0.52 (0.22)	5.34	0.02	1.68	1.08 - 2.61
Abrasions	0.38 (0.20)	3.59	0.06	1.46	0.99 - 2.17
Calf	0.51 (0.21)	5.94	0.01	1.67	1.11 - 2.52
Knee	0.24 (0.11)	4.68	0.03	1.27	1.02 - 1.58
Aware of injury risk	0.23 (0.12)	3.85	0.05	1.26	1.00 - 1.59
Standard operating procedures not in use	0.75 (0.24)	9.66	<0.01	2.12	1.32 - 3.41
Mining a hazardous geology	0.27 (0.12)	4.99	0.03	1.31	1.03 - 1.66

Results

Severity of injury

Table 4.1 shows the results of the model building for underground mine workers using severity of injury as the dependent variable. The model was significant ($X^2 = 77.76$, $p < 0.0001$), and correctly predicted 69% of observations.

perceived as potentially serious or fatal than potentially moderate or less severe. An accident involving a worker who was aware of the injury risk was 26% more likely to be perceived as

Table 4.2: Significant predictors for severity of injury for open cut mine workers.

Variable	B (SE of B)	Wald	p	Exp (B)	95% CI Exp(B)
Lack of job planning	0.79 (0.38)	4.24	0.04	2.20	1.04 - 4.68
Not enough light	0.85 (0.35)	5.95	0.01	2.33	1.18 - 4.62

Ten variables were identified as being related to severity of injury for underground mine workers. An accident occurring when standard operating procedures were not in use was 112% more likely to be perceived as potentially serious or fatal than potentially moderate or less severe. An accident involving a crush injury was 68% more likely to be perceived as potentially serious or fatal than potentially moderate or less severe. An accident involving a calf injury was 67% more likely to be perceived as potentially serious or fatal than potentially moderate or less severe. An accident involving a fracture was 66% more likely to be perceived as potentially serious or fatal than potentially moderate or less severe. An accident involving cuts/lacerations was 47% more likely to be perceived as potentially serious or fatal than potentially moderate or less severe. An accident involving abrasions was 46% more likely to be perceived as potentially serious or fatal than potentially moderate or less severe. An accident involving mining a hazardous geology was 31% more likely to be perceived as potentially serious or fatal than potentially moderate or less severe. An accident involving a knee injury was 27% more likely to be potentially serious or fatal than potentially moderate or less severe. Finally, an accident involving a worker who had secondary or higher education was 32% less likely to be perceived as potentially serious or fatal than potentially moderate or less severe.

Table 4.2 shows the results of the model building for open cut mine workers using severity of injury as the dependent variable. The model was significant ($X^2 = 8.54$, $p = 0.0140$), and correctly predicted 72% of observations.

Two variables were identified as being related to severity of injury for open cut mine workers. An accident involving not enough light was 133% more likely to be perceived as potentially serious or fatal than potentially moderate or less severe, and an accident involving lack of job planning was 120% more likely to be perceived as potentially serious or fatal than potentially moderate or less severe.

Table 4.3 shows the results of the model building for other coal industry workers using severity of injury as the dependent variable. The model was significant ($X^2 = 7.20$, $p = 0.0073$), and correctly predicted 67% of observations.

Table 4.3: Significant predictors for severity of injury for other coal industry workers.

Variable	B (SE of B)	Wald	p	Exp (B)	95% CI Exp(B)
Education	-0.84 (0.33)	6.32	0.01	0.43	0.22 - 0.83

One variable was identified as being related to severity of injury for other coal industry workers. An accident involving a worker who had secondary or higher education was 57% less likely to be perceived as potentially serious or fatal than potentially moderate or less severe.

Delay to production

Table 4.4 shows the results of the model building for underground mine workers using delay to production as the dependent variable. The model was significant ($X^2 = 27.38$, $p < 0.0001$), and correctly predicted 60% of observations.

Three variables were identified as being related to delay to production for underground mine workers. An accident involving abrasions was 75% more likely to be perceived as resulting in more than 1 hour production delay than resulting in a production delay of 1 hour or less. An accident occurring when standard operating procedures were not in use was 73% more likely to be perceived as resulting in more than 1 hour production delay than resulting in a production delay of 1 hour or less, and an accident involving mining a hazardous geology was 36% more likely to be perceived as resulting in more than 1 hour production delay than resulting in a production delay of 1 hour or less.

Table 4.5 shows the results of the model building for open cut mine workers using delay to production as the dependent variable. The model was significant ($X^2 = 4.59$, $p = 0.0321$), and

Table 4.4: Significant predictors for delay to production for underground mine workers.

Variable	B (SE of B)	Wald	p	Exp(B)	95% CI Exp(B)
Abrasions	0.56 (0.18)	9.78	<0.01	1.75	1.23 - 2.48
Standard operating procedures not in use	0.55 (0.23)	5.77	0.02	1.73	1.11 - 2.71
Mining a hazardous geology	0.31 (0.12)	6.92	0.01	1.36	1.08 - 1.71

Table 4.5: Significant predictors for delay to production for underground mine workers.

Variable	B (SE of B)	Wald	p	Exp(B)	95% CI Exp(B)
Not enough space	0.83 (0.42)	3.83	0.05	2.29	1.00 - 5.26

correctly predicted 62% of observations.

One variable was identified as being related to delay to production for open cut mine workers. An accident involving not enough space was 129% more likely to be perceived as resulting in more than 1 hour production delay than resulting in a production delay of 1 hour or less.

Table 4.6 shows the results of the model building for other coal industry workers using delay to production as the dependent variable. The model was significant (X^2 = 10.49, p = 0.0053), and correctly predicted 67% of observations.

Table 4.6: Significant predictors for delay to production for underground mine workers.

Model/Variable	B (SE of B)	Wald	p	Exp(B)	95% CI Exp(B)
Education	-0.73 (0.35)	4.37	0.04	0.48	0.24 - 0.96
Equipment poorly designed	0.72 (0.36)	3.92	0.05	2.05	1.01 - 4.17

Two variables were identified as being related to delay to production for other coal industry workers. An accident involving equipment poorly designed was 105% more likely to be perceived as resulting in more than 1 hour production delay than resulting in a production delay of 1 hour or less, whereas an accident involving a worker who had secondary or higher education was 52% less likely to be perceived as resulting in more than 1 hour production delay than resulting in a production delay of 1 hour or less.

Summary of Results

Several factors have been identified, which when present at the time of an accident, increases or decreases the likelihood that the injury may be a serious or fatal injury. Locations of injury (knee and calf), type of injury (cuts, fractures, crushes and abrasions), awareness of injury risk and several causes/contributing factors (standard operating procedures not in place, mining a hazardous geology, lack of job planning and not enough light) increase the likelihood that the injury would be serious or fatal. Higher education on the other hand, decreases the likelihood that the injury would be serious or fatal. Type of injury (abrasions), and several causes/contributing factors (standard operating procedures not in place, mining a hazardous geology, not enough space and poorly designed equipment) increases the likelihood that the delay to production will be more than one hour. Again, higher education decreases the seriousness of the accident by decreasing the likelihood of delay to production.

Discussion

Some injury locations and some types of injury, such as fractures, crushes and knee injuries, are found to be predictors of more severe injuries. It is however, of importance that knee injuries are predictive of more severe injuries, and are also most frequent. Knee injuries are reported in about one-half of the lower limb injuries and are 27% more likely to be serious. This combination of frequency and seriousness indicates that research into knee injury, and the rehabilitation of injuries of the knee need to be a major priority for research and development funding.

Workers who were aware of the risk of injury are more likely to rate the potential for injury as serious or fatal. Again this is important because one-half of the injured workers knew the risk of injury and therefore combination of frequency and seriousness indicates that this issue needs to be addressed. Workers know a certain activity is unsafe. They know that if they engage in the activity the consequences may be that they sustain a serious injury but they still do it. The data even supports a view that the more miners know a particular activity is unsafe and the more likely they believe a serious injury may result, the more likely they will undertake the task, regardless. This may be a sort of macho approach-" its risky, but I can do it- it won't happen to me".

The survey identified the following causes/contributing factors as likely to result in a more severe injury: standard operating practices not in use, mining a hazardous geology, lack of job planning and not enough light. It must be noted that these causes/contributing factors were not uncommon in accident reports. Mining a hazardous geology was reported in 28.1% of underground mine injuries, not enough light was reported in 18.2 % of open cut mine injuries, lack of job planning was reported in 13.6% of open cut mine injuries and standard operating practices not in use was reported in 7.7% of underground mine injuries. While it may not be possible to modify a hazardous geology as a potential cause/contributing factor, the other causes/contributing factors (which are all capable of modification), double the chances of an injury being serious or fatal. OHS programs to target these causes/contributing factors need to be developed and evaluated as a matter of urgency. Also an educational program to highlight the risks of severe injury while mining in a hazardous geology may be beneficial if it were couched in terms which enable positive steps to be taken.

The following causes/contributing factors were more likely to result in a longer delay to productivity: standard operating practices not in use, mining a hazardous geology, not enough space and equipment poorly designed for use. As discussed above, the importance of neglect of standard operating practices and mining a hazardous geology needs to be considered and addressed. Also, not enough space in open cut mines and equipment poorly designed for using for other coal industry workers are moderately frequent causes/contributing factors but increase the risk of delay to production. Therefore these issues need to be addressed, however, given the economic consequences of these causes/contributing factors, sources other than the JCB, for example, industry bodies, should fund research into these factors.

Chapter 5

Safety equipment: Boots, cap lamps and equipment access.

Synopsis

The objective of this chapter is to report our investigation of the relationship between selective safety equipment and lower limb injuries in the NSW coal industry. All workers reporting an injury in 1994/95 financial year were surveyed to identify the relationship between hazard control mechanisms, and injuries and seriousness of lower limb injuries.

Introduction

Hazard control mechanisms can be classified into five types (CCH, 1996): elimination (the complete removal of a hazard), substitution (replacing hazardous materials or equipment with less hazardous ones), engineering/design (using protective barriers or changing process design to minimise exposure), administration (using administrative controls such as training and safe work procedures) and personal protective equipment. Elimination is the preferred mechanism for controlling hazards, whereas using personal protective equipment is the mechanism of choice when other control mechanisms are not practical.

Safety Footwear (boots) are the most obvious piece of personal protective equipment for preventing or reducing lower limb injuries. As such, they are the last line of defence against hazards which may injure the lower limb. Recently, the design of safety footwear has been implicated as affecting foot problems (Marr, 1991), and boots are reported as causing, or being contributing factors, in lower limb injuries, in particular, in underground mine workers (Chapter 3).

Other hazard control mechanisms which should assist in preventing or reducing lower limb injuries include the use of cap lamps for underground mine workers, which could be considered an engineering/design mechanism for controlling hazards in that it reduces a workers exposure to a hazard (ie, poor lighting), and use of equipment such as ladders or baskets designed to carry workers up to or down from cabs in open cut mines, which again is an engineering/design mechanism for controlling hazards.

