SAFETY SCIENCE Monitor

ISSUE 2 1998

Article 4

VOL 2

STRATEGIC OCCUPATIONAL INJURY PREVENTION OCCUPATIONAL BLACK SPOTS - BALLARAT REGION

GEORGE RECHNITZER[1], TORE J. LARSSON[2], BARRY MANTLE[3]

[1]Monash University Accident Research, [2]Ballarat University, [3]Victorian WorkCover Authority

ABSTRACT

This report covers the identification of priority areas for the initiation of systematic activities by the Authority to reduce occupational trauma in the Ballarat Region, and the rest of Victoria.

The project included the analysis of the claims data for the 25 month period from 1.12.1992 to 31.12.1994. The main analysis was devoted to lost time injuries/diseases sustained during the period, which formed a subset of 1433 cases, for Ballarat and 37,782, cases for the rest of Victoria. The Ballarat region was defined by postcodes.

The severity index developed in the previous Stage 1 Project was used as a criterion in assessing priorities for prevention activities. Three aspects of severity were used: days admitted as in-patient to hospital; all possible indication of maims in relation to the injury; and the duration of earnings related compensation payments (lost time). In addition an injury volume/severity indicator (HARM) was developed, defined as average severity by number of claims.

Priority areas for Ballarat were identified as: **Transport and distribution** (vehicle-associated) lifting, loading, unloading; and **Nursing personnel** (hospital-based, and other key associated groups) lifting, moving, transporting people/ goods in all situations.

Recommendations include the development and implementation of 3 year rolling program for **Victoria** wide projects focussing initially on:

- **Transport workers** - overexertion lifting, loading, falls from vehicle
- **Nursing personnel** - overexertion, back injuries
- **Construction Workers** - falls to lower level
- **Construction Workers** - traumatic contacts with vehicles
- Traumatic contact with forklift trucks - pedestrian workers

Further activities in regard to **Coding system** upgrading for better use in injury prevention activities; and **on-going research and analyses** of the claims material, are also recommended.

Table of Contents

ACKNOWLEDGMENTS

The authors wish to thank and gratefully acknowledge the staff of the WorkCover Authority, particularly Max Vickery, Bronwyn Richardson, Alan Clayton and Eileen McMahon, for their assistance, and support of the project.

EXECUTIVE SUMMARY

Regional Study

A key goal in the Victorian WorkCover Authority's (VWA) Corporate Plan is the reduction of workplace injuries. A prevention Strategy is a major part of that plan, and following its endorsement by the Board in April 1995, is currently being implemented.

An important step in the Prevention Strategy is a pilot study which will enable the evaluation/testing of systematic activities undertaken by the VWA to reduce occupational trauma in priority areas. For this reason a study of the Ballarat region has been undertaken by the VWA. The Ballarat region was chosen by the VWA due to;

(i) its mix of Industry

(ii) the area is suitably isolated from Melbourne, and provides an ideal environment to determine media/marketing activities suitable for use in a Prevention Strategy.

Once the optimal activities necessary for implementing prevention activities have been determined, it is intended the project be rolled out to the rest of Victoria.

Prevention strategy

This report covers the identification of potential priority areas for the initiation of systematic activities by the Authority to reduce occupational trauma in the Ballarat region, and ultimately the rest of Victoria. This project follows on from the previous study by the project team, involving the preliminary analysis and review of the VWA claims database.

A strategy for prevention is based on the understanding that occupational injuries are preventable; exposure, equipment, environment and operational procedures can be modified for preventive purposes. Solutions to these problems should, primarily, be sought in modifications of technology, organisation and exposure. Safe systems of work are the necessary foundations for safe behaviour in the workplace.

The application of scientifically based strategies to injury prevention and the benefits attainable is exemplified by road safety programs, and the significant reduction in the road toll achieved over the last 23 years (in particular the last five years). Examples of major programs include those of the TAC together with the Police Force and other agencies investing some $80M (booze buses, speed cameras, supporting publicity etc) resulting in estimated savings over the period of 881 fatalities, 8891 serious injuries and 22450 other. Other programs include the accident '**blackspot**' programs for which the TAC is contributing $75M over two years to help eradicate **500 blackspot locations** in Victoria. These programs provide valuable models which can be adapted to a workplace injury prevention program, and have been drawn on in this project.

Claims Data

The major steps in the project involved the analysis of the claims data base with the objective of identifying priority target areas characterised by having above average severe injuries, and above average contribution to the pool of all claims.

The claims period selected for study was the **25 month** period, **1 December 1992 through 31 December 1994.** The selection of this period minimised the complication of including data from before the major legislative changes to the scheme in December 1992. The main analysis was devoted to injuries/diseases sustained during the period, that resulted in either lost time or a Maim payment. This amounted to the analysis of **1,433 claims** on the database for the **Ballarat region** (**$8,320,649** of claims costs), and **37,782 claims** for the rest of **Victoria** (**$234,920,762** of claims costs).

It is noted that prior to July 1993 the excess was 5 days and the first $378 of medical; from July 1994 the excess was 10 days and the first $398 of medical. Claims falling under these excess conditions are typically covered by the employer and are of course not part of the WorkCover claims pool.

Severity Index

One important task for this study has been to establish a preliminary measurement of injury severity, to be used as a criterion in assessing priorities for prevention activities. In the present study, indicators of these three aspects of severity were used. As a variable indicative of medical severity**, days admitted as in-patient to hospital** was used. As a measure of permanent medical impairment, all possible indication of **maims** in relation to the injury were recorded. And lastly, as a measure of temporary incapacity due to injury, the **duration of earnings related compensation payments** was recorded. These three index components are added to give a total severity index. The total severity index is multiplied by the frequency of claims to give a measure of **harm.** Harm is a measure for quantifying total injury severity sustained from occupational injuries, involving both a frequency and a severity component. It enables the identification of areas that contribute significantly to the total pool of claims.

The main analyses were carried out on the basis of occupational groups. The 400 categories of occupational code used in the WorkCover system, were condensed into **64** logical occupational groups, where exposure was similar.

Results - Occupations

The following occupational groups were identified as accounting for most harm resulting from occupational injuries:

(i) Ballarat (n = 1433, cost = $8,320,649, T = 25 months)

Occupation	Claims	Severity	%Harm	%Payment
Transport, car, truck	72	4.56	8	9
Farmers, etc *	78	2.94	5	7
Welders, etc	32	6.17	5	4
Fitters & turners	65	2.68	4	3
Textile/shoe workers	42	3.84	4	4
Sales workers	40	3.95	4	3
Transport, other	33	4.66	4	2
Nurses, etc	76	1.89	3	4
Woodworkers, etc	40	3.30	3	3
Teachers	41	2.62	2	3
Housekeeping, etc	31	3.40	2	3
Vehicle builders, etc	39	2.50	2	2
Police, guards	23	3.68	2	3
Other metal workers	12	6.72	2	1
Professionals	24	3.31	2	2
Construction	22	3.24	2	2
Cleaners	15	4.73	2	2
Earthmoving, etc	17	4.02	2	1
Hotel, restaurant, etc	39	1.71	2	2
Managers & Clerks	25	2.54	1	2
	766		60	62

* Farmers as a group are typically self employed, with the majority not covered by the WorkCover scheme.

(ii) Rest of Victoria (n = 37,782, cost = $234,920,762, T = 25 months)

Occupation	Claims	Severity	%Harm	%Payment
Transport, car, truck	2307	2.95	6	7
Construction	1105	3.98	4	4
Woodworkers, etc	1427	3.07	4	4
Vehicle builders, etc	1324	3.12	4	3
Waterside, freight	1493	2.51	3	3
Nurses, etc	1715	2.17	3	4
Fitters & turners	1092	3.22	3	3
Textile/shoe workers	1052	3.23	3	3
Sales workers	927	3.22	3	3
Assembly&process	1005	2.87	3	2
Farmers, etc *	1117	2.53	2	3
Hotel, restaurant, etc	1140	2.41	2	2
Managers & Clerks	848	3.04	2	3
Welders, etc	836	2.79	2	2
Cleaners	756	2.92	2	2
Police, guards	756	2.77	2	2
Professionals	666	2.76	2	2
Machinists	461	3.82	2	1
Rubber/plastics, etc	552	3.17	2	1
Other metal workers	546	3.21	2	1
	21125		55	56

The top twenty occupational groups for Ballarat account for 60% of Harm, and the top twenty for the rest of Victoria account for 54%.

In this selection, priority was given to occupational groups that accounted for most harm, resulting from occupational injuries. These groups should form the basis for prevention activities. Additionally, for Victoria, a number of smaller groups such as forestry workers, riggers, miners, painters, and printers, exhibit above average severity ratings and would warrant further investigation and subsequent applied prevention activities.

Occupation by Type of accident

To more closely identify particular contributors to Harm, the data was further disaggregated by type of accident with the highest contributors to harm identified, and presented in the following two tables.

(iii) Occupation by type of accident - Ballarat

Occupation	Type of accident	Claims	Payment	Harm
Transport, other	OTHER TYPES OF ACCIDENT	16	51885	67.03
Fitters & turners	OVEREXERTION OR PHYSICAL STRESS IN LIFTING OBJECT	18	116099	57.07
Nurses, etc	OVEREXERTION OR PHYSICAL STRESS IN LIFTING OBJECT	30	116611	51.05
Fitters & turners	OTHER TYPES OF ACCIDENT	15	72864	50.99
Transport, car, truck	OVEREXERTION OR PHYSICAL STRESS IN LIFTING OBJECT	16	86474	49.09
Textile/shoe workers	OTHER TYPES OF ACCIDENT	10	74355	47.02
Police, guards	OTHER TYPES OF ACCIDENT	11	183048	46.80
Farmers, etc *	STRUCK BY MOVING OBJECT	13	102013	45.22
Sales workers	OVEREXERTION OR PHYSICAL STRESS IN LIFTING OBJECT	11	86314	40.56
Farmers, etc *	OTHER TYPES OF ACCIDENT	10	209714	40.38
Vehicle builders, etc	OVEREXERTION OR PHYSICAL STRESS IN LIFTING OBJECT	12	68579	29.01
Woodworkers, etc	OTHER TYPES OF ACCIDENT	10	86580	28.75
Farmers, etc *	OVEREXERTION OR PHYSICAL STRESS IN LIFTING OBJECT	12	71702	23.19
Nurses, etc	OVEREXERTION OR PHYSICAL STRESS IN HANDLING OBJECT	12	61853	21.89
Hotel, restaurant, etc	FALL ON SAME LEVEL	11	30839	14.19
Butchers, etc	STRIKING AGAINST MOVING OBJECTS	12	21877	5.99
Dairy/food process	OVEREXERTION OR PHYSICAL STRESS IN LIFTING OBJECT	10	17390	4.46
Butchers, etc	STRUCK BY MOVING OBJECT	12	5912	1.50
		241	1464108	

(iv) Occupation by type of accident - Victoria

Occupation	Type of Injury	Claims	Payment	Harm
>200 CASES				
Nurses, etc	OVEREXERTION OR PHYSICAL STRESS IN LIFTING OBJECT	688	4,123,057	1620.18
Vehicle builders, etc	TYPE OF ACCIDENT NOT KNOWN	254	1,042,059	1263.11
Transport, car, truck	OVEREXERTION OR PHYSICAL STRESS IN LIFTING OBJECT	481	3,178,422	1240.58
Waterside, freight	OVEREXERTION OR PHYSICAL STRESS IN LIFTING OBJECT	481	3,142,657	1191.99
Sales workers	OVEREXERTION OR PHYSICAL STRESS IN LIFTING OBJECT	269	1,895,220	820.02
Fitters & turners	OTHER TYPES OF ACCIDENT	231	1,207,969	808.03
Transport, car, truck	OTHER TYPES OF ACCIDENT	211	1,481,934	804.84
Nurses, etc	OVEREXERTION OR PHYSICAL STRESS IN HANDLING OBJECT	343	2,048,284	716.25
Transport, car, truck	OVEREXERTION OR PHYSICAL STRESS IN HANDLING OBJECT	269	1,664,954	709.51
Transport, car, truck	FALL FROM HEIGHT OR INTO DEPTH	286	1,654,983	698.23
Woodworkers, etc	OVEREXERTION OR PHYSICAL STRESS IN LIFTING OBJECT	231	1,837,972	688.47
Transport, rail	OTHER TYPES OF ACCIDENT	211	823,586	687.49
Waterside, freight	OTHER TYPES OF ACCIDENT	200	905,513	638.54
Transport, car, truck	FALL ON SAME LEVEL	243	1,356,568	542.32
Hotel, restaurant, etc	OVEREXERTION OR PHYSICAL STRESS IN LIFTING OBJECT	205	1,141,908	459.62
Waterside, freight	OVEREXERTION OR PHYSICAL STRESS IN HANDLING OBJECT	204	1,063,753	373.22
		4807	28,568,840	

From these tables it can be seen that nurses and transport come up high in both Ballarat, and Victoria, for their contribution to harm based on the analysis by type of accident.

Detailed Analysis of High Severity/Harm Occupational Groups

To more closely identify particular priority areas within each of the selected occupational groups, accident 'mechanism' was determined manually from the free text in the claim form.

From the subsequent detailed analyses of the occupational groups, the following priority areas were identified for each group. For Ballarat and the rest of Victoria,

(i) 'Transport (car, truck, other)', in the areas of :

- Overexertion or physical stress in lifting/handling objects
- Fall from height or into depth (typically from the vehicle)

(ii) 'Nurses', in the areas of:

- Overexertion or physical stress in lifting/handling patients/objects

For Victoria, some examples from the larger group of **'Construction Workers'** include

- Fall from height or into depth
- Fall on same level
- Overexertion or physical stress in lifting/handling objects

Occupational "blackspots"

It became apparent from the analyses that each occupation group has its own particular " areas, which are characteristic and most likely peculiar to that occupation. For example '**transport workers**' have a high harm contribution from '**overexertion or physical stress in lifting/handling objects' and 'falls'.** u**rses'** injuries are conspicuous by their association with '**overexertion or physical stress in lifting/handling patients/objects'**. Each occupation has associated with it particular equipment, processes, practices, injury type and circumstances.

These observations suggest that a powerful and effective injury prevention program utilising the concept of "black spot analyses" developed in the road safety area, can be applied systematically to each occupational group (and particular types of industrial sites).

Similarly, this type of "blackspot" analysis could **focus on specific agencies of injury** identified in terms of high frequency and severity occurring across occupational groups. In this category, some examples based on the preliminary analyses carried out in this study, include, ladders; forklifts; and sawing machines.

SUGGESTED PROGRAM

On the basis of the data analysis carried out, and consideration of feasibility of implementation of initiatives, it is recommended that an applied injury prevention program in Ballarat focus on the areas of:

1. **Transport and distribution** (vehicle-associated) lifting, loading, unloading, lugging cargo between vehicle and terminal/customer, and

2. **Nursing personnel** (hospital-based, and other key associated groups) lifting, moving, transporting people in all situations during medical care and treatment

Importantly, as noted, these two groups represent major claims groups (in terms of severity index, harm and total claims cost) for Victoria overall. Thus, following the comprehensive development and experience gained through the proposed Ballarat based programs (July 1995 - June 1996), **it is recommended that expansion to Victoria** as a whole be initiated for these two major groups, noted above.

Experience gained in the Ballarat region should also be drawn upon for other major Victorian initiatives, including projects addressing

- **prevention of falls associated with working from heights, and**

- **pedestrian/ vehicle interaction in the workplace**

The analysis of severe injuries among workers in the Construction Industry, in this and previous studies, indicates the need to assess the possibilities of changing practices and upgrading equipment for work at heights; equipment for working on roofs, ladders, trestles, scaffolding etc. This would be specifically needed in the area of low-rise, residential construction, where perceptions of risks and present equipment and practices should be addressed on an industry basis. However a number of different occupational groups and associated work practices outside the core house-building industries should also be included.

The problems of vehicles interacting with pedestrian workers in the workplace, are of general importance and constitute a top priority in a large number of industries. The analysis of traumatic contacts with vehicles among Construction Workers points specifically to the safety priorities at construction sites. In addition previous research has highlighted that the interaction of Forklift trucks with pedestrian workers, still constitutes a significant cause of severe and fatal occupational injury at a broad range of workplaces in Victoria.

Planning for these Victoria wide projects, including supporting media campaigns should be conducted in the period February-June 1996, for project commencement in July 1996 through to June 1997.

In addition to these activities upgrading of the coding system and on-going research and analysis of the claims material, as recommended in the stage 1 project, should be carried out.

COST BENEFIT ANALYSIS

Based on the claims data over the 25 month period (nominally 2 years), for **transport in Ballarat,** an assumed claims reduction rate of 30% following study interventions - would result in claims cost reductions of **$110,000.** These estimates and savings, if translated to Victoria, would represent savings of approximately **$2.1 M.** For **Nurses,** a 30% saving would represent equivalent cost reductions of around **$80,000** for the Ballarat region**.** These estimates and savings, if translated to **Victoria**, would represent savings of approximately **$2.4 M.**

Thus, the estimated total savings following intervention in **Ballarat for Transport and Nurses is approximately $190,000** over a two year period**.** The equivalent savings Victoria wide would be approximately **$4.5 M** over a two year period**.**

1.0 BACKGROUND

A strategic framework was developed for the Victorian WorkCover Authority aimed at initiating an approach to long term, systematic and cost-efficient occupational injury prevention, built on the specific role and competence of the comprehensive worker's compensation system.

The initial **Stage 1 Project 1,** carried out in 1994, was essentially a pilot project with the following objectives:

- developing injury severity criteria for identifying and prioritising injury/occupational categories;
- analysing the claims data bases to identify initial priority target groups;
- identifying upgrades to the data base to facilitate its use in providing appropriate claims data for use in injury prevention activities

This report follows on from the developmental work of the Stage 1 project, and covers the identification of potential priority areas for the initiation of systematic activities by the Authority to reduce occupational trauma in the Ballarat region, and ultimately the rest of Victoria. The work included in this study was:

- index development, and validation
- the detailed analysis of the claims data base for Ballarat and the ‘rest of Victoria’,
- identifying target groups for the applied injury prevention program in Ballarat, and subsequently to be the basis for Victoria wide initiatives.

1.1 A Strategy for Prevention

The proposed injury prevention strategy involves the following five basic stages, applied systematically:

Stage 1. Determine priorities for prevention.

Stage 2. Problem identification.

Stage 3. Countermeasure development/ selection.

Stage 4. Implementation phase.

Stage 5. Evaluation Phase.

The injury information held in the **WorkCover database** forms the key source of injury data for use as a basis for prevention programs, and is essential to a serious program. The form in which such information is collected and held, however, must be adapted to the applied needs and goals of prevention (Larsson, 1991).

Injury information, to be effective, must identify harmful exposures, hazardous practices and dangerous agencies at a reasonably detailed level. It must reliably indicate which industries and occupational groups expose its workers to the highest risks of sustaining occupational trauma and disease. And it must make it possible to differentiate between occupational risks in terms of relative frequency/incidence and severity, and thus to indicate the priorities for applied prevention.

Primary analyses by 'occupation'

In regard to injury risk and severity, it is pertinent to emphasise that these are largely ***exposure dependent***. For this reason the primary analyses were by "**occupation**" which can be regarded as reflecting most closely exposure to specific risks and the tasks undertaken by the worker. On a national or industry-wide level, similar exposures, similar operations under similar conditions, tend to produce a stable volume of similar injuries to those that are exposed. A low level of physical risk, associated with low probabilities of death and severe medical trauma, tend to produce low grade physical injuries at times when the man-machine system becomes unstable, whereas a high level of physical risk, associated with higher probabilities of death and severe medical trauma, typically is associated with severe physical injuries to its operators. (Hovden & Larsson, 1987).

Once the pertinent occupational groups are identified, detailed disaggregation by other classifications, such as **type of accident**, **agency** etc are also carried out - including identification of specific **establishments**.