The aim of this part of the study was to determine the problems associated with these hazard control mechanisms and to determine their association with seriousness of injury.

Method

The data for this chapter are from the survey reported in Chapter 3.

Results

Part 1: Boots.

Satisfaction with work boots is shown in Table 5.1. There was a significant difference between the three groups for satisfaction (X^2 = 74.67, df = 4, p < 0.001). Over one half of the underground mine workers were dissatisfied with their boots (56.5%), whereas about one quarter of open cut mine workers and other coal industry workers were dissatisfied with their boots (21.2% and 29.6% respectively).

There was no relationship between reported contribution of boots to injury and seriousness of incident when measured by perceived seriousness or lost time injury for the three workplace groups. This is to say, as groups, workers who were more seriously injured reported that their workboots contributed to their injury as much as workers who were less seriously injured.

Table 5.1: Injured workers satisfaction with boots (percentages).

	Underground mine workers	Open cut mine workers	Other coal industry workers
Satisfied - a lot	15.3	57.6	40.7
Satisfied - a little	28.2	21.2	29.6
Not satisfied	56.5	21.2	29.6

There was no relationship between satisfaction with boots and seriousness of incident when measured by perceived seriousness or lost time injury for the three workplace groups. This is to say, as groups, workers who were more seriously injured were just as satisfied with their workboots as workers who were less seriously injured.

Reported contribution of boots to lower limb injury is shown in Table 5.2. There was a significant difference between the three groups for reported contribution of boots ($X^2 = 27.50$, $df = 4$, $p < 0.001$). Over one half the underground mine workers reported that their boots contributed to their injury (53.3%), whereas about one quarter of open cut mine workers reported that their boots contributed to their injury (22.7%), and one third of other coal industry workers reported that their boots contributed to their injury (66.7%).

There was however, a relationship between reported contribution of boots to injury and satisfaction with workboots for the three workplace groups. Almost all workers who reported that their boots contributed a lot to their injury were dissatisfied with their boots (94.5%), whereas about one quarter of workers who reported that their boots did not contribute to their injury were dissatisfied with their boots (28.8%).

Respondents who reported that their boots contributed to their injury also reported how the boots contributed to their injury (see Table 5.3). There was no relationship between any of these contributing variables and seriousness of incident when measured by

Table 5.2: Reported contribution of boots to injury (percentages).

	Underground mine workers	Open cut mine workers	Other coal industry workers
Contributed - a lot	28.6	9.1	20.4
Contributed - a little	24.8	13.6	13.0
Did not contribute	46.7	77.3	66.7

perceived seriousness or lost time injury for the three workplace groups.

Table 5.3: How boots contributed to injury (percentages).

Note: Totals do not add to 100% as more than one location of injury can be reported per accident.

	Underground mine workers	Open cut mine workers	Other coal industry workers
Not enough ankle support	65.3	66.7	55.6
Boots don't fit properly	52.1	26.7	44.4
Slippery soles	38.1	46.7	33.3

A large number of respondents reported that they wanted the boots changed. There was a significant difference between the three groups ($X^2 = 43.30$, df = 2, $p < 0.001$). Over two thirds of the underground mine workers wanted boots changed (71.4%), whereas about one third of open cut mine workers (34.4%) and just under half the other coal industry workers (44.0%) wanted boots changed. There was no relationship between wanting the boots changed and seriousness of incident when measured by perceived seriousness or lost time injury for the three workplace groups.

Table 5.4: Relationship between brand of boot and perceived seriousness of injury in Underground mine workers (percentages).

	Moderate or less severe	Serious or fatal
Bata	56.0	44.0
Dunlop	57.7	42.3
Blundstone	55.3	44.7

Table 5.5: Relationship between brand of boot and lost time injury in Underground mine workers (percentages).

	No lost time injury	Suitable duties	Lost time injury
Bata	30.4	20.1	49.0
Dunlop	27.9	12.9	59.3
Blundstone	38.3	14.9	46.8

There was however, a relationship between reported contribution of boots to injury and wanting the boots changed for the three workplace groups. Almost all workers who reported that their boots contributed a lot to their injury wanted boots changed (99.2%), whereas about one half of workers who reported that their boots did not contribute to their injury wanted boots changed (45.9%).

Most underground mine workers were wearing gum boots (87.9%) when they were injured, whereas most open cut mine workers were wearing high cut boots (77.3%). Most underground mine workers were wearing Bata brand boots (45.9%) or Dunlop brand boots (33.1%) when they were injured, and most open cut mine workers were wearing Dunlop brand boots (72.3%).

For underground mine workers, there was no significant difference between brand of boot and seriousness of incident when measured by perceived seriousness (see Table 5.4) or lost time injury (see Table 5.5). Furthermore, there was no significant difference between brand of boot and satisfaction with boots (see Table 5.6), nor between brand of boot and perceived contribution to injury (see Table 5.7). Similar results were found with open cut mine workers and other coal industry workers.

Table 5.6: Relationship between brand of boot and satisfaction with boot in Underground mine workers (percentages).

	Satisfied a lot	Satisfied a little	Not satisfied
Bata	13.4	31.4	55.2
Dunlop	17.3	28.8	54.0
Blundstone	10.6	25.5	63.8

Table 5.7: Relationship between brand of boot and perceived contribution of boot to injury in Underground mine workers (percentages).

	Contributed a lot	Contributed a little	Did not contribute
Bata	27.5	28.0	44.6
Dunlop	25.4	22.5	52.2
Blundstone	36.2	21.3	42.6

Part 2: Lamps.

Most underground mine workers were satisfied with their cap lamps (38.2% satisfied a lot, 45.0% satisfied a little). There was no relationship between satisfaction with cap lamps and seriousness of incident when measured by perceived seriousness or lost time injury. However, there was an expected relationship between satisfaction with cap lamps not enough light being reported as a cause/contributing factor and ($X^2 = 20.03$, df = 2, $p < 0.001$; see Table 5.8).

About two out of every five injured underground mine workers want their cap lamps changed (42.1%). There was no relationship between wanting the cap lamps changed and seriousness of injury when measured by perceived seriousness or lost time injury. However, there was an expected relationship between wanting the cap lamps changed and poor lighting being reported as a cause/contributing factor (exact $p < 0.001$; see Table 5.9).

Table 5.8: Relationship between satisfaction with cap lamp and not enough light being reported as a cause/contributing factor in Underground mine workers (percentages).

	Not enough light as a cause/ contributing factor	Not enough light not a cause/ contributing factor
Satisfied a lot with cap lamps	12.5	87.5
Satisfied a little with cap lamps	18.5	81.5
Not satisfied with cap lamps	36.8	63.2

Table 5.9: Relationship between wanting cap lamps changed and poor lighting being reported as a cause/contributing factor in Underground mine workers (percentages).

	Poor lighting as a cause/ contributing factor	Poor lighting not a cause/ contributing factor
Want cap lamps changed	28.1	71.9
Do not want cap lamps changed	12.0	88.0

Part 3: Equipment access.

Equipment access was surveyed for open cut mine workers, by asking 'Do you have to jump up, or down from the ground, to get on and off mining equipment?'. Just over half the open cut mine workers reported that they did this 'a lot' (52.4%), and a further third reported that they did this 'a little' (34.9%). There was no relationship between having to jump on and off equipment and seriousness of incident when measured by perceived seriousness or lost time injury. Furthermore, there was no statistically significant relationship between having to jump on and off equipment and the perceived role of climbing on and off equipment in causing an injury, however, this result may be due to low numbers of respondents.

About one third of injured open cut mine workers reported that all equipment at their mine was fitted with 'devices, such as ladders or baskets, that carry miners up and down from the ground to the operating cabs' (31.7%), and just over half reported that some equipment at their mine was fitted with these devices (58.7%). There was no relationship between having equipment fitted with access devices and seriousness of incident when measured by perceived seriousness or lost time injury. Furthermore, there was no statistically significant relationship between having to jump on and off equipment and the having equipment in the mine fitted with devices, however, again this result may be due to low numbers of respondents.

Summary of results

Injured workers were dissatisfied with their boots. This was especially the case for underground mine workers and for workers who perceived that the boots contributed to their injury. More severely injured workers were not more dissatisfied with their boots than less severely injured workers. Underground mine workers were more likely to report that their boots contributed to their injury than open cut or other coal industry workers, and reported that the boots contributed by not providing enough ankle support. Many injured workers wanted their boots changed. This was especially the case for underground mine workers and for workers who perceived that the boots contributed to their injury, but not necessarily more severely injured workers. The brand of boot was not a significant factor associated with seriousness of injury, satisfaction or perceived contribution to injury.

Underground mine workers were generally satisfied with their cap lamps and this was not dependent upon severity of injury. However, as expected, miners who thought poor light contributed to their injury were less satisfied. Also, less than half the underground mine workers wanted cap lamps changed, although again for underground mine workers who thought poor light contributed to their injury about two thirds wanted changes.

Most injured open cut mine workers reported that they had to 'jump' on and off equipment. This need was not related to severity of injury, nor the perception of the contribution of climbing on/off equipment as a cause of their injury. Almost all mines where the injured workers were employed had access devices fitted to at least some machines, however, these devices did not appear to reduce the need for workers to 'jump' on and off equipment.

Discussion

In general, injured workers were not satisfied with boots. This is especially the case for workers who perceive the boot as contributing to their injury. The survey design did not allow the determination of the actual contribution of the boots to the worker's injury. It may be that workers are erroneously attributing injury, or more severe injury, to boot design and construction, whereas the injury may have had the same consequences regardless of the type of footwear being worn. The perception of the role of boots in their injury may be responsible for the dissatisfaction.

It is disturbing that a large number of injured workers, especially in underground mines, perceive that their last line of defence against lower limb injuries contributes to their injury. This raises two issues. First, why are there so many accidents in which the last type of hazard control mechanism (ie, personal protective equipment) is relied upon to prevent injury? This means that all other mechanisms for hazard control are considered impractical, or have failed. For example, better housekeeping, a mechanism to eliminate hazards, should be one of the first mechanisms considered to prevent lower limb and ankle injuries. Second, the results from the study reveal worker perceptions that boots contribute to an injury, and the most reported contribution is the inability of current boots to provide ankle support. These perceptions require close examination. Furthermore, there is evidence that increasing ankle support will result in greater stress and potential for injury on the knee joint, and the knee joint is currently most often injured (Chapter 3) and such injuries are more serious by and large (Chapter 4).

Whatever brand of boot is used by the underground mine workers, they are all reported to be unsatisfactory. Anecdotally, underground miners identify boots other than the brand that they are currently wearing as superior. However, the finding in our survey is that the level of dissatisfaction is equal for all brands, and it may be a case of 'the grass being greener on the other side of the fence'.