Target severe injuries

Systematic and criteria-based occupational injury prevention will improve safety, reduce suffering and improve workers' health by targeting severe trauma in the high-risk occupational groups. Such prevention activities, properly conducted, will also be conducive to increased productivity, reduce the cost of workers' compensation and, as a result, reduce premiums/levies.

A strategy for prevention must be based on the conviction that **occupational injuries are indeed preventable**; exposure, equipment, environment and operational procedures can effectively be modified for preventive purposes. This is the first - and possibly the most important - requirement of a strategy for prevention.

Allied with this view, a shift in general community attitude is required which moves away from regarding individual behaviour and "lack of care" as the main explanation for occupational injuries. The solution to these problems is to create safe systems of work, where technology and organisation reduce risk exposure and are conducive to safe behaviour in the workplace.

Secondly, a prevention strategy must state the **priorities for prevention**. Some injuries, some heavily exposed groups or some hazardous tasks or products must be singled out as more important targets for prevention than others. The strategy must also contain reasons for these choices based on real knowledge of severity, incidence and consequence costs.

Finally, the prevention strategy must state **how and by what means prevention will be pursued**, in terms of human, technical and financial resources for specific activities and set targets in terms of reduced severity, incidence or consequence costs for specific injury problems over periods of time.

A **selective** approach means defining an injury problem at a level where it can be addressed by prevention. It also means defining the problem of occupational trauma according to specific criteria like type of exposure, task, machine/product, hazard, rather than compensation-driven labels like "sprains and strains". It means establishing a constructive and uncontentious way of differentiating between severe and minor occupational trauma.

With a closer look at which occupations claim the highest average consequences in injury severity, the compensation data will potentially indicate which **activities** and **accident mechanisms** are typically associated with these **occupational exposures** (Larsson, 1990). This can focus preventative intervention in the form of technical redesign or development of details of machines, special attention to details of, or implements used in, certain tasks for training and retraining efforts, redesign or the introduction of new protective equipment, and selective information efforts targeted at the groups in question.

The importance of the injury problem depends on the relative severity of the trauma, the loss of life or degree of loss of quality-of-life, and the incidence and volume of the particular problem. An advantage to a compensation agency initiating and monitoring prevention activities, is the readily available **consequence and severity data**, which will make it possible to evaluate and assess the cost-benefit ratio of successful intervention.

1.2 Information for Applied Prevention

Traditional injury databases tend to focus on injury outcomes, i.e. the cause of death or hospital diagnosis for admitted patients, and thus provide little information about the sequence of events leading to injury. Information which is particularly valuable for developing prevention programs relate to identification of the product, machines, tools or activities involved in the incident that lead to injury.

The **WorkCover database** is well placed to provide this information, with the need however to focus on upgrading the 'pre-event' variables, which would greatly improve the prevention potential of the system. Increased precision of variables describing pre-event exposure and post-event consequences would also improve present or future severity indicators, thereby making decisions on the cost-benefit of applied prevention more precise, as well as enabling additional sophisticated analyses on the effectiveness of various treatment and rehabilitation procedures for various injury categories.

Precedents for the use and upgrading of workers' compensation databases can be found in other countries. In Sweden, for example, a decision was made to introduce a specific 'injury information system' into the claims-handling of the Swedish Occupational No-Fault Liability Insurance (Larsson, 1990).

1.3 Application of Road Safety Strategies to OH&S

The significant reduction in the road toll achieved over the last 23 years (in particular the last five years) exemplifies the benefits attainable from the application of scientifically based strategies to injury prevention. Some of the lessons learnt in the road safety area have been drawn on for this project, and are briefly reviewed in the following.

Since 1989 the Victorian road toll has nearly halved, from 776 fatalities in 1989, to 396 in 1992. Victoria's fatality rate of 1.6 deaths per 10,000 registered vehicles is amongst the lowest of any comparable community in the world. This drop in the toll is attributed partly to a downturn in the economy, but with over 70 % of this fall attributed to the various road safety programs implemented from September 1989.

The returns from the major investments in the road safety programs have been subject to extensive evaluation and typically show returns in the order of seven or more times their initial investment. For example, the Transport Accident Commission (TAC) together with the Police Force and other agencies have invested some $80M (booze buses, speed cameras, supporting publicity etc) resulting in estimated savings over the period of 881 fatalities, 8891 serious injuries and 22450 other injuries, or a saving of $1617M (7). If only half of this saving is attributed to the speed and RBT programs, the return on the $80M investment is ten fold estimated at $800M, over the three year period 1990/92 (Vulcan, 1993).

These programs have relied initially on the extensive analysis of the major data bases of VICROADS and the TAC. MUARC has played a key role in this and in identifying priority areas for further research, countermeasure development and implementation. The techniques and experience gained in this type of analysis have been utilised by MUARC in this project.

Other programs which could be adapted to the workplace injury prevention program are based on the accident '**blackspot**' programs, which commenced in Australia in 1979, following overseas success. These have proved to be very effective use of resources, with the TAC announcing that it will contribute $75M over two years to help eradicate **500 blackspot locations** in Victoria. The objective (Tziotis, 1993) of the programs is to reduce the incidence and severity of crashes at road locations that experience high numbers of casualty crashes by implementing targeted, cost-effective remedial treatments.

The sites are identified by analysis of mass crash data. Detailed follow up investigations of each site is made to identify the casual factors contributing to this higher accident involvement. Countermeasures typically take the form of various low cost modifications to the road system (traffic light, roundabouts, line markings, sealing of road shoulders, etc) are used. The returns on this investment have been evaluated at

various treated sites with over 30% reductions in crashes being common. The benefit cost ratio has typically been over seven (7:1).

2.0 METHODOLOGY

The study methodology involved the following five stages:

- definition of the Ballarat Region
- selection of the claims period and claims group,
- defining the severity criterion,
- formulation of the severity index and harm parameters,
- primary analyses by 'occupation', with subsequent detailed analyses.

2.1 The Ballarat Region

The Ballarat region was chosen by the VWA due to;

(i) its mix of Industry

(ii) the area is suitably isolated from Melbourne, and provides an ideal environment to determine media/marketing activities suitable for use in a Prevention Strategy.

Once the optimal activities necessary for implementing prevention activities have been determined from the experience in the Ballarat region, these will form the basis for application and implementation on a state-wide basis.

The Ballarat region has been defined on the basis of postcodes, these can be used to identify claims on a regional/ location basis - in particular the address of the Establishment.

The geographic region identified as suitable for the study was based on:

- sufficient claims volume
- good coverage by local media: TV channel, radio service, and local newspaper service. This would make it possible to evaluate/test the efficiency of media used during the study.

Based on these criteria, the region was defined by post codes, and is mapped on the following page. *(Refer appendix for the list of postcodes).*

2.2 Selection of Claims Period and Claims Group

The selected period for study is **1 December 1992 through 31 December 1994**. It was considered unwise to include data from before the major changes to the scheme, as the entry criteria for claims and claims assessment were significantly different pre and post November 1992.

Two different samples were constructed:

(i) for the Ballarat region **(N = 1,433),** - includes all claims **sustained** during the period resulting in either lost time or a maim payment

(ii) for the rest of Victoria **(N = 37,782**) - includes all claims **sustained** during the period resulting in either lost time or a maim payment.

The selection of this group of claims was predicated on the basis that the minimum threshold for "severe injury", which is the focus of this study, was to have at least one day of lost time (over the WorkCover minimum excess) or a maim payment (or maim payment application).

It is noted that prior to July 1993 the excess was 5 days and the first $378 of medical; from July 1994 the excess was 10 days and the first $398 of medical. Claims falling under these excess condition are typically covered by the employer and are of course not part of the WorkCover claims pool.

2.3 Severity Criterion

There are a number of variables describing the consequences of traumatic injury and occupational disease available in the workers' compensation system. The task of selecting those that are the most valid and reliable for successful applied prevention is wrought with a number of problems associated with the structure of the scheme, the actual demand and utilisation of the benefits provided, the administrative routines applied in the system, the injury information system in use, and the general attitudes to the problem of occupational injury and disease in society.

The aim here has been to select variables for a measurement of **severity** which can be seen to be as independent as possible of bias introduced by any of the aspects above. To create a completely objective measurement would be a formidable task; definitions of severity of injury/disease contain many different medical, psychological, sociological, philosophical, political and economical aspects.

In these analyses, the aim is pragmatic: we have tried to isolate a small number of indicators representing different aspects of injury/disease severity and turn these into a **preliminary index of severity**, in order to put forth the priorities of applied prevention of occupational trauma. This preliminary index of severity has been built on the three main indicators of severity: **lost time**, **medical severity, permanent impairment.**

Lost time, ie. the time the claimant has been away from work, is the most basic indicator of injury/disease consequence available in the compensation system. It can be argued, of course, that this figure is related to structural variables and circumstances outside the area of occupational hazards, ie. unemployment, age, family and gender issues, and other labour market aspects and biases. If used as a single indicator it can be highly inappropriate as a measure of occupational hazard. If used in conjunction with other indicators it contributes important information about the consequence of certain exposures.

In road safety research, for example, a number of standardised indicators are used for measurements and/or classification of injury severity. The most widely used is the Abbreviated Injury Scale (AIS) which was devised in 1969 through a meeting of physicians, researchers and engineers, with the aim of the development and acceptance of a uniform injury scale that would become an integral component of motor vehicle related crash investigations and statistical analyses (Petrucelli, States & Hames, 1981). From these meetings "an injury scale was drafted that was medically accurate and philosophically acceptable to the multi-disciplines involved". The AIS scale ranks injuries (on the basis of risk of dying) on a scale of 1-6, with AIS 6 rated as maximum injury severity and virtually unsurvivable. The AIS scale can be considered as a measure of the **medical** severity of injury, which was based, to a certain extent, on the subjective classification by the expert group.

Medical severity cannot be measured by the payments for medical and rehabilitation services. It is clear that while a number of variables related to medical treatment can be used as indicators of severity of trauma, only a few in the present WorkCover system could be regarded as valid and included among the priority criteria for applied prevention. We have sought to isolate the **number of days spent as in-patient** in hospital as one possible criteria for medical severity which we have included in our index.