Underground mine workers appear to be satisfied with their cap lamps and do not seek any changes. The large difference in satisfaction between those perceiving poor light as a contributing factor and those that do not suggests that underground miners are content with the poor light conditions, or at least accept it, until something goes wrong. Cap lamps as a hazard control mechanism are an engineering/design type mechanism, and other types of mechanisms, for example, elimination of dark areas by using environmental lighting should be used as a preferred hazard control mechanism according to the hierarchy of hazard control mechanisms.

Hazard control in open cut mines is also problematic. A large number of open cut mine workers use unsafe methods (jumping) for access to and egress from machinery. This behaviour is not always identified as being a cause of their injury, but appears to be an acceptable way of getting on and off machines. It is most concerning that the practice of this behaviour is widespread, despite devices being provided to avoid the necessity of jumping. This issue needs to be addressed more fully in terms of determining how frequently jumping on and off machines occurs, the reasons for it, its role in injury and methods which may discourage jumping and increase the use of access equipment. It raises an important question of whether workers are not using the devices because the devices are inadequate, or for other reasons.

Chapter 6

Risk management for lower limb injuries in the coal mining industry: Results of a workshop.

Synopsis

The objective of this chapter was to investigate alternative approaches to risk management of lower limb and ankle injuries in the NSW coal industry. Individuals from various sectors of the coal mining industry attended a workshop. The aims of the workshop were to (i) feed back research information regarding lower limb and ankle injuries in the coal mining industry, (ii) receive comments on this feedback, and (iii) stimulate ideas regarding lower limb and ankle injury prevention strategies.

Introduction

Consultation with a representative group is considered an essential mechanism for verifying results of research and obtaining ideas for future directions for research. A number of different group methods can be used (eg, see Egger et al., 1990). These range from didactic methods in which the presenter has an authoritative role, through to experiential group methods in which group participants play a more active role. Didactic methods are good for transferring information from the group leader to group participants whereas experiential methods permit a greater involvement of group participants in information transfer (ie, participants are able to share their experience and knowledge about a particular issue with other members of the group). Consequently, experiential group methods in the form of, for example, workshops or seminars, are good mechanisms for information giving, information seeking and information sharing.

The project team were interested in validating the results of their analyses of the JCB database, and their survey regarding injury prevention. They were also interested in exploring options for industry-wide strategies which would assist injury prevention. To achieve these objectives, a workshop was organised to discuss findings and implications of the lower limb and ankle injury study. Participants included representatives from Unions, management, workers, OH&S staff, JCB rehabilitation staff and the research team.

Method

Industry representatives were invited to a meeting in Parramatta to discuss results from the analyses of the JCB database, and the survey (Chapters 3 & 4). Representatives were chosen from unions, mine management, occupational health and safety committees, and rehabilitation providers.

A presentation was given regarding the data analyses of the JCB database followed by a presentation on the survey. These presentations were for approximately one hour each. Participants were encouraged to raise questions or make comments if they wanted to during the presentations.

Issues raised during these presentations are reported in Part 1 of the Results. Participants were divided into three groups to 'develop' strategies for risk management to avoid lower limb injuries in future. Three posters were designed in this session based upon the results and issues raised during the presentations, and their own experience. Issues raised during poster development are reported in Part 2 of the Results.

Results

Part 1: Feedback of data analyses and comments from industry

While the data presented from the JCB database analyses provided some information to the workshop participants, there were several reservations about its utility for injury surveillance. The widely held view was that the database only contained information for determining insurance premiums and had no further use. Furthermore, there were questions raised about the accuracy of data submitted to the database. There is anecdotal evidence suggesting that not all incidents are reported, and that only the more serious incidents are reported. Also, there is anecdotal evidence to suggest that the severity of some injuries are disguised by, for example, having staff return to work despite major injuries to ensure that a lost-time injury is not recorded.

Discussion highlighted another potential problem with integrity of information in the database. It was suggested that when reports are filled in there is sometimes a reluctance to include a thorough description of the incident if the person filling in the form is directly responsible for the welfare of the injured worker. An example used was that Deputies are often reluctant to fill in the description of the accident because, if a prosecution occurs, the Deputy may be charged for failing Duty of Care and information from the D-forms can be (and are) used in prosecutions.

These comments questioning the integrity of the JCB database do not acknowledge that more than one source of information is used in coding injury details (ie, the M-Form and Medical Certificates). Industry-wide education of data recording and coding practices may lessen these misconceptions.

The results of the survey were accepted as a fair representation of the actual causes of injury in the coal mining industry in NSW. For example, many injuries occur to the knees, boots are reported as a problem, and poor lighting is often a cause of injury in open cut mines. There were also a few comments made regarding further issues that needed exploration. For example, the survey considered environmental and equipment factors, however, there was no consideration of the individual, that is, weight, fitness, training, and motivation. Also, the workforce is well educated and some are well trained, however, Standard Operating Procedures (SOPs) are not always followed. There is a need to explore why SOPs are not always followed and how to improve compliance. This may include an increased involvement of workers in developing procedures. Finally, often causes/contributing factors act in combination, for example, uneven and wet/slippery surfaces with poor lighting, which should be explored in more detail.

In closing these presentations, a statement was made that while exploration of factors associated with injuries is useful, a more interesting question may be "Why are some workers not injured?". That is, given the working conditions, how do some workers carry out their duties over many years without injuring themselves? It was suggested that a very worthwhile research study would carefully monitor and investigate the workplace activities of a small group of 'never injured' miners.

Part 2: Discussion and poster development

Group 1:

An attempt was made to identify strategies to improve Occupational Health and Safety - vehicles for implementing those strategies were listed: environmental (including housekeeping), plant and equipment, individual (and teams), and operating procedures (including SOPs).

The message needed from management was their commitment to Occupational Health and Safety; it is up to the individual to ensure their own safety, but organisational safety must be driven from above. Therefore there must be effective two way communication. Each mine has its own Occupational Health and Safety Committee and in some cases, a Hazard Identification Committee, but more commitment needs to be shown by senior management.

Lighting was identified as a particular problem. However, it was accepted that ultimately, it is better work practices which will reduce all injuries, including lower limb and ankle injuries.

The issue of hazard identification was discussed. Workers need to do their own inspections (ie, crews need to do own inspections in underground mines). A suggestion was made that each crew should spend the first 15 minutes of each shift on their own hazard inspection, as workers cannot rely on the previous shift identifying and rectifying hazards. This should also reinforce safety awareness. However, hazard identification is not the sole solution. Hazard inspections (audits) often reveal that workers know of problems, but do not do anything about the problem. Workers must become responsible for fixing problems, or notifying others who can fix the problem. Furthermore, hazard inspections should not concentrate solely on equipment (as these are regularly serviced) but also on the surrounding area.

Discussion moved to who is responsible for safety. There was an acceptance that mine management do not want the unnecessary costs of injuries. But with respect to the personal level, responsibility must be with the individual. Opinion was divided here - JCB Occupational Health and Safety staff restated that the individual is responsible for their own safety. However, a couple of underground miners thought that the team needed to be responsible for their own safety as miners work as teams, not as individuals. This raises the possibility that the team should be the target unit for safety promotion. Team building training is needed. A suggestion was made that 15 minutes at start of shift be used for team building. The team can then search, identify and where possible, rectify, hazards at start and end of shift. Ownership will be better if the team develop the process of hazard audit.

The slogan *Work Smart - Work Safe* was suggested as a slogan. However others were critical of this approach saying "slogans don't work". Toolbox talks are needed as an "ongoing revision of issues". Each group needs to identify risk at their own worksite as they are the ones able to make a difference; therefore toolbox talks and similar should be used, eg, some collieries have monthly team meetings for ~4 hours to improve safety awareness and skill of the team. Overall, attitudes need to be changed, with both responsibility and accountability of managers and workers clearly defined and known.

A parallel should be drawn in that miners are aware that they are responsible for safety at home (their own and their families); they need to be told that "you are not at home now, but at work you are as accountable for your mates as you are for your family at home" - treat workmates like family members.

The poster from this group was a circle (Safety Circle) with spokes leading outwards to some of the essential safety elements. The Safety Circle comprised the important people in safety: management, teams and individuals. The spokes led to important variables and issues: ownership, housekeeping, education (revision), better investigation into injury, attitude, more relevant database, consistent feedback, mine planning, footwear, safety talks, audits, accessing plant and equipment, lighting, and team building.

Group 2:

Lighting was discussed, especially with reference to underground mines; there are two forms of lighting underground, cap lamps and area/wall lighting. The group thought that if the area/wall lighting were improved underground, particularly in working areas, then the following may occur:

- Housekeeping would improve because miners would see the mess accumulate and therefore take steps to clean up. This has apparently been demonstrated in several mines.
- Miners would be able to negotiate uneven ground, slippery areas and *swillies* better as they are able to see properly where they place their feet.
- Miners would be able to negotiate stepping on/off or up/down from equipment with better visibility.

The group thought that improvement in cap lamp set up would also assist in preventing lower limb injuries by:

- Removing the heavy battery from around the waist thereby improving balance.
- Improving the cap lamp light so that it has a broader brighter beam.
- Re-introducing the use of a universal swivel on the cap so that the light itself may be appropriately adjusted to suit working conditions.

Machinery was also an issue. There was a view that equipment is often not built with the operators in mind. This has the potential to cause injury in a number of ways and the following should be recommended in order to prevent injury:

- Better fitting and supporting footwear should be provided to miners.

- Steps should be fitted to machines to assist miners up and down without jumping.
- Safe Operating Procedures should be devised and followed.
- Operators should receive feedback as to their performance and take responsibility for operating machinery appropriately.
- Companies should insist upon ergonomically designed equipment or not buy it, for example, ensure that there is enough space for the miner to work in while on the machine to avoid awkward postures and footings.

Training needs to be targeted in that miners should be taught how to work safely rather than just told to work safely. For example, checklists could be provided which lead the miner through a process of what to do before, during and after a task. Not everyone knows how to plan appropriately to ensure a job is done successfully and safely.

A proper balance between safety and production needs to be achieved. There is a perception that working safely means working slowly. Miners do not always recognise that working safely is also working efficiently. This misperception needs to be changed. Safe Operating Procedures should be determined, implemented and followed at all times. Training should incorporate these ideas.

Individuals must learn to take responsibility for their actions and follow the rule, *If you can fix it, fix it!* Too often things are not fixed or picked up because individuals are not taking responsibility for the safety of themselves or others. Proper training could address this. Refresher training should be provided regularly and it should be compulsory as well as competency based.

There is an acceptance in the mining industry of the harsh working conditions, *this is the way it is always done*, therefore change occurs more slowly than it should. Better training programs are needed to change attitudes. Comparison of the mining industry with other industries and how they approach safety may be helpful for individuals and companies.

The following improvements need to be made:

Lighting

- Increase lighting throughout pits, particularly underground pits.
- improve cap lamp design/technology.

Modify environment where practicable

- Improve housekeeping by setting and enforcing standards.
- Improve training in line with previous suggestions.
- Provide appropriate footwear.
- Instil individual and collective responsibility for safety.

Equipment design/ergonomics

- Purchasing specifications - there should be both expert and operator input.
- Retrofits should be arranged so that equipment is appropriate for use.
- Organisation of labour should be improved to include rest breaks and similar.

Visible/demonstrable setting of safety standards by supervisor

- Accountability of supervisors in safety matters should be enforced.
- safety performance indicators should be part of performance appraisals.

Safety Benchmarking

- Comparison with outside industries should be undertaken regularly to shake up old practices and culture.

The resulting poster had two diagrams of interrelated issues:
Lighting and caplamp issues including housekeeping, uneven ground, swillies, slippery areas, visibility for on/off or in/out equipment, walking, cap lamp battery, cap lamp universal swivel, cap lamp increase balance, and cap lamp broader beam. *Machinery and training* including ergonomic issues considered, footwear, steps on equipment, SOPs, competency based training and feedback, compulsory refresher course, ownership, responsibility, accountability for operators, taught how to work safely - checklists, a way of thinking or an approach, proper planning, balance between safety and production, initiative - if it can be fixed, fix it, and supervisor accountability.

Group 3:

The role of general fitness in safety, and the value of annual medicals and health assessments were discussed. In particular, it may be politically unwise and possibly illegal to dismiss workers based on medical and health assessments. However, it was felt that a general health and fitness program would be advantageous in improving safety.

Major environmental modification are still an important tool in improving safety. There is still an attitude in the industry of "why clean up and improve the roads for 6 months worth of work - its not worth it". However, some engineering solutions to safety are not always simple. For example, the perceived need for boots to provide better ankle support. Too much ankle support has been shown to damage knees, which are the main lower limb problems in the coal mining industry. More emphasis should be placed on reducing water in a mine. It contributes to the break up of floors, and is often an unseen hazard.

Modern machine logistics mean that machines are designed so that the operator can 'stay on' for much longer periods to operate, whereas in the past you had to keep climbing on and off continuously throughout the day to operate the machine. This has possibly reduced the number of injuries attributable to climbing on and off machines, however, jumping from trucks in open cut mines, for example, in poor light could be an explanation for some injuries. Lighting is an important issue.

The following could be used for improvements:
- Awareness - education programs, toolbox talks, handovers
- Lighting, road conditions, stonedusting
- Taking time to do safe work
- Inspections
- Housekeeping taskforce with management blessing
- Medical assessment for tasks
- Health and fitness programs - gym facilities, access to dietitian, health monitoring
- Improved rib and roof support methods, ie, control
- Maintenance Program - environmental, road, lights, stonedust, H_2O, Grader program, rubber tyres for vehicles
- Improved footwear for comfort - non slip

The poster was of miner with hardhat and other safety equipment. Terms used included: roof control, improved visibility - cap lamp removed and fixed lighting used, stonedusting program, Bolle bandits (safety glasses), rib control, Safe Working Practice or SOP (in written format), road maintenance and housekeeping, leather boots for comfort, support, hygiene, and practicality, no battery and reduced risk of back pain, neck pain, decreased weight on waist will lead to better balance and therefore better proprioception, miner thinking - 'take time!, watch your step'. The slogan *Miners do not do it better in the dark!* was used.

Summary of Results

While there was general acknowledgment that the JCB database has potential to provide valuable information for injury surveillance, the workshop view was that the integrity of the database was suspect. Furthermore, injury/incident database analyses will not answer the equally important question of who does not get injured and why not.

In-terms of injury prevention strategies, several themes emerged: management commitment, employee ownership, authority and responsibility, importance of teams, lighting - both environmental and personal, equipment purchase and modification, employee attitudes and behaviour, and general health.

Discussion

Issues for occupational health and safety in the coal mining industry for managing risk for lower limb injuries, and injuries in general, can be considered in five broad inter-related areas: *Safety culture, Safe environment, Safe individuals, Safe work practices, Safe equipment,* and *Safety audit and continuing improvement.*

Safety culture is the collection of customs which produce and maintain safe workplaces. Strong leadership is required to change from unsafe cultures to a safety culture. Responsibility and accountability must be clearly stated and enforced. With the exception of some statutory responsibilities, responsibility and accountability in the industry is currently poorly understood. Promotion is needed to change attitudes, which will in turn result in a change in behaviours and actions. The belief amongst workers that there is a trade-off between safety and production must be overcome, as a safe workplace will be a productive workplace. Safety standards must be visible and consistently enforced by supervisors. This includes supervisors adhering to the same safety standard that are expected from their workers. Systems for implementing a safety culture can in some cases be adapted from best practice organisations, including organisations outside the coal industry. Finally, a safety culture must be owned by workers for it to be effective.

Safe environments need to be created and maintained. In some instances, this involves the provision of Personal Protective Equipment (PPE), such as safety boots and glasses. In other instances, the environment is modified by, for example, the provision of cap lamps, and the use of stonedusting. Safe environments remain safe only if they are correctly maintained. This means a proper housekeeping program must be implemented. Furthermore, regular inspection and maintenance programs must be implemented.

Safe individuals are always a key element in risk management. Unless individuals are prepared to act safely, it is not possible to implement a safe working culture. The option of selection of workers on the basis of potential for injury may be of questionable value, and may have implications for anti-discrimination legislation. In addition, the role of general health and fitness in managing injury risk is also debatable. Safe individuals must however be aware that a loss of productivity is not a trade off for improvements in safety. Increased safety often leads to increased productivity. Ultimately, safe individuals need to be cultivated through training, including improved induction processes, increased use of refresher courses and the use of new ways for educating and training. Finally, safe individuals must take responsibility for their own and others safety, and should not tolerate or accept an unsafe work culture.

Safe work practices need to be considered at all levels from mine planning through to more local, task planning. Standard Safe Operating Practices need to be identified, and documented. Their implementation then needs to be encouraged through education and training, and enforced. These documented procedures should also be regularly reviewed and updated.

Safe equipment must be built with the operator in mind. Often the man-machine interface is not carefully considered, and design concentrates on economics, or ease of construction with little consideration of ergonomics. Although one solution is to modify equipment consequent to purchase and operator feedback, a better solution to avoid poor ergonomic design is a thorough inspection and trialing prior to purchase. This inspection and trialing should involve specialist engineers, but should also involve the workers who will be expected to operate the equipment. Finally, machines must be well maintained through proper maintenance programs, and the machines should be kept clear of clutter to ensure safe access and egress.

Safety audit and continuing improvement is essential to monitor the effectiveness of occupational health and safety programs. The engineering field is comfortable with concepts such as quality assurance and continuous quality improvement to maintain quality in produced goods. Such concepts and processes need to be adapted for maintaining quality in safety as well as product output. Furthermore, safety audits need to be proactive, as well as reactive. That is to say, safety audits must include proactive elements where potentially harmful situations are identified and rectified before an accident and consequent injury occurs. As a complement to this, safety audits must also include reactive elements where accident investigations are conducted and findings are fed back to workers. This can be enhanced by maintaining a database containing relevant information.

Chapter 7

Self reports of post injury management following lower limb and ankle injuries in the NSW coal industry.

Synopsis

The objective of this chapter was to report on our investigations of post injury management practices following lower limb and ankle injuries in the NSW coal industry. All workers reporting a lower limb injury in 1994/95 financial year were surveyed to identify (i) injury assessment practices, (ii) injury treatment practices, and (iii) accident reporting and investigation practices.

Introduction

Research into coal mine injuries, like most occupational injury research, has concentrated upon identifying factors associated with the cause of the injury. Risk of injury is identified to determine potential interventions and to assess the success of such interventions. These studies typically record events leading up to and around the time of the worker's injury. Little or no consideration is given to the assessment and treatment that the worker receives immediately after the injury, nor for any medium or long-term treatment that the worker receives.

Post-injury management and rehabilitation deal with the failures of risk management systems. That is, the assessment and treatment of an injured worker, including the rehabilitation of that worker, are necessary because a fault has occurred with safety resulting in injury. As such, post-injury assessment and management, and rehabilitation are integral components of occupational health and safety, and should not be considered as systems separate from occupational health and safety. The objective of this study was to develop a more complete picture of lower limb injuries in the coal mining industry in NSW by investigating post-injury assessment and management processes.

Method

The data for this chapter are from the survey reported in Chapter 3.

Results

Part 1: Injury assessment.

About half the injured workers reported that they their injury was assessed by a staff member at their worksite (51.1%). The percentage of respondents reporting assessment of their injury was the same for the three workplace groups. For underground mine workers, there was a relationship between lost-time injury and reporting of injury assessment ($X^2 = 23.47$, df = 2, $p < 0.001$) with 55.2% and 63.9% of workers with lost-time injury and suitable duties respectively reporting that their injury was assessed while 33.6% of workers with non-lost-time injury reported that their injury was assessed.

Staff members assessing the injuries are shown in Table 7.1. Most assessments were made by First Aid Officers (58.7%) or Deputies/Immediate supervisors (24.7%). There was a difference between workplace groups for assessment by First Aid Officers ($X^2 = 20.08$, df = 2, $p < 0.001$) with almost all open cut mine assessments being performed by these officers (91.7%), whereas just over half the underground mine assessments were by First Aid Officers (52.5%).

workers with lost-time injury, while no assessments were conducted by the undermanager/shift supervisor for workers with non-lost-time injury or those given suitable duties.

Just over half the workers assessed at the worksite were assessed immediately (57.2%). There was a difference between workplace groups ($X^2 = 13.94$, df = 6, p = 0.030) with one-half the injured underground mine workers assessments occurring immediately (52.8%), whereas almost three quarters of the assessments of injuries of open cut mine and other coal industry workers occurred immediately (71.4% and 73.3% respectively).

Table 7.1: Persons assessing lower limb and ankle injuries at the work site (percentages).

	Underground mine workers	Open cut mine workers	Other coal industry workers
First aid officer	52.5	91.7	64.5
Nurse	4.1	0.0	0.0
Deputy or immediate supervisor	26.2	11.1	12.7
Undermanager or shift supervisor	19.0	5.6	12.9
Other	21.3	8.6	12.9

Note: Totals do not add to 100% as more than one person can assess each injury.

For underground mine workers who were assessed at their worksite, there was a relationship between lost-time injury and assessment by the undermanager/shift supervisor ($X^2 = 9.74$, df = 2, p = 0.008) with 25.8%, 13.0% and 6.4% of assessments conducted by the undermanager/shift supervisor for workers with lost-time injury, suitable duties and non lost-time injury respectively. Also, for other coal industry workers who were assessed at their worksite, there was a relationship between lost-time injury and assessment by the undermanager/shift supervisor ($X^2 = 6.36$, df = 2, p = 0.042) with 30.8% of assessments conducted by the undermanager/shift supervisor for

For underground mine workers who were assessed at their worksite, there was a relationship between lost-time injury and when the injury was assessed ($X^2 = 12.60$, df = 6, p = 0.050) with 56.7% of assessments of lost-time injury occurring immediately, while 46.7% of assessments of non-lost-time injury occurred immediately. Furthermore, 12.6% of workers with non-lost-time injury and 10.9% of

Table 7.2: Treatment of workers with lower limb and ankle injuries (percentages).