There is an independent tradition in the area of insurance to seek to determine severity of consequence associated with externally caused injury through tables of maims and constructive damages related to degree of impairment. **Permanent impairment** would be a strong component in any measurement of occupational injury severity. The compensation system is the only place where such long-term losses are systematically recorded (AMA, 1984; Larsson, 1994).

2.4 Formulation of The Severity and Harm Parameters

(i) Severity Index

The three indicators representing lost time, days in hospital and permanent impairment have been translated into a common denominator ($) for each injury case in the samples.

The **days lost** were multiplied by a standard $120 for each claim. In this indicator we have included all lost time associated with injury/disease. Days compensated by employers under excess agreements have been added to the count for these respective cases.

Days spent as in-patient in private hospital is not given in the present claims data. This figure had to be estimated using a sample of 650 claims from seven participating hospitals, where more detailed data was available. 80% of the cost for in-patients in this sample represented lodging, at an average per diem rate of $400. Thus, for each claim, indicated in-patient days in public hospitals were multiplied by $400; half day episodes in private hospitals were recorded at $200; and for the remaining relevant cases 80% of the in-patient cost in private hospitals was recorded as indicative of **days in hospital**.

Since a substantial number of permanent impairments have yet to be settled for the period ending 31 December 1994, it was decided to include as many indicators of permanent impairment as possible. Thus three separate maim indicators have been recorded; **maim benefit applied for**, **maim payment** and **maim pending**. **Permanent impairment** was set at an estimated average of 8%, representing $7,500 of maximum benefit ($93,080).

For all analyses on group level (for occupations, afflictions, body parts and mechanisms), the indicators have been normalised, ie. group values on the indicator have been divided by the population average. This means that the average on each indicator for the population is 1, making the total average severity index 3.

In summary, the overall severity index is a sum of three components:

Maim Index = (7500 x maim indicator) / average

Days Index = (Days compensated x 120) / average

Hospital Index = [(public hospital days x 400) +
(private day surgery x 200) +
(private hospital costs x 0.8)] / average

Total Index **= (Maim Index + Days Index + Hospital Index**)

(ii) Harm

The total severity index is multiplied by the frequency of claims to give a measure of **harm.** Harm is a measure for quantifying total injury severity sustained from occupational injuries, involving both a frequency and a severity component. It enables the identification of areas that contribute significantly to the total pool of claims. Harm can also be used for both quantifying and disaggregating injury 'costs' by type of accident/ injury/ injury source etc as well as quantifying likely benefits of various proposed countermeasures.

Harm is a relatively recent concept, used extensively and effectively in the road safety area.

2.5 Analyses by Occupational Groups

Out of the 400 categories of the 1981 occupational code recorded in the WorkCover system, **64** logical occupational groups were constructed, where exposure was roughly similar, ie. workers and labourers in the same industry were put together; bricklayers, plasterers, concrete workers, etc were put together.

This occupational code was used as the main identifying variable in the analysis.

2.6 Validation of the Severity Index and Database

The detailed presentation of the statistical validation analyses of the severity index is given in Appendix 1, with the main conclusions presented below.

Correlation analysis showed each component of the index to independently describe different measures of severity with the total severity index to be most strongly related to the hospital index component ahead of the days and maim index components in that order. The total severity index showed good relationship to the relative severities of coded claimant afflictions.

Claim total cost showed strong relationship with all three index components with the days component being strongest followed by the hospital and maim component in that order.

Overall these analyses confirmed the 'validity' of the index to identify "high severity" injury groups, with a bias towards the 'hospitalisation' and days components.

Future analyses and construction of a "severity index", can readily be modified to focus on other attributes of the injury spectrum, as is considered necessary.

3.0 RESULTS

The main focus of analysis has been on claims over the 25 month period associated with compensation for **lost time** or **maim payment; 39,215** cases comprising 1433 cases for Ballarat and 37,782 for the rest of Victoria. The claims payments total $243,241,411 with Ballarat at $8,320,649 constitutes 3.4% of this total.

The drop in the overall number of claims for compensation since the late 1980's is considerable. However, a number of factors, such as legislative changes, increased self insurance, high unemployment rate and a drop in the reporting of injuries, have probably had an impact on these figures (Larsson, 1994b). Without venturing further into this territory we will, for the benefit of this report, assume that the observed number cases of lost time occupational injuries for the 25 months, truly represents the occupational injury problem in Victoria 1993/94 for those employees covered by WorkCover.

3.1 Exposure

The identification and selection of priority areas for injury prevention, ideally takes into account exposure and hence enables calculation of incidence and identification of high risk categories of activities/ occupations etc. Data on the two important elements in this regard were not able to be identified: the coverage of employees in Victoria for different occupation groups by the WorkCover compensation system; and secondly the number of employees covered in each occupational group.

Since the occupational code used by the WorkCover Authority is the ABS occupational code of 1981, which is no longer in use in the census, comparisons on a reasonably detailed occupational level, with contemporary census data, though attempted, was not feasible.

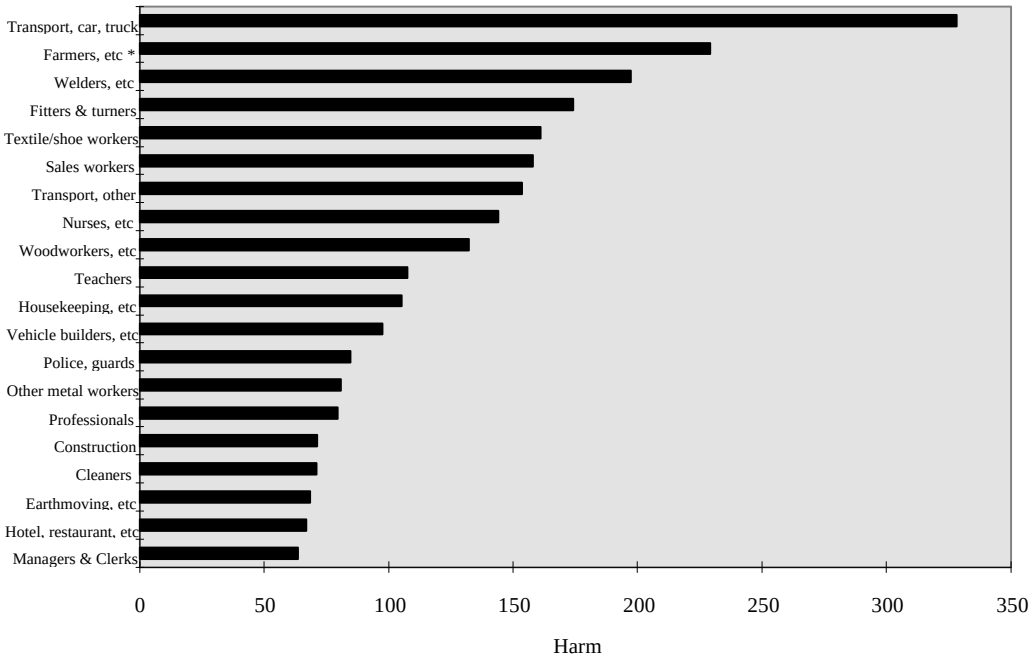
The VWA’s implementation of recommendations from the Stage 1 Report, of replacing the present 1981 occupational code with the 4-digit ASCO, will enable the exposure and risk analyses to be carried out.

3.2 Harm/Severity; Occupations

The occupational code was used to identify those groups of employees who suffered the highest average severity in terms of lost time, days in hospital and indicated permanent impairment associated with injury.

Among the lost time injuries sustained in the 25 month period under study for Ballarat, those contributing most to harm were identified, as presented in the following chart:

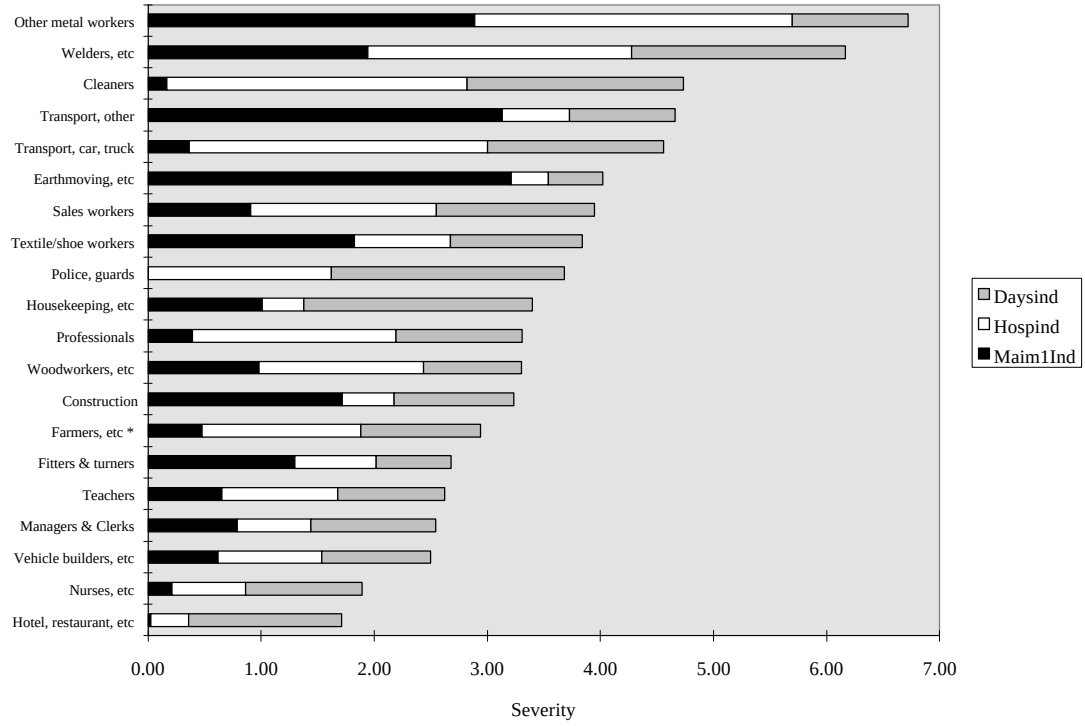
Ballarat; Harm; occupations; lost time/maim injuries 1.12.92 - 31.12.94



The top 20 occupations graphed above, account for 60% of harm in Ballarat.