	Underground mine workers	Open cut mine workers	Other coal industry workers
First aid officer	55.2	60.0	66.7
Family Doctor	56.3	47.7	59.3
Hospital	29.4	24.6	29.6
Specialist	37.8	21.5	46.3

Note: Totals do not add to 100% as more than one treatment can be provided per accident.

workers given suitable duties following their injury were assessed at the end of shift, while 31.3% of workers with non-lost-time injury were assessed at the end of shift.

Almost all the assessed workers reported that they were satisfied with the injury assessment process at their worksite (91.2%). The percentage of assessed workers reporting satisfaction of assessment of their injury was the same for the three workplace groups. For underground mine workers assessed at their worksite, there was a relationship between perceived severity of injury and satisfaction with the assessment process (Fisher's exact test, $p = 0.014$) with 85.0% of assessed workers with perceived serious injuries being satisfied with the assessment process and 94.8% of assessed workers with moderate or less severe injuries being satisfied with the assessment process. There was a relationship between immediacy of assessment and satisfaction with the assessment process ($X^2 = 16.11$, $df = 3$, $p = 0.001$) with 96.5% of workers who were assessed immediately being satisfied with the assessment process and 81.8% of workers who were assessed at the end of the shift being satisfied with the assessment process. There was also a relationship between immediacy of assessment and satisfaction with the assessment process for other coal industry workers ($X^2 = 13.33$, $df = 3$, $p = 0.004$) with 100.0% of workers who were assessed immediately being satisfied with the assessment process and 50.0% of workers who were assessed at the end of the shift being satisfied with the assessment process.

Part 2: Injury treatment.

Treatment services received by injured workers is shown in Table 7.2. Over half the injured workers received first aid treatment (56.8%) and over half required treatment by their family doctor (55.6%). There was a difference between workplace groups for treatment by a specialist ($X^2 = 8.81$, $df = 2$, $p = 0.012$) with one third of underground mine worker injuries being treated by a specialist, about a quarter of open cut mine workers being treated by a specialist and almost one half the other coal industry workers being treated by a specialist.

For underground mine workers, there was a relationship between lost-time injury and treatment by first aid officer ($X^2 = 14.04$, $df = 2$, $p = 0.001$), family doctor ($X^2 = 32.71$, $df = 2$, $p < 0.001$), hospital ($X^2 = 68.38$, $df = 2$, $p < 0.001$), and specialist ($X^2 = 47.26$, $df = 2$, $p < 0.001$). Workers given suitable duties following their injury were more likely to have received first aid (66.2%), than workers with non-lost-time injuries (63.2%) and workers with lost-time injuries (46.8%). In order of frequency, other treatments were more likely to be given to workers with lost-time injuries, then workers with suitable duties following their injury, and then workers with non-lost-time injuries. There was also a relationship between potential injury severity and treatment in hospital (Fisher's exact test, p = 0.001) with 37.5% of workers who judged their injury as being potentially severe having hospital treatment and 22.7% of workers who judged their injury as being potentially less severe having hospital treatment.

For open cut mine workers, there was a relationship between lost-time injury and treatment by first aid officer (X^2 = 8.19, df = 2, p = 0.017), family doctor (X^2 = 8.71, df = 2, p = 0.013), hospital (X^2 = 9.41, df = 2, p = 0.009), and specialist (X^2 = 17.85, df = 2, p < 0.001). For all treatment types, workers given suitable duties following their injury were more likely to have treatment than workers with non-lost-time injuries and workers with non-lost-time injuries. However, it should be noted that there were only 4 workers with suitable duties and therefore the rates for this group are unreliable.

For other coal industry workers, there was only a relationship between lost-time injury and treatment by hospital (X^2 = 13.66, df = 2, p = 0.001). Workers with lost-time injuries were more likely to be treated in hospital (54.5%) than workers given suitable duties following their injury (33.3%) and workers with non-lost-time injuries (4.3%).

Half the respondents (48.5%) received physiotherapy treatment following their injury. The percentage of respondents receiving physiotherapy treatment following their injury was the same for the three workplace groups. For underground and open cut mine workers, there was a relationship between lost-time injury and receiving physiotherapy treatment (X^2 = 49.87, df = 2, p < 0.001 and X^2 = 8.42, df = 2, p = 0.015 respectively) and between perceived potential injury severity and receiving physiotherapy treatment (Fisher's exact test, p = 0.040 and Fisher's exact test, p = 0.032 respectively). Over half the underground mine and half the open cut mine workers with lost-time injuries (63.8% and 50.0% respectively) received physiotherapy treatment, whereas less than half the workers with non-lost-time injuries (26.9% and 20.0% respectively) received physiotherapy treatment. Just over half the underground mine and open cut mine workers who rated their injury as serious (55.5% and 57.1% respectively) received physiotherapy treatment, whereas less than half the workers who rated their injury as moderate or less severe (46.7% and 29.5% respectively) received physiotherapy treatment.

Physiotherapy service to injured workers is shown in Table 7.3. About three quarters of workers receiving physiotherapy were treated at a private clinic (73.6%), and about one quarter were treated by the JCB Occupational health service (22.7%). There was a difference between workplace groups for treatment by JCB Occupational health service (X^2 = 8.55, df = 2, p = 0.014) with one quarter of underground mine workers getting treatment from JCB Occupational health service, and no open cut mine workers getting treatment from JCB Occupational health service.

When physiotherapy treatment was received, most injured workers commenced physiotherapy within a week of the injury (63.1%), or in the following 3 weeks (22.2%). However, some workers did not receive physiotherapy until more than 6 months after their injury (2.3%). There was no relationship between time to receiving physiotherapy and workplace, nor between time to receiving physiotherapy and seriousness of injury.

whereas more lower limb and ankle injuries of open cut mine and other coal industry workers were reported immediately (59.4% and 59.3% respectively) rather than at the end of shift (20.3% and 18.5% respectively).

More severe injuries were likely to be reported immediately rather than later. For underground mine workers, 51.1% of injuries rated as potentially serious or fatal were reported immediately, for open cut mine workers, 61.9% of injuries rated as potentially serious or fatal were reported immediately, and for other coal industry workers, 65.0% of injuries rated as potentially serious or fatal were reported immediately. Similar results were found with lost-time injuries with 44.2%, 65.6% and 72.7% of lost-time injuries being reported immediately for the three workplace groups.

Table 7.3: Provision of physiotherapy services (percentages).

	Underground mine workers	Open cut mine workers	Other coal industry workers
Private clinic	72.6	79.2	78.3
JCB occupational health	25.7	0.0	17.4
Local hospital	6.6	12.5	13.0
Other	3.1	4.2	0.0

Note: Totals do not add to 100% as more than one source per injury can provide physiotherapy.

Part 3: Accident report and investigation.

Twenty three (4%) respondents reported that a report form was not filled in for their accident. This was not the case as selection of injured workers for the survey was based on injury report forms. These respondents were however excluded from further analyses in this section as they were unaware of the report of their injury.

Just under half of the report forms were filled in immediately (45.6%), and just over a third were filled in at the end of the shift (37.8%). There was a difference between workplace groups ($X^2 = 22.94$, df = 6, p = 0.001) with more lower limb and ankle injuries of underground mine workers being reported at the end of shift (42.9%) rather than immediately (41.7%),

About three quarters of respondents (72.3%) reported that they were consulted about the report of their injury. The percentage of respondents reporting that they were consulted was the same for the three workplace groups. For underground mine workers, there was a relationship between lost-time injury and consultation about the report ($X^2 = 12.22$, df = 2, p = 0.002) with 72.4% of workers with lost-time injuries being consulted and 61.7% of workers with non-lost-time injuries being consulted, and between immediacy of reporting and consultation (X^2 = 11.78, df = 3, p = 0.008) with 78.4% of immediate reports involving consultation and 62.4% of end of shift reports involving consultation. For open cut mine workers, there was also a relationship between immediacy of reporting and consultation (X^2 = 8.64, df = 3, p = 0.034) with 78.9% of immediate reports involving consultation and 46.2% of end of shift reports involving consultation.

Almost all respondents (92.3%) rated the report of their injury as accurate. The percentage of respondents reporting that the report was accurate was the same for the three workplace groups. For underground mine workers, there was a relationship between perceived severity of injury and perceived accuracy the report (Fisher's exact test, p = 0.045) with 90.0% of workers with potentially serious or fatal injuries rating the report as accurate and 94.9% of workers with potentially moderate or less severe injuries rating the report as accurate, and between consultation and perceived accuracy the report (Fisher's exact test, p < 0.001) with 95.7% of consulted workers rating the report as accurate and 83.5% of non-consulted workers rating the report as accurate. For open cut mine workers, there was also a relationship between perceived severity of injury and perceived accuracy of the report (Fisher's exact test, p = 0.036) with 76.2% of workers with potentially serious or fatal injuries rating the report as accurate and 95.2% of workers with potentially moderate or less severe injuries rating the report as accurate.

Less than half of the respondents (43.8%) reported that the accident leading to their injury was investigated by mine management. The percentage of respondents reporting that their injury was investigated was the same for the three workplace groups. For underground mine workers; there was a relationship between lost-time injury and reporting of investigation by mine management (X^2 = 6.79, df = 2, p = 0.034) with 47.2% and 47.9% of workers with lost-time injury and suitable duties respectively reporting that mine management investigated the accident while 34.4% of workers with non-lost-time injury reported that mine management investigated the accident. For underground mine workers, there was a relationship between consultation and reporting of investigation by mine management (Fisher's exact test, p < 0.001) with 52.5% of consulted workers reporting that mine management investigated the accident while 20.7% of workers not consulted reported that mine management investigated the accident.

Just over half of the injured workers who reported that mine management investigated the accident (51.7%) received feedback about the investigation. There was a difference between workplace groups (X^2 = 6.01, df = 2, p = 0.050) with about half the underground and open cut mine workers receiving feedback (50% and 54.8% respectively), whereas about a quarter of the other coal industry workers received feedback (27.3%).

Summary of results.

Half the workers with lower limb injuries were assessed at the worksite. This was more likely for workers with lost-time injuries or those given suitable duties. The worksite assessment was most likely from a first aid officer. If the worker was assessed by an undermanager/shift supervisor, they were more likely to have a lost-time injury. Half of all the worksite assessments were made immediately, with most others at the end of shift. More worksite assessments were made immediately for open cut mine and other coal industry workers than for underground mine workers. There was a high rate of satisfaction about the worksite assessments, but assessments of less serious injuries were more satisfactory than assessments of more serious injuries. Also, assessments made immediately were more satisfactory than assessments made at the end of shift.

Half the injured workers received first aid treatment and half received treatment from their family doctor. Treatment from the various services were related to lost-time injuries. Also, half the injured workers had physiotherapy. Receipt of this therapy was related to seriousness of injury. While most injured workers received therapy promptly, a few injured workers reported substantial delays.

Half of the lower limb injuries were reported immediately. However, in underground mines, lower limb injuries were slightly more likely to be reported at the end of shift. More serious injuries are more likely to be reported immediately. Most injured workers reported that they were consulted for the report. Consultation was more likely to occur for lost-time injuries and when a report was compiled immediately. A high proportion of reports were rated as accurate, but reports on more serious injuries, and reports involving no consultation were less likely to be reported as accurate.

Less than half the injured workers reported that their injury was investigated by mine management. Lost-time injuries and suitable duties were more likely to be reported as being investigated, as were injuries where the worker reported that they were consulted. Only half the workers reporting that their injury was investigated by mine management received feedback.

Discussion

Workplace injuries should be assessed by a qualified person as soon as possible after an accident. This serves two purposes. First, immediate assessment and treatment results in better outcome in terms of injury and disability reduction (Rondinelli et al., 1997). Second, systems and processes which result in immediate assessment of injuries will reinforce workers views of management commitment to workplace OH&S. The results of the current study showed that workers who were assessed immediately were more likely to be satisfied with the process than workers who were assessed at the end of their shift. It is acknowledged that immediate assessment and treatment by first aid officers may be difficult, particularly in underground mines. The solution may be to encourage all workers to obtain suitable qualifications. While this will result in a financial cost to a mine, benefits may be gained through reduced disability and greater satisfaction with OH&S processes. A suitable trial, with 'control' mines, would permit the evaluation of the benefits and cost of this option.

Many injured workers (one out of every two) received physiotherapy treatment. The rate was higher for workers with lost-time injuries or potentially serious injuries. While many of these workers commenced physiotherapy treatment promptly, there were substantial delays for some workers. Excessive delays in obtaining treatment can result in aggravation of the injury, and an increase in the duration of disability which is costly.

Reporting of an injury should also occur as soon as possible after the incident. Report must be compiled with full consultation with the injured worker.. When consultation does not occur, the accuracy of the report can be questioned. This results in suspicion about the accuracy of OH&S statistics in general and about management's commitment to improving OH&S. Consideration of having the injured miner signing the report should be made, however, this should not be done if the action may be misinterpreted as injured workers signing a confession of their wrong-doing.

About one in two injured workers report that their injury was investigated by mine management. This low rate of investigation is in our view unacceptable. Serious injuries were more likely to be investigated, however, this may be due to statutory or financial requirements. In addition, injured workers report a low rate of feedback about the investigation. This suggests that mine management may have investigated more of the injuries than reported by the injured workers, however, a failure to effectively feedback the results of the investigation causes a perception of low levels of investigation.

Management must be seen to be concerned about safety, and this can be assisted by openly investigating injuries and providing full feedback. The best risk management for injury and associated disability involves thorough incident investigation with feedback to the injured worker and his colleagues. Results of investigations must be communicated to the workers and their colleagues through appropriate channels (eg, tool box talks), and incorporated into training, and job and machinery design.

Chapter 8

Risk management, post injury assessment and treatment, and rehabilitation for serious injuries in the coal mining industry: A survey of workers with fractures and/or more than 4 weeks off work.

Synopsis

The objective of this chapter was to report our investigation of serious lower limb injuries in the NSW coal industry. All workers reporting a lower limb fracture or lower limb injury resulting in more than 4 weeks off work in the 1994/95 financial year were interviewed to identify (i) causes/contributing factors, (ii) injury assessment practices, (iii) injury treatment practices, (iv) accident reporting and investigation practices, and (v) most importantly, the experience of having a serious lower limb injury sustained at work.

Introduction

Analyses of workplace injuries, and in particular, back injuries, often reveal a small group of injured workers, whose injuries result in a relatively large proportion of the financial costs of the workers' compensation system (eg, Ho et al., 1995, reported this observation from a retrospective case study of 3 NSW coal mines). The chronic injuries and disabilities of these workers not only result in a disproportionately large amount of workers' compensation costs, but also result in great social costs of workplace injuries. Social costs of workplace injuries include pain and suffering, career uncertainty, loss of income and decline in general health and quality of life.

Recently the WorkCover Authority of NSW was sufficiently concerned about the economic cost of chronic workplace injuries that they required all injured workers who were off work for more than 4 weeks to have a rehabilitation provider and use rehabilitation plans to assist the worker to recover and return to work. The benefit of this requirement is that it should also reduce the social cost to the worker by getting them back to work and therefore back to a wage earning capacity.

In this part of the project, serious injuries, which were defined as those that resulted in a fracture of the lower limb or more than 4 weeks off work following a lower limb injury, were investigated. The nature and causes/contributing factors of these injuries were described and comparisons made with less seriously injured workers (from Chapter 3). Furthermore, the use of qualitative techniques for analyses permitted the exploration of the injury and consequences from the injured workers perspective (see Sackett & Wennberg, 1997, for a discussion on the use of qualitative and quantitative research techniques).

Method

Coal industry workers with a fracture or injury resulting in more than 4 weeks off work recorded in the JCB database of accident and incidents with an injury location below the hip in the financial year 1994/95 were invited to participate in this study. Face to face interviews were conducted with the 48 workers (17 identified with fractures and 31 with injuries resulting in more than 4 weeks off work) who accepted. Participants were divided into 2 groups - underground mine workers (39 workers) or open cut mine workers (9 workers). Tests of significance were not used to test differences between the two workplace groups because of low numbers.

Over half the injured workers had achieved their High School Certificate or Leaving Certificate or a higher qualification (66.7%). This is somewhat higher than that found in the injured population (54%; see Chapter 3).

Results

Causes/contributing factors

In general, injured workers were experienced in the industry (see Table 8.1). Half the injured workers had 10 to 20 years experience working in the industry. Just over half the workers had a previous lower limb injury (54.2%).

Table 8.1: Experience of injured workers (percentages).

	Underground mine workers	Open cut mine workers
< 5 years	2.6	0.0
5 - 10 years	10.3	0.0
10 - 20 years	46.2	66.7
20 - 30 years	25.6	33.3
30 or more years	15.4	0.0

Tables 8.2 and 8.3 show the location of lower limb and ankle injuries and the type of lower limb and ankle injuries respectively (the type of injury was only coded for the 31 workers with injuries resulting in more than 4 weeks off work). The main locations of injuries were knees and ankles. The main types of injuries were sprain/torn ligaments and cuts/lacerations.

Just over half the workers were aware of the risk of injury; 69.2% of underground mine workers and 44.4% of open cut mine workers. Furthermore, of those that were aware of the risk of injury, about a quarter of workers were aware of a safer way to do the job; 25.9% of underground mine workers and 25.0% of open cut mine workers. Almost all injured workers (87.2% of underground mine workers and 88.9% of open cut mine workers) were performing tasks which were part of their regular duties, however, these tasks rarely had written work procedures (25.0% of underground mine workers and 19.4% of open cut mine workers).

Table 8.4 shows the perceived cause/contributing factors which resulted in lower limb and ankle injuries. The major perceived cause/contributing factors for underground mine workers were uneven floor/surface (46.2%), wet/slippery floor conditions (46.2%), mining a hazardous geology (41.1%), poor housekeeping/untidy work area (25.6%), and climbing on/off equipment (23.1%). The major perceived cause/contributing factors for open cut mine workers were uneven floor/surface (55.6%), climbing on/off equipment (22.2%), and equipment poorly designed for use (22.2%).

assessments were most likely to be made by a first aid officer (76.3%), an undermanager/shift supervisor (26.3%) or a deputy/supervisor (15.8%). In just

Table 8.2: Location of lower limb and ankle injuries (percentages).

Note: Totals do not add to 100% as more than one location of injury can be reported per accident.

	Underground mine workers	Open cut mine workers
Knee	46.2	66.7
Ankle	25.6	22.2
Foot	15.4	0.0
Shin	12.8	0.0
Toes	5.1	0.0

Table 8.3: Type of non-fracture lower limb and ankle injuries (percentages).

Note: Totals do not add to 100% as more than one type of injury can be reported per accident.

Type of injury	Underground mine workers	Open cut mine workers
Sprain/torn ligament	54.2	42.9
Cuts/laceration	20.5	0.0
Strain/torn muscle	8.3	0.0
Crush	8.3	0.0
Bruise	4.2	0.0
Abrasions	0.0	0.0

Injured workers also rated the potential seriousness of their accident by rating how severe their injury could have been, and how much production time could have been lost because of their injury (see Tables 8.5 and 8.6). Most injured workers rated their injury as having the potential to be a serious lost-time injury.

Most injured workers rated their injury as having the potential to result in less than 1 hours loss of production. Only one underground mine worker rated a potential loss of one day's production from their injury.

Injury assessment practices

Just over three quarters of the injured workers reported that their injury was assessed at the mine (79.5% of underground mine workers and 77.8% of open cut mine workers). These

over three quarters of the accidents, the assessment was made immediately (77.4% of underground mine workers and 85.7% of open cut mine workers). While most workers were 'satisfied a lot' with the assessment process (82.5%), there were a few workers who were not satisfied with the assessment process. Most colleagues knew what to do once the worker was injured (84.6% rated a lot, and 10.3% rated a little).

Most of workers were first assessed by a medical or health professional at the mine (39.6%) or at their family doctor's office (37.5%). In just under half the cases, this assessment did not occur until more than 6 hours after the accident (41.3%), however, in a number of cases, this assessment occurred in less than 30 minutes (15.2%) or between 30 minutes and an hour (23.9%).

Table 8.4: Perceived cause/contributing factors which resulted in lower limb and ankle injuries (percentages).

Note: Totals do not add to 100% as more than one perceived cause/contributing factor can be reported per accident.

Perceived cause/contributing factor	Underground mine workers	Open cut mine workers
Uneven floor/surface	46.2	55.6
Wet/slippery floor conditions	46.2	11.1
Mining a hazardous geology	41.1	0.0
Climbing on/off equipment	23.1	22.2
Poor housekeeping/untidy work area	25.6	0.0
Equipment poorly designed for use	20.5	22.2
Not enough space to work in	20.5	0.0
Badly supporting boots	15.4	11.1
Not enough light/lighting a problem	15.4	11.1
In a hurry/short on time	12.8	11.1
Lack of job planning	10.3	11.1
Emphasis on production, not safety	10.3	0.0
Recommended equipment not available	10.3	0.0
Standard operating procedures not in use	7.7	11.1
Poorly guarded equipment	7.7	0.0
Not enough manpower	5.1	11.1
Poorly maintained equipment	5.1	0.0
Lack of training	2.6	0.0

Table 8.5: Potential severity of injury (percentages).

	Underground mine workers	Open cut mine workers
Fatality or permanent disability	23.1	0.0
Serious lost-time injury	46.2	88.9
Moderate lost-time injury	17.9	11.1
Minor lost-time injury	12.8	0.0
No lost-time injury	0.0	0.0

Table 8.6: Potential delay in production (percentages).