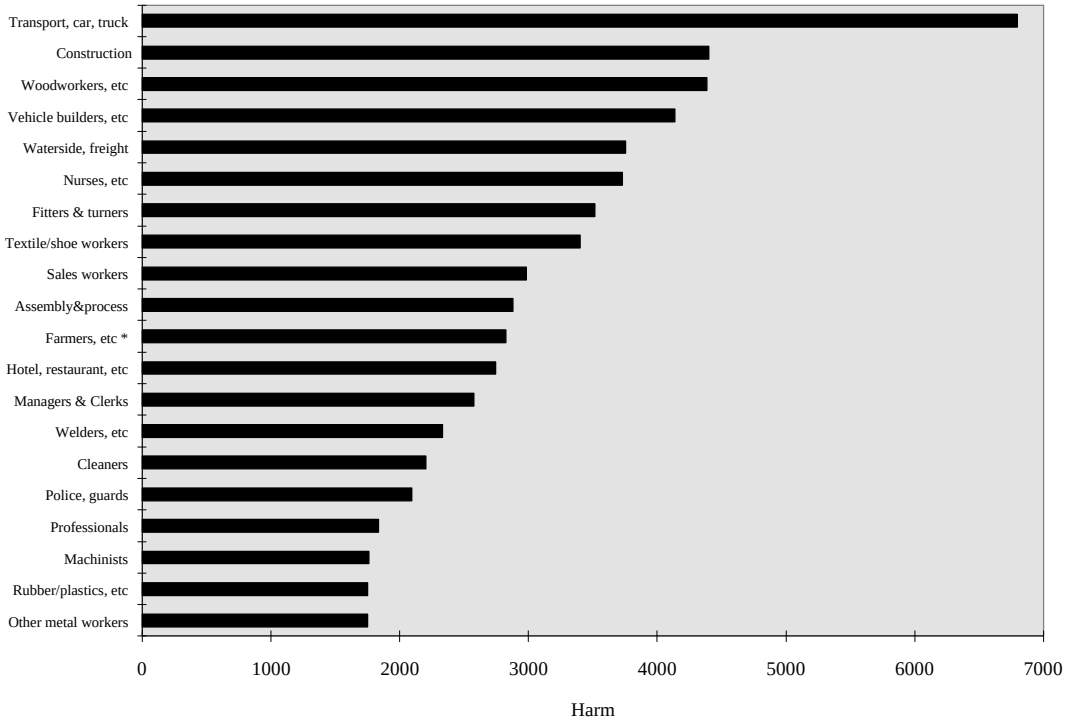
The severity index for each occupation within the top 20 was also taken into account.

Ballarat; Severity; occupations; lost time/maim injuries 1.12.92 - 31.12.94

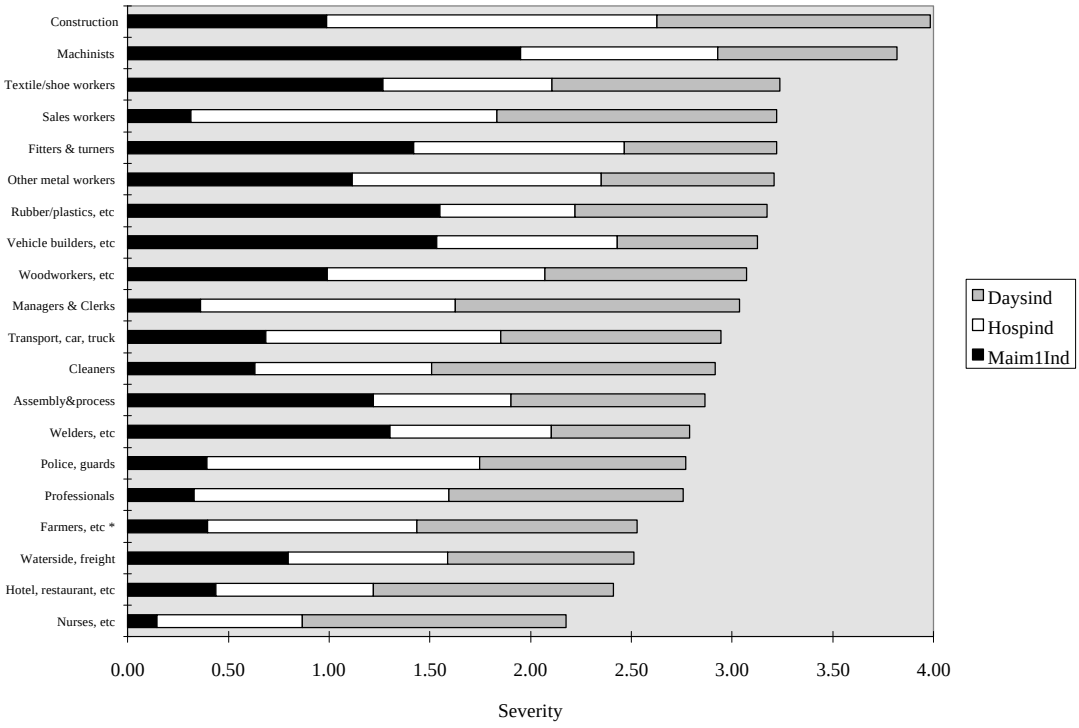


Parallel results for the rest of Victoria are graphed below.

Victoria; top 20 occupations by harm; lost time/maim injuries 1.12.92 - 31.12.94



Victoria, Severity Index for top 20 Harm Occupation groups



For the **Ballarat** region, given their contribution to Harm, and their severity index ratings, the following occupational groups were short-listed for further analysis.

Ballarat Occupational Group Short-list

Occupation	Claims	Severity	%Harm	%Payment
Transport, car, truck	72	4.56	8	9
Farmers, etc	78	2.94	5	7
Welders, etc	32	6.17	5	4
Fitters & turners	65	2.68	4	3
Textile/shoe workers	42	3.84	4	4
Sales workers	40	3.95	4	3
Transport, other	33	4.66	4	2
Nurses, etc	76	1.89	3	4
Woodworkers, etc	40	3.30	3	3
Teachers	41	2.62	2	3
Housekeeping, etc	31	3.40	2	3
Vehicle builders, etc	39	2.50	2	2
Police, guards	23	3.68	2	3
Other metal workers	12	6.72	2	1
Professionals	24	3.31	2	2
Construction	22	3.24	2	2
Cleaners	15	4.73	2	2
Earthmoving, etc	17	4.02	2	1
Hotel, restaurant, etc	39	1.71	2	2
Managers & Clerks	25	2.54	1	2
	766		**60**	**62**

Thus for Ballarat, the ten highest occupational categories contributing to harm were: transport (car truck); farmers; welders; fitters and turners; textile shoe workers; sales workers; transport-other, nurses; wood workers & teachers. These constituted 36% of claims and 42% of harm and costs.

For the '**rest of Victoria'**, given their contribution to Harm, and their severity index ratings, the following occupational groups were short-listed for further analysis.

Victoria - Occupational Group Short-list

Occupation	Claims	Severity	%Harm	%Payment
Transport, car, truck	2307	2.95	6	7
Construction	1105	3.98	4	4
Woodworkers, etc	1427	3.07	4	4
Vehicle builders, etc	1324	3.12	4	3
Waterside, freight	1493	2.51	3	3
Nurses, etc	1715	2.17	3	4
Fitters & turners	1092	3.22	3	3
Textile/shoe workers	1052	3.23	3	3
Sales workers	927	3.22	3	3
Assembly & process	1005	2.87	3	2
Farmers, etc	1117	2.53	2	3
Hotel, restaurant, etc	1140	2.41	2	2
Managers & Clerks	848	3.04	2	3
Welders, etc	836	2.79	2	2
Cleaners	756	2.92	2	2
Police, guards	756	2.77	2	2
Professionals	666	2.76	2	2
Machinists	461	3.82	2	1
Rubber/plastics, etc	552	3.17	2	1
Other metal workers	546	3.21	2	1
	21125		55	56

Thus for the rest of Victoria, the ten highest occupational categories contributing to harm were: transport (car truck); construction; woodworkers; vehicle builders; waterside, freight; nurses; fitters and turners; textile shoe workers; sales workers; assembly and process workers. These constituted 36% of claims and 42% of harm and costs.

Those groups in the top ten, common to Ballarat and Victoria are:

- transport (car truck);
- fitters and turners;
- textile shoe workers;
- sales workers;
- nurses;
- wood workers.

In this selection, priority was given to high scores on contribution to Harm, and individual severity indicators, rather than a total index score.

Additionally, for Victoria, a number of smaller groups such as forestry workers, riggers, miners, painters, and printers, exhibit above average severity ratings and would warrant further investigation and subsequent applied prevention activities.

This report, however, has limited further analysis to the occupational groups mentioned above.

3.3 Harm/Severity; Occupation by type of accident

To more closely identify particular contributors to Harm, the data was further disaggregated by *type of accident* (using the VWA coding) with the highest contributors to harm identified, and presented in the following two tables.

(i) Ballarat - Occupation by type of accident

Occupation	Type of accident	Claims	Payment	Harm
Transport, other	OTHER TYPES OF ACCIDENT	16	51885	67.03
Fitters & turners	OVEREXERTION OR PHYSICAL STRESS IN LIFTING OBJECT	18	116099	57.07
Nurses, etc	OVEREXERTION OR PHYSICAL STRESS IN LIFTING OBJECT	30	116611	51.05
Fitters & turners	OTHER TYPES OF ACCIDENT	15	72864	50.99
Transport, car, truck	OVEREXERTION OR PHYSICAL STRESS IN LIFTING OBJECT	16	86474	49.09
Textile/shoe workers	OTHER TYPES OF ACCIDENT	10	74355	47.02
Police, guards	OTHER TYPES OF ACCIDENT	11	183048	46.80
Farmers, etc *	STRUCK BY MOVING OBJECT	13	102013	45.22
Sales workers	OVEREXERTION OR PHYSICAL STRESS IN LIFTING OBJECT	11	86314	40.56
Farmers, etc *	OTHER TYPES OF ACCIDENT	10	209714	40.38
Vehicle builders, etc	OVEREXERTION OR PHYSICAL STRESS IN LIFTING OBJECT	12	68579	29.01
Woodworkers, etc	OTHER TYPES OF ACCIDENT	10	86580	28.75
Farmers, etc *	OVEREXERTION OR PHYSICAL STRESS IN LIFTING OBJECT	12	71702	23.19
Nurses, etc	OVEREXERTION OR PHYSICAL STRESS IN HANDLING OBJECT	12	61853	21.89
Hotel, restaurant, etc	FALL ON SAME LEVEL	11	30839	14.19
Butchers, etc	STRIKING AGAINST MOVING OBJECTS	12	21877	5.99
Dairy/food process	OVEREXERTION OR PHYSICAL STRESS IN LIFTING OBJECT	10	17390	4.46
Butchers, etc	STRUCK BY MOVING OBJECT	12	5912	1.50
		241	1464108	

(ii) Victoria - Occupation by type of accident

Occupation	Type of Injury	Claims	Payment	Harm
>200 CASES				
Nurses, etc	OVEREXERTION OR PHYSICAL STRESS IN LIFTING OBJECT	688	4,123,057	1620.18
Vehicle builders, etc	TYPE OF ACCIDENT NOT KNOWN	254	1,042,059	1263.11
Transport, car, truck	OVEREXERTION OR PHYSICAL STRESS IN LIFTING OBJECT	481	3,178,422	1240.58
Waterside, freight	OVEREXERTION OR PHYSICAL STRESS IN LIFTING OBJECT	481	3,142,657	1191.99
Sales workers	OVEREXERTION OR PHYSICAL STRESS IN LIFTING OBJECT	269	1,895,220	820.02
Fitters & turners	OTHER TYPES OF ACCIDENT	231	1,207,969	808.03
Transport, car, truck	OTHER TYPES OF ACCIDENT	211	1,481,934	804.84
Nurses, etc	OVEREXERTION OR PHYSICAL STRESS IN HANDLING OBJECT	343	2,048,284	716.25
Transport, car, truck	OVEREXERTION OR PHYSICAL STRESS IN HANDLING OBJECT	269	1,664,954	709.51
Transport, car, truck	FALL FROM HEIGHT OR INTO DEPTH	286	1,654,983	698.23
Woodworkers, etc	OVEREXERTION OR PHYSICAL STRESS IN LIFTING OBJECT	231	1,837,972	688.47
Transport, rail	OTHER TYPES OF ACCIDENT	211	823,586	687.49
Waterside, freight	OTHER TYPES OF ACCIDENT	200	905,513	638.54
Transport, car, truck	FALL ON SAME LEVEL	243	1,356,568	542.32
Hotel, restaurant, etc	OVEREXERTION OR PHYSICAL STRESS IN LIFTING OBJECT	205	1,141,908	459.62
Waterside, freight	OVEREXERTION OR PHYSICAL STRESS IN HANDLING OBJECT	204	1,063,753	373.22
		4807	28,568,840	

From these tables it can be seen that **nurses** and **transport** come up high in both Ballarat, and Victoria, for their contribution to harm based on the analysis by type of accident.

Following this analysis it was concluded that the most viable initial target groups for Ballarat were the transport workers and nurses. These groups provide both sufficient claims numbers for the regional study, and were also high on priority criteria for Victoria as a whole. Thus, the Ballarat projects for each of the target groups can be used as a vital and efficient pilot for the proposed future large scale intervention in Victoria as a whole.

3.4 Detailed Analysis of 'Transport' and 'Nurses' Occupational Groups

The transport and nurses occupational groups, identified as having higher than average injury severity index ratings, and significant contribution to harm, were analysed in more detail with regard to type of accident, affliction, and bodily location. For each of these occupational groups, a printout of each case (for Ballarat) was obtained with the following variables:

- Observation no; Industry; Claim description; Incident text;
- Accident text; Affliction text; Bodily location text;

- WIC code; Affliction & code; sex; bodily location code; agency of injury and the severity index by each component- days, maims, hospital, total.

This information was reviewed manually and for each case a 'mechanism' type variable was allocated. This variable was then added to the data base for the cases in each of the selected occupational groups, and additional analyses carried out to highlight high severity index values within each occupational group, in terms of mechanism; types of afflictions and bodily location. The objective of these analyses is to more closely identify particular priority areas within each of the selected occupational groups.

The mechanism categories were general, except that in certain cases peculiar to that particular occupation (eg sport, or hit by animal). The proforma used for this screening of mechanism is given in Appendix 4.

(i) GROUP 1. 'Transport (car, truck) and Transport (other)

The 'Transport (car, truck)' group comprises VWA Occupational Groups 510, 511, 512, 513 defined as Transport workers: car, taxi, hire car drivers; motor & van drivers, deliverymen; mail contractors, post and telecommunication; drivers, road transport. This group has a high severity rating for hospital days and days compensated.

The 'Transport (other)' group comprised group 531 defined as Transport workers - other workers.

Transport car truck - Ballarat

The severity index (SI)[1] for this group has above average ratings for the 'Hospital' and 'Days

Occupation	Claims	Maim1Ind	Hospind	Daysind	Totind1	%Harm	%Payment
Transport, car, truck	72	0.36	2.64	1.56	4.56	7.64	9.26

Transport other - Ballarat

Occupation	Claims	Maim1Ind	Hospind	Daysind	Totind1	%Harm	%Payment
Transport, other	33	3.13	0.60	0.93	4.66	3.57	2.27

For comparison purposes the results for the rest of Victoria are:

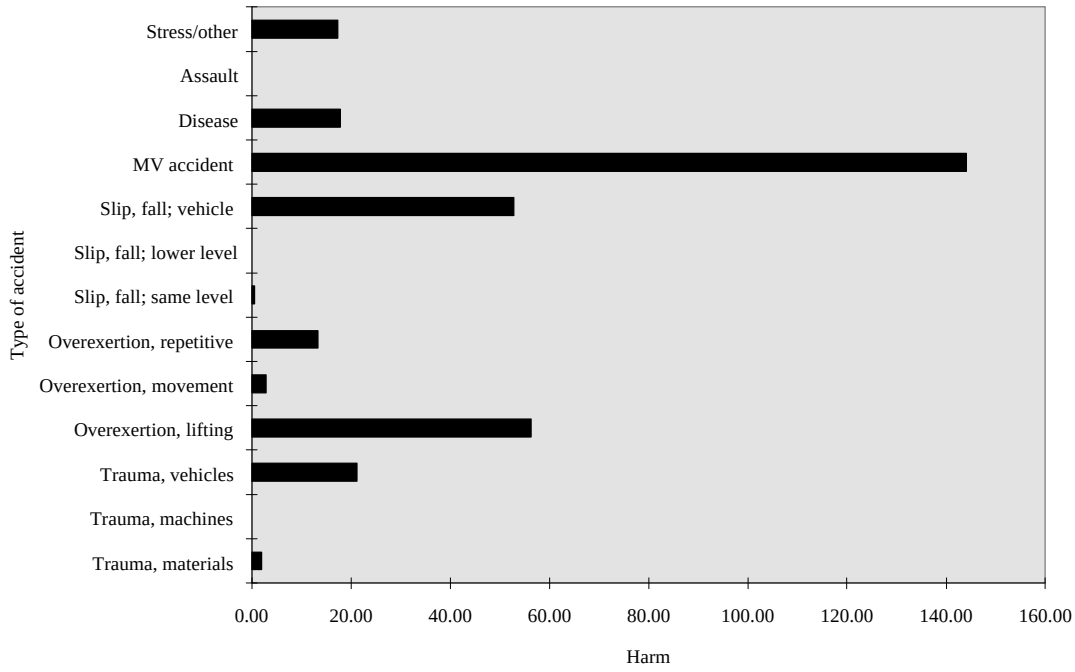
Occupation	Claims	Maims 1 Ind	Hospind	Daysind	Totind1	% Harm	% Payment
Transport, car, truck	2307	0.69	1.17	1.09	2.95	6.0	6.54

Occupation	Claims	Maims 1 Ind	Hospind	Daysind	Totind1	% Harm	% Payment
Transport, other	490	1.59	0.55	0.65	2.79	1.21	1.18

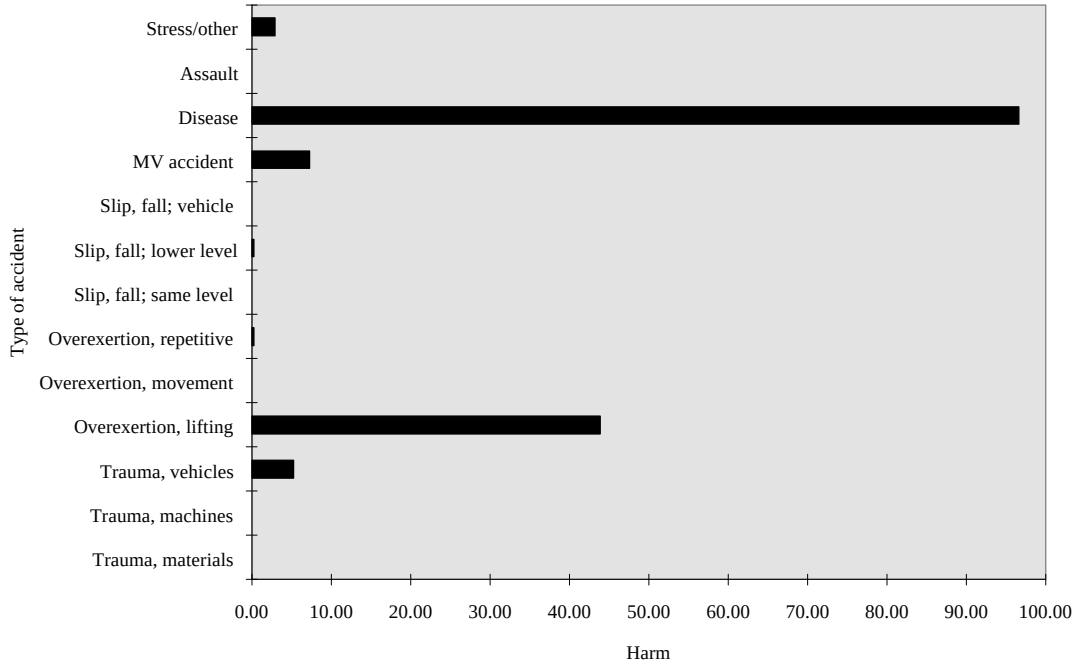
The distribution of Severity Index by type of accident for the Ballarat region is shown in the following two charts.

[1]The average severity index, normalised =1 for each of the three components of lost days, maims, hospital days. The total average index, therefore, =3.

(a) Transport car, truck

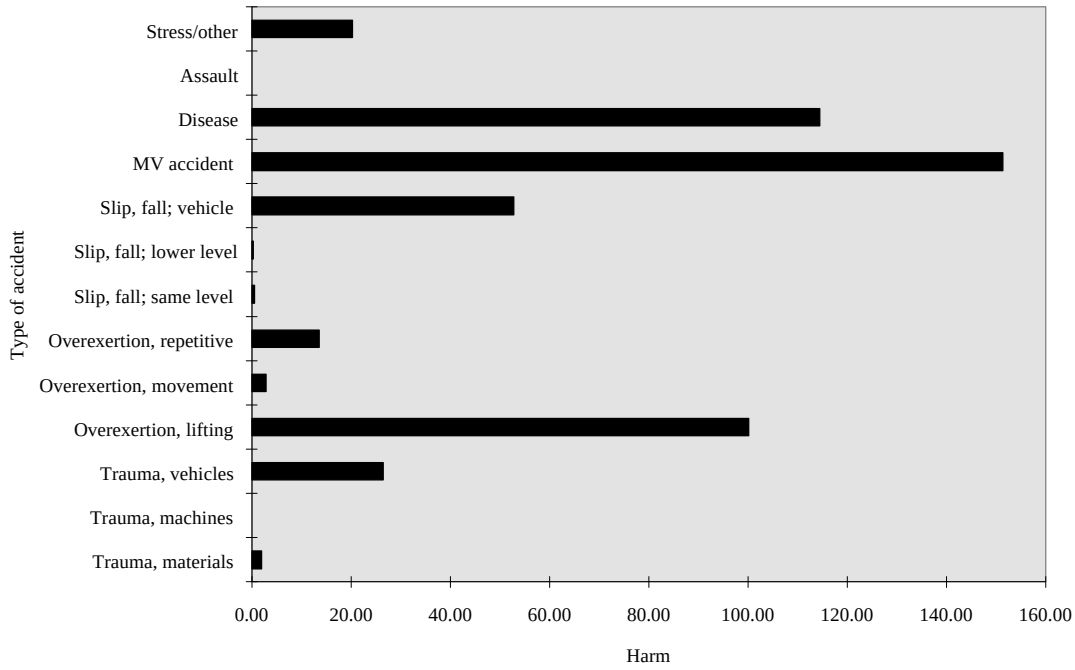


(b) Transport, other



Note: Hearing loss is the main contributor to the disease category

(c) Total for the two Transport groups (Ballarat):



From Chart C, the highest harm is associated with '**motor vehicle accident'** (n = 16); **overexertion - lifting & slip, fall from vehicle** (n = 50); and **disease** (n = 26). Under 'diseases' nearly all of the cases are for hearing loss. Other categorise associated with the loading etc of transport vehicles is **traumatic contact with vehicles**, such as being struck by forklifts.

Some examples of incidents for the largest category of overexertion - lifting & slip, fall from vehicle, traumatic contact with vehicles are:

- 'forklift truck ran over both legs - compound fracture of both legs'
- 'slipped and fell from truck, falling on head causing fractured skull'
- 'fell off top of truck spreading out tarp, shoulder, arm, head injury'
- 'slippery floor of truck, fell, breaking right ankle'
- 'back strain while lifting pipes'
- 'hernia - I was lifting a 20lt drum of diesel fuel out the back of truck'
- 'shoulder strain whilst unloading containers'
- 'loading empty pallets on truck, slipped, and sprained ankle'
- 'Rope hitch let go when securing tray- ruptured disc in back'

(ii) GROUP 2. 'Nurses

This group comprises Occupational Groups 23-27, 820, 822, defined as Nurses (from certified to non-certified); nursing aides (certified and trainee); attendants hospital and other medical. For Victoria and Ballarat, Nurses show an above average severity index for days compensated.

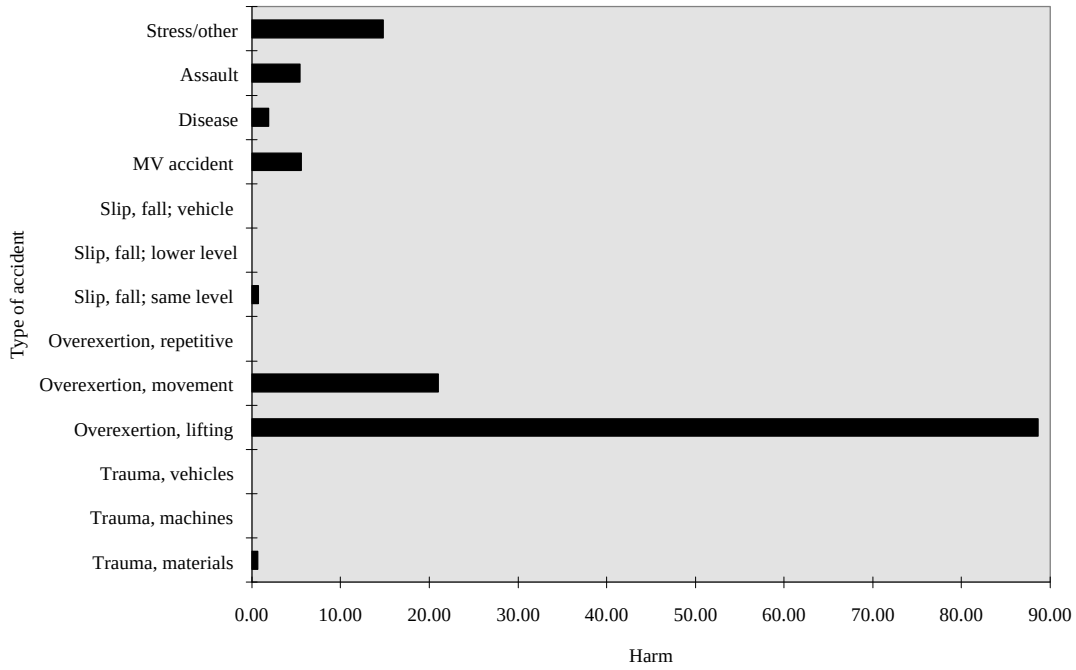
Ballarat

Occupation	Claims	Maims 1 Ind	Hospind	Daysind	Totind1	% Harm	% Payment
Nurses	76	0.21	0.65	1.03	1.89	3.35	3.97

Rest of Victoria

Occupation	Claims	Maims 1 Ind	Hospind	Daysind	Totind1	% Harm	% Payment
Nurses	1715	0.15	0.72	1.31	2.17	3.29	4.19

For Ballarat, the distribution of harm by accident mechanism is shown in the following chart:



For Nurses, clearly the most conspicuous factor is **overexertion, lifting, pulling, pulling , pushing and movement**. This constitutes some **72% of the claims**, and is typically associated with back injury.

Examination of the Accident description for the Ballarat Nurses cases provides the following examples:

- 'lifting patient strained back'
- 'transfer of resident from bathchair to wheel chair - strained back'
- 'lifting patient with student nurse, sprained lumbar spine'
- 'back injury - in the course of general nursing duties'
- 'disc protrusion- strain when lifting patient'
- 'back strain whilst changing patients bed and patient'
- 'neck, shoulder strain whilst lifting patient'
- 'physical strain from handling patient'

4.0 DISCUSSION AND RECOMMENDATIONS

4.1 Severity Index

In the present study, preliminary indicators of three aspects of severity were used. As a variable indicative of medical severity (risk of dying**), days admitted as in-patient to hospital** was used. As a measure of permanent medical impairment, all possible indication of **maims** in relation to the injury were recorded. And lastly, as a measure of temporary incapacity due to injury, the **duration of earnings related compensation payments** was recorded.

Obviously, these variables should be viewed as preliminary and approximations, but still, in our view, reflect the optimal way of expressing injury severity in the present system. It should also be noted, that there are no alternative ways of securing severity indicators in relation to occupational trauma in Australia.

Validation analyses confirmed that the variables, presented as a severity index, represented separate and different aspects of injury consequence, and that the variables seemed to identify those occupational groups with the most substantial injury problems.

An important addition to the severity index itself was the use of **"harm**" as a measure of the severity and 'volume' of injury. The use of severity in conjunction with the measure of claims numbers helps to identify those categories of occupation and activities contributing most to the pool of claims. This then enables setting of prevention priorities based on targeting the main injury contributors first. The concept of harm has been adopted from the road safety area.

The cost of claims is highly related to compensation paid for **lost time**, which is the normal way of describing injury consequences in the Workers' Compensation system. However the variables of the severity index have been combined in such a way that increased weight has been given to days in hospital and maims, underlining further that severity is different to cost.

Thus this preliminary severity index was considered to perform well in regard to its objective of helping to identify high injury severity groups. However further development and refinement of the index and use of the harm parameter is appropriate to identify specific priority areas in terms of selected injury type and cost.

4.2 Suggested Interventions/ Priority Areas

Parallel analyses were carried out for the Ballarat region and 'the rest of Victoria', using the severity index and harm for identifying priority occupational groups and injury mechanisms.

Priority areas identified for Ballarat were transport related occupations, nurses, welders, textile workers amongst others. For these first two groups 'over-exertion/lifting' was identified as one of the key injury mechanisms. Similarly for Victoria Construction workers, Transport workers, as well as Nurses were identified as groups which were amongst the largest in terms of harm contribution, but also had above average severity components.

Following further analysis it was concluded that **the most viable initial target groups for Ballarat were the transport workers and nurses.** These groups provide both sufficient claims numbers for the regional study, and were also high on priority criteria for Victoria as a whole.

On the basis of the available data of lost time injuries on record with the VWA, and the extensive data analysis carried out, the most reasonable areas for the initial regional intervention seem to be:

- **Transport (car, truck, other) manual lifting, loading**
- **Nurses manual lifting, loading**

This leads to suggested applied injury prevention focus in the areas of:

1. **Transport and distribution** (vehicle-associated) lifting, loading, unloading, lugging cargo between vehicle and terminal/customer, and

2. **Nursing personnel** (hospital-based, and other key associated groups) lifting, moving, transporting people/ goods in all situations during medical care and treatment & support.

The balance reached by selecting the hands-on, equipment and logistics-oriented problems associated with these two categories is reasonable and should be quite practical to target the exposed occupational groups regionally.

Importantly, as noted these two groups also represent major claims groups (in terms of severity index, harm, as well as claims total cost for **Victoria** overall. Thus following the comprehensive development and experience gained through the proposed Ballarat based programs, expansion to Victoria as a whole can be initiated.

Claims data Summary for Nursing and Transport

The number of claims for Ballarat and Victoria and the contribution from the two selected target groups is set out in the following table for the 25 months period 1.12.1992 to 31.12.1994. Only lost time claims (ie. exceeding the WorkCover minimum excess), or claims with "maims" were included in this data set.

Occupation category	Ballarat			Victoria		
	N= claims	Payment	Harm	N=claims	Payment	Harm
All claims	1433	$8,320,000	4299	37,782	$234,920,000	113,346
1. Transport car- truck' & transport other	72 33 105	$770,000 $189,000 $959,000	328 154 482	2307 490 2797	$ 15,364,000 $ 2,783,000 $18,147,000	6796 1369 8165
2. Nurses	76	$330,600	144	1715	$ 9,840,000	3730
Total 1+2	181 (12.6%)	$1,289,600 (15.5%)	626 (14.6%)	4512 (11.9%)	$27,987,000 (11.9%)	11,895 (10.5%)

Estimate of potential claims and cost reduction for the target groups

For **transport in Ballarat**, approximately 60 claims would fall with the ambit of the focus group (ie. appr. $355,000). Assuming a claims reduction rate of **30%** following the study intervention - this suggests a cost reduction in claims of approximately **$110,000**. These estimates and savings, if translated to **Victoria**, would represent savings of approximately **$2.1M** over the 25 month period.

For **Nurses,** the case by case analysis of the 76 claims from Ballarat, shows that most claims are manual handling related, over 70%. This leaves approximately 54 claims within this project ambit ($266,000). Assuming a claims reduction rate of **30%,** this would result in cost reductions of around **$80,000** over a 25 month period. These estimates and savings, if translated to **Victoria**, would represent savings of approximately **$2.4M** for a 25 month period.

Thus the estimated total savings following **intervention in Ballarat for Transport and Nurses is approximately $190,000**. The equivalent savings if translated to **Victoria** would be approximately **$4.5M** over a two year period.

The actual reductions are, of course, only able to be determined following the actual project findings and interventions, and may be more or less than these estimates.

4.3 Additional Interventions/ Priority Areas for Victoria

From the detailed analyses conducted under the Stage 1 project, and as also identified in this study, the large groups of '**Construction Workers'** is considered as a suitable priority group for Victoria. In addition, from the Stage 1 project, analyses across occupational groups indicate that traumatic contact with forklift trucks remains a priority area.

Thus the following three project areas, as summarised below are suggested as additions to the Ballarat project for **Transport** and **Nurses**:

1. Falls to lower level among Construction Workers indicate a need to assess the possibilities of changing practices and upgrading equipment for work on height (equipment for working on roof, ladders, trestles, scaffolding). This would be specifically needed in the area of single-family, residential construction, where perceptions of risks and present equipment and practices should be addressed on an industry basis.

2. Traumatic contacts with vehicles among Construction Workers point to the complicated area of pedestrian-vehicle interaction at construction sites (road, bridge, etc. but also residential and non-residential construction). Pedestrians directing vehicle movements, the successive storing of building

materials during the construction period, together with problems of access/egress of vehicles and pedestrians on the site during different phases of the construction period are areas of concern.

3. Traumatic contact with forklift trucks is still one of the biggest problems of occupational trauma in Victoria. This problem is high-lighted among the Fitters & Turners, as it would be among a number of other occupational groups. Specifically, the use of forklift trucks in the manufacturing industries should be focused, and questions such as in-house traffic systems, pedestrian/vehicle separation, forklift-free work-stations should be investigated.

Targeting Occupational "Blackspots"

The Stage 1 project highlighted that a strategic prevention program needs to include a focus on the "blackspot" areas associated with particular occupational groups. These are characteristic and most likely **millers and bakers**" have a high severity rating for **traumatic contact with materials (substances/burns) and machine power tools**, but related to the particular equipment used in that industry**.** Similarly '**printers'** injuries are conspicuous by their association with **traumatic contact with machines** (printing presses etc). Each occupation has associated with it, particular equipment, processes and practices and injury type and circumstances.

These observations suggest that a powerful and effective injury prevention program utilises the concept of "black spot analyses" as used in the road safety area, but applied systematically to each occupational groups (and particular industry site). Of course countermeasures developed in one area may well be able to be applied in other areas, directly or appropriately modified, but as found in road safety each site must be investigated and treated individually.

This type of "blackspot" analysis could similarly **focus on specific agencies of injury** identified in terms of high frequency and severity occurring across occupational groups. In this category, some examples would include, ladders; sawing machines, and **forklifts** as previously noted.

Manual handling

As part of, and in parallel to, the systematic treatment of each occupation a specific focus can also be placed on manual handling related injuries pertinent to each occupational area. As manual handling (in its many forms) constitute some 50% of claims overall, the WorkCover Authority's program can address not only the high injury severity areas, but also high claims frequency and cost areas.

As manual handling issues and problems can be similar across various occupational groupings, a focus would also be placed on **specific agencies or manual handling activities** identified in terms of high frequency and severity.

Under the Victorian Occupational Health and Safety (Manual Handling) Regulations (1988), there is a requirement for employers to assess and control risks arising from manual handling activities in the workplace, with the objective of reducing the number and severity of injuries resulting from these activities. The *Manual Handling Regulations and Code of Practice* (1988), and *Part 2* of this Code of Practice - *Occupational Overuse Syndrome* (1992) provide detailed guidance for *Risk identification*, *Risk assessment* and *Risk Control* in regard to manual handling tasks.

However from experience gained in other studies (Finch, Rechnitzer et al), it appears that implementation and compliance is poor and that few companies appear to have ongoing programs for manual handling risk assessment and control. The corollary to this observation is that there is significant scope for effective implementation of preventive activities relating to manual handling.

4.4 Summary of Proposed Activities

It is recommended that:

(1) A three-year plan for the prevention of severe occupational trauma in Victoria is developed, which would include:

- *The Ballarat region project, addressing*
  - Transport and distribution (vehicle-associated) lifting, loading, unloading

- Nursing personnel (hospital-based, and other key associated groups) lifting, moving, transporting people/ goods in all situations

- *Victoria Wide projects (following on from the Ballarat project)*

  - **Transport and distribution** - overexertion lifting, loading, falls from vehicle
  - **Nursing personnel** - overexertion, back injuries
  - **Construction Workers** - Falls to lower level among
  - **Construction Workers** - Traumatic contacts with vehicles
  - **Traumatic contact with forklift trucks** - pedestrian workers
  - **Identify and target occupational "**
  - **Effective implementation of across-industry programs for Manual handling**

(2) Coding system. Implementation of the information system upgrading for the claims data, as recommended in the Stage 1 Project.

(3) On-going Resear**ch and analyses of the claims material** be undertaken by suitable institutions like Monash University Accident Research Centre, University of Ballarat, IPSO Australia and others, according to the priorities set forth by the WorkCover Authority.

5.0 REFERENCES

American Medical Association, *Guide to the Evaluation of permanent impairment,* AMA, Chicago, 1984.

EUROSTAT: Commission of the European Communities. *Methodology for the Harmonisation of European Occupational Accident Statistics.* Luxembourg, 1992.

Finch C., Rechnitzer G., Brumen I., Hodgson R. & Caple D.; *Risk management plans for women: reducing workplace manual handling injuries.* OH&S In Manufacturing Conference, 26-27 June 1995 Sebel Town House, Sydney

Heidenström, PN: *Accident recording: The need for a new approach.* ACC Statistics, Wellington, 1982.

Hovden, J & Larsson, TJ: Risk: Culture and Concepts. In Singleton, WT & Hovden, J (Ed:s): *Risk and Decisions.* John Wiley & Sons, 1987.

Jørgensen, K: Occupational injury data as a basis for the grading of industrial injury insurance premiums - Denmark and the European Community. In Larsson, TJ & Clayton, A (Eds): *Insurance and Prevention; some thoughts on social engineering in relation to externally caused injury and disease.* IPSO Factum 46. Folksam Insurance and the Swedish Work Environment Fund, 1994.

Larsson, TJ: *Severe occupational injuries and disabilities among Swedish woodworkers: Accident epidemiology and no-fault liability insurance.* J Occup Health Safety - Aust NZ 1988, 4(4): 325-334.

Larsson, TJ: *Accident information and priorities for injury prevention.* Thesis. IPSO Factum 21. Depart. of Work Science, Royal Institute of Technology, Stockholm 1990.

Larsson, TJ: *A review of the injury prevention potential of the ACC.* Commissioned report to the New Zealand Accident Compensation Corporation. IPSO New Zealand, 1991.

Occupational Health and Safety Commission. Code of Practice Manual Handling (Occupational Overuse Syndrome). In effect from 1st January 1992.

Occupational Health and Safety Commission. Manual Handling Regulations and Code of Practice. In effect from 1st February 1989.

Victorian WorkCover