	Underground mine workers	Open cut mine workers
More than 1 day	2.6	0.0
One shift to 1 day	5.1	0.0
One shift	2.6	0.0
One hour to one shift	35.9	11.1
Less than 1 hour	53.8	88.9

Injury treatment practices

Injured workers received treatment from various sources (80.4% had treatment from their family doctor, 79.2% had physiotherapy treatment, 76.6% had specialist or consultant treatment, 70.8% had first aid treatment, and 62.5% had treatment in a local hospital). When physiotherapy treatment was received, this most likely occurred in a private hospital or clinic (78.9%), rather than a local hospital (17.2%) or JCB's occupational health services (10.3%). While almost all injured workers receiving physiotherapy reported that a formal program was set up (97.4%), only two thirds of injured workers were able to get back to work as scheduled by the program (66.7%). Furthermore, about one in six injured workers receiving physiotherapy reported that the program did not help them get back to work (16.2%).

Accident reporting and investigation practices

In almost all cases, the injured worker reported that a report was filled out (1 open cut mine worker did not recall this happening). About three quarters of the injured miners reported that they were consulted about the report (71.8% of underground mine workers and 87.5% of open cut mine workers), and almost all workers rated that the report was accurate (96.9% of underground mine workers and 85.7% of open cut mine workers). Less than two thirds of injured workers reported that management had investigated the accident (62.2% of underground mine workers and 55.6% of open cut mine workers), and few reported getting any feedback from an investigation (33.3% of underground mine workers and 50.0% of open cut mine workers).

Experiential reports of having serious injuries

Participants were also given the opportunity to respond to open-ended questions regarding possible improvements to personal protective equipment (eg, cap lamps and boots), appropriate suitable duties for injured workers and general comments. Respondents typically reported that the batteries for cap lamps were too heavy (and that new technologies using NICAD batteries for example may improve the weight), the cable was dangerous as it was occasionally caught on equipment, and that the light beam needed to be brighter and have an option for it to be wider. Boots attracted many comments with respondents requesting better instep protection, better ankle support, better traction and improved comfort and ventilation.

Suitable duties, when deemed necessary, need to be well organised and appropriate for the injury. This requires careful consideration of the walking surface for workers with lower limb injuries. The ground needs to be even, and if, for example, crutches are being used, with sufficient space for assistive devices. Duties in the office or workshop, or cleaning or courier duties were considered appropriate. Some workers reported having faced problems regarding the perception of some workers that suitable duties take another worker's job. These attitudes were felt to impede the recovery process. Sometimes there are no suitable jobs available. Suitable duties are often referred to as 'rehab' and in many cases are differentiated from physiotherapy and other therapeutic processes aimed at improving recovery and assisting the worker to return to work.

Several participants reported negative views of treating doctors and physiotherapy services (although there were also some positive reports of physiotherapy services). Often these comments questioned whether early mismanagement prolonged recovery time. Negative views of CMI were also reported. These typically reflected suspicion over the motivation of CMI arranged doctor appointments, and over late or decreased payments for loss of salary. Finally, some comments questioned management's concern for safety and the overuse of lost-time injury frequency rate for safety performance measurement.

Summary of results

Injured workers were experienced in the industry, and many had previous lower limb injuries. The knee was mostly commonly injured, and injuries were most likely sprain/torn ligament. Workers were aware of the risk of injury and one quarter of the injured workers knew of a safer way to do the job. Most of the injuries occurred while the workers was performing regular tasks, which rarely had written procedures. Uneven floor/surface, wet/slippery floor, mining a hazardous geology, poor housekeeping and climbing on/off equipment were major causes/contributing factors for lower limb injuries. Workers judged that their injury had the potential to be a serious lost-time injury, but resulting in less than one hours delay to production.

Most injured workers were assessed immediately at the mine by trained personnel (first aid officers). There was a high level of confidence in fellow worker's knowledge of what to do following accidents. Although some workers were assessed by health professionals within one-hour of their accident, some workers needed to wait for more than 6 hours. Most workers were treated by their family doctor, as well as other health professionals.

Although there was widespread consultancy regarding accident reports, many workers claimed that the accident was not investigated by mine management and many said that they received no feedback.

Comments elicited from participants indicated that generally there are suitable duties which can be performed by injured workers. There appears to be a lack of acceptance that suitable duties are part of the recovery and adjustment process which can lead to a worker returning to full duties faster than would otherwise occur. Finally, there were some negative views of medical and physiotherapy services, and a question that poor initial management may have contributed to a worker's disability.

Discussion

The group of seriously injured underground mine workers, as defined as workers with fractures or more than 4 weeks off work due to a workplace-related lower limb and/or ankle injury, had similar experience in the industry and a similar injury location for all injured underground mine workers (see Chapter 3). On the other hand, seriously injured open cut mine workers in this analysis were more experienced and had more knee injuries than all injured open cut mine workers (see Chapter 3), although this may be an artefact because of low numbers of participants in this current study.

Seriously injured workers had the same level of awareness of risk and knowledge of safer way to do things as less seriously injured workers (see Chapter 3). This does not support the findings of Chapter 4, that knowing a safer way to do things is more likely to result in a serious injury. There are several possible explanations. First, the small participation rate in the current study and fear of providing information of potential harm to compensation cases may result in bias in reporting of knowledge of a safer way to do things. Also there is a possible bias in over reporting potential seriousness of an injury in the previous study (Chapters 3 & 4), or over reporting their awareness of better way to do things. Injured workers may attribute their knowledge of a safer way to do things with preventing a more serious injury.

Seriously injured workers were often performing 'regular duties' when injured. Therefore, novelty is not necessarily associated with seriousness of injury, although, it is uncertain as to how regular these duties were as most did not have written procedures. While it is not known how many activities in the coal industry have written work procedures, nor whether the lack of written work procedures would contribute to seriousness of injury, the lack of written work procedures may contribute to a worker's perception of where blame lies and therefore contribute indirectly to the effects of injury. All work procedures should be in writing and all employees should know the written procedures to reduce injury risk and to reduce the perception of company responsibility for an injury should one occur.

Earlier analyses (Chapter 4) identified that, for underground mine workers, *Mining a Hazardous Geology* and *Standard Operating Procedures not in use* increase the risk of serious injury. This was partially confirmed in that *Mining a Hazardous Geology* was greater in this group of seriously injured workers than in all injury reports (see Chapter 3), however, *Standard Operating Procedures not in use* was the same. This may at least in part be explained by a possible response bias from the current group of participants being reluctant to acknowledge that *Standard Operating Procedures were not in use* at the time of their injury, which if admitted, has the potential to jeopardise their compensation claim. The picture for open cut mine workers is less clear because of the small n.

After an accident seriously injured workers are more likely to be assessed at the worksite, be assessed by a first aid officer and/or undermanager/shift supervisor and be assessed immediately, than other workers with lower limb injuries (see Chapter 7). Seriously injured workers are also less likely to be satisfied with the assessment process than other workers with lower limb injuries. It is unclear whether the dissatisfaction with the assessment process is due to anger following a serious injury, or whether the assessment process for serious injuries is sub-optimal. While worksite assessments occurred rapidly, (associated with greater satisfaction - see Chapter 7), the process of the assessment may require general improvement.

There was a substantial delay for many seriously injured workers before being first assessed by a medical or health professional. There are, obviously, physical barriers, for example, having to retrieve a worker injured underground at the coal face distant from an egress point, or the relative geographical isolation of some mines, which may contribute to delay for assessment. However, it is essential that medical or health professional assessment and intervention commences as soon as possible as delays probably heighten anxiety and may then retard rehabilitation and return to work outcomes (Rondinelli et al., 1997).

As expected, when compared to other workers with lower limb injuries, seriously injured workers were more likely to receive specialist medical and physiotherapy treatment. Also, when receiving physiotherapy treatment, seriously injured workers were more likely to use private services, rather than public or JCB provided services when compared to other injured workers. However, there are some questions regarding the efficiency and effectiveness of physiotherapy services. Only two of three seriously injured workers reported that they returned to work as scheduled by a plan. Furthermore, one in six workers considered that the program did not assist them in returning to work. The quantitative results were supported by some negative opinions about physiotherapy services and their possible role in exacerbating injury and disability. Outcomes of physiotherapy treatment need to be monitored to improve efficiency and effectiveness, and reduce costs.

Accident reporting and investigation practices need to be reviewed. Although a greater proportion of seriously injured workers reported that their accident was investigated by management when compared to other workers with lower limb injuries (see Chapter 7), few workers reported that they received feedback about the investigation. The consequences of failure to feedback information includes distrust in the injured worker regarding management's commitment to safety and health in the workplace. Accident reporting and investigation systems will only be effective if they are open and timely feedback is given to people who can make a difference, ie, injured workers and their colleagues.

Open comments made by seriously injured workers regarding technological improvements for OH&S also support comments made elsewhere (eg, Chapters 5 and 6). Cap lamps and their associated equipment, and boots were identified as needing improvement. However, as discussed earlier, these are the last line of defence against injury and other higher priority hazard reduction techniques should be attempted before concentrating on these devices (see Chapter 5).

Finally, two issues regarding modified duties need to be addressed. First, when a worker is returning to work following an injury, modified duties that are offered are not always appropriate. For example, modified duties may involve 'jobs' which are created for the worker which have no practical value, or may include activities which the worker is unable to perform. Modified duties must involve meaningful work and must take into account the restrictions or disabilities which the worker may have to deal with. Second, there is a perception that modified duties are managements' attempts at getting as much as possible out of the injured worker, sometimes to the detriment of the worker and his colleagues. There is limited recognition within the industry that modified duties are designed to assist the worker recover from their injury and return to full wage-earning capacity. Modified duties, also commonly labelled 'rehab', are viewed differently and distinctly from other rehabilitation processes, for example, physiotherapy. It may be useful to develop a health promotion program to educate mine management and workers about the role of modified duties, as part of the overall rehabilitation process aimed at assisting injured workers.

Chapter 9

Risk management, post injury assessment and treatment, and rehabilitation for the coal mining industry: A trial of an audit system.

Synopsis

The objective of this chapter was to develop and trial an audit system for evaluating the occupational health and safety system combined with the rehabilitation system for NSW coal mines.

Introduction

While injury surveillance systems can play an important role in OH&S, they are inevitably reactive. That is, they rely upon information collected after an adverse event has occurred to monitor and adjust OH&S systems. To supplement incident and accident investigation, systems have been used which are proactive in that they are designed to detect OH&S problems before an adverse event occurs. This has most often taken the form of an OH&S audit in which an inspection is conducted, and unsafe situations or practices are identified and rectified. Such audits can also be positive in identifying strengths in OH&S systems (Glendon, 1995).

There is a wide range of OH&S audit protocols available for the coal mining industry, eg, SafeGuard (Alexander et al., 1996) and Prominex (Lilic et al., 1996). While these may prove useful tools to conduct accident prevention audits as part of OH&S, little, if any consideration is given to auditing rehabilitation processes and systems for post-injury management. There are some general principles regarding rehabilitation and return to work following a work-related injury. These include good early injury assessment and treatment (Rondinelli et al., 1997), thorough accident investigation, and good return to work practices including suitable duties programs where necessary (Shrey & Olsheki, 1992). These need to be implemented with formalised policies, procedures and protocols and with collaboration between employees and management (Bruyere & Shrey, 1991; Shrey & Olsheki, 1992).

The aim of this part of the study was to develop and test a protocol for auditing rehabilitation and return to work practices. This protocol was not designed to replace accident prevention audit protocols, but to supplement them.

Method

The Research Team identified seven components of rehabilitation and return to work practices which satisfy principles of best practice post-injury management in the coal mining industry. These are:

1. Post-injury management policy,
2. Reporting and follow up of incidents and injuries,
3. Injury treatment,
4. Accident investigation,
5. Rehabilitation and return to work procedures,
6. Liaison with treating doctors, and

7. Rehabilitation management performance measurement.

These components have been embedded in a continuous improvement model (the Post-Injury Management Audit), designed to assist coal mines achieve best practice through a graduated and staged process. Each component is rated on a four point scale according to evidence provided about current mine practices. (see Appendix to this Chapter). Scores are weighted such that components 2 to 7 had equal weight which was higher than component 1.

The Audit was trialed at 7 participating coal mines from November 1996 to June 1997. Prior to the audit mine staff were advised of the components to be audited. A member of the Research Team travelled to the mine to conduct the audit. While the primary evidence used in the audit was documentary, where possible employees were interviewed to confirm the documentation.

Results of the audit were compiled at a later date and a report was provided to the participating mine. The report included a score for each component and narrative explaining the reasons for scores. Results were also provided as profiles and as a composite score.

A feedback questionnaire was sent to each of the mines 3 months following the return of their audit. The questionnaire inquired whether the components in the audit covered all aspects of rehabilitation and return to work practices, whether the scoring system provided practical advice, whether the audit was used to plan or review rehabilitation and return to work practices, and if it was used, how easy and useful it was, and whether the audit improved the understanding of rehabilitation and return to work practices.

Results

Scores achieved in the audit by the mines and their median scores are shown in Table 9.1. While some mines achieved the maximum score on some components, no mines achieved the maximum scores on all components. Also, some mines achieved the minimum score on some components, but no mines achieved the minimum scores on all components.

Table 9.1: Scores on the Post-Injury Management Audit for individual mines.

Mine	Component						
	1	2	3	4	5	6	7
T	B	B	B	D	A	C	C
U	B	B	B	B	A	D	B
V	B	A	B	A	A	B	C
W	C	C	B	D	C	B	C
X	C	C	B	C	A	B	C
Y	C	B	C	B	A	B	C
Z	C	B	B	A	A	D	B
Median	C	B	B	B	A	B	C
Range	B - C	A - C	B - C	A - D	A - C	B - D	B - C

Six of the seven feedback questionnaires were returned. Two of the respondents reported that they strongly agreed that the components in the audit covered all aspects of rehabilitation and return to work practices, and the other four reported that they agreed. One respondent reported that they strongly agreed that the scoring system provided practical advice about types of activities which should be included in rehabilitation and return to work practices, and the other five reported that they agreed. One respondent reported that they strongly agreed that the scoring system provided practical advice to managers/coordinators on how to achieve best practice in rehabilitation and return to work practices, and the other five reported that they agreed.

Three of the respondents reported that they have used the audit to plan or review rehabilitation and return to work practices. Follow up questioning revealed that the remaining three were intending to use it. All three respondents who used the audit to plan or review rehabilitation and return to work practices found it useful and intended to use it again.

Comments received regarding the question on whether the audit improved the understanding of rehabilitation and return to work practices included: 'The emphasis that there are seven (7) components in the process, not just 2 or 3', 'The results will help me achieve a better program. Unfortunately, I have not reviewed our program since the audit, but when I do I will use it as a measure and a tool to improve areas required', 'I think breaking it up into the 7 areas makes you think more clearly about how the process should work', and 'Reinforces what is required by WorkCover and what is good management of injured employees'.

Summary of results

The audit revealed a range of performance in rehabilitation and return to work practices between different mines. No mines were performing at the maximum level, but similarly, no mines were performing at the minimum level. That is to say, all mines have room for improvement, and all are to some degree progressing towards best practice. Feedback questionnaires revealed that the audit was acceptable and could, and were being used to review and improve rehabilitation and return to work practices.

Discussion

Glendon (1995) has discussed the advantages of OH&S injury prevention auditing. These include the process being explicitly preventative, it giving managers (who have a duty of care) more control over safety matters, it is transparent, it is a sensitive measure of safety performance, and it can measure success, not just failure. Such systems can therefore provide positive information about the OH&S system, as well as negative information. Similarly, auditing of post-injury management, or rehabilitation and return to work practices, should be able to provide positive indicators of how well these systems are operating.

While auditing of post-injury management systems may not directly prevent an accident and injury from happening, it may be able to prevent, or at least reduce, disability following an injury. Employer concern and advocacy will improve return to work following injury (Rondinelli et al., 1997). In this way post-injury auditing can be considered as preventative.

Auditing of post-injury management will also give managers more control over this important aspect of OH&S. If done regularly, it will provide management with information about their current compliance with regulations for rehabilitation following work-related injury, as well as their progress towards best practice. Areas where the organisation is deficient can be identified and remedial action taken.

Such audits are transparent. That is, the process of reviewing the post-injury management is open and not hidden from the employees. Bruyere and Shrey (1991), and Shrey and Olsheki, (1992) have emphasised the need for collaboration between employees and employers in dealing with OH&S matters. Combined employee/employer audits of post-injury management will enhance this collaboration.

Finally, audits can be a sensitive measure of safety performance, and they can measure success, not just failure. The post-injury management audit protocol developed in this project scores a mine on 7 different components of post-injury management, at four performance levels. All audits of mines showed better than minimal performance, but also revealed different areas requiring improvement at different mines.

The audit protocol developed in this study has proven to be acceptable to OH&S employees at several coal mines. Furthermore, some of the OH&S employees have used the results of the audit to review and improve their services. This corresponds to an increasing acceptance of audit for OH&S injury prevention within the coal mining industry, and other industries in general.

Appendix

POST INJURY MANAGEMENT

In order to achieve a set level, documented evidence must be provided which demonstrates compliance. In addition, observation of the workplace and discussions with employees must confirm documented evidence.

1 Post Injury Management Policy

D No statement of Post Injury Management (or Rehabilitation) Policy .

C There is a written Policy for Post Injury Management (or Rehabilitation).

B There is a written Policy for Post Injury Management (or Rehabilitation) which outlines responsibilities of management, supervisors and employees. A copy of this policy has been provided and all participants are aware of their responsibilities and rights under the policy.

A In addition to B, the policy statement is reviewed annually and redistributed. A system is in place to monitor its success and any changes required.

2 Reporting and Follow up of Incidents and Injuries

D Incidents and injuries are reported on a standard form following the event and signed by appropriate supervisor.

C In addition to D, in the event of an injury, the supervisor/qualified First Aider assesses the injured worker immediately to determine if and what further action is required.

B In addition to C, all injured workers are followed up within 24 hours of the event by their Supervisor or Rehabilitation Coordinator to discuss return to work options, if appropriate, and inquire after the health of individual.

A In addition to B, all workers involved in incidents are followed up within 48 hours of occurrenee. Also, injured workers who require further medical treatment or advice from their own treating doctors are contacted by a mine representative prior to seeking this advice. This contact provides an opportunity to convey the Mine's concern about the injured worker and reinforces the options available to the miner such as suitable duties should he/she require assistance in returning to work.

3 Injury Treatment

D Inadequate provision of first aid facilities for employees

C Adequate facilities for First Aid are provided. There is a qualified First Aider in every crew. Documentation is maintained to ensure First Aid Qualifications are current.

B Procedures are in place to provide injured employees with prompt First Aid Treatment and access to further emergency medical treatment if required. For example, policy stating that ambulance always called or designated person drives or taxis injured worker to hospital.

A Written policies and procedures are in place for D to B and are reviewed regularly. Written Emergency Response Procedures are available. Emergency Response Procedures are reviewed regularly and updated as required. Exercises in Emergency Response Procedures are regularly conducted for the workforce.

4 Accident Investigation

D Only serious injuries are investigated. No written investigation procedures exist.

C Written investigation procedures are in use. All injuries requiring first aid or more are investigated by immediate supervisor.

B In addition, all incidents are investigated by immediate supervisor and a system is in place to ensure that recommendations are actioned by management and feedback is given to workers. Management/supervisors are trained in investigation procedures.

A In addition to B, all investigations are carried out in a timely manner. Investigation reports are discussed at senior management and OH&S Committee meetings and results of discussions are communicated to workforce.

5 Rehabilitation and Return to Work Procedures

D When appropriate, suitable duties are offered to injured workers to assist them in returning to work.

C The suitable duties provided are injury specific and based on medical advice from the injured worker's treating doctor as to what tasks the injured worker is and is not capable of doing.

B In addition to C, a Rehabilitation Plan with goals and objectives is developed in consultation with the Injured Worker, Rehabilitation Coordinator, Deputy or Supervisor and possibly a Union Representative. The Rehabilitation Plan is time limited. However, the time limit is based on the individual circumstances of the injured worker not an across the board standard.

A The Rehabilitation Plan is reviewed weekly (or fortnightly) and is aimed at returning the injured worker, through a gradual, staged process, back to his/her own shift and crew. The rehabilitation has an agenda and minutes are recorded. The individual is considered supernumerary with suitably modified tasks and duties until full duties are achieved.

6 Liaison with Treating Doctors (TD)

D No contact with injured worker's TD .

C Form letter sent to every injured worker's TD outlining the Mine's concern for, and commitment to rehabilitating, the injured worker. This letter includes a form requesting information outlining what tasks the injured worker is and is not capable of doing.

B All of the above is documented and has been developed in consultation with the workforce and its representatives. Information received from TD is reviewed regularly. Updated medical information is sought from TD as injured worker progresses. TDs are supplied with a copy and sign off on rehab plans.

A In addition to B, TDs are invited to view, or provided with information about, environmental and working conditions at the mine to see what suitable duties may be available. This may help to stop the practice of writing "surface duties only" medical certificates.

7 Rehabilitation Management Performance Measurement

D No reporting to management on Rehabilitation issues and performance.

C Reports confined to Lost Time Injury statistics and compensation claims

B All rehabilitation cases are monitored using objective performance measures such as but not limited to; rehab plans, reviews, dates for progression, objectives achieved and completion dates, length of time on rehab, successful return to work. Reports are prepared monthly and circulated appropriately, including senior management.

A In addition to B, performance measures are reviewed regularly, issues identified are acted upon, and any changes or feedback are communicated to the workforce.

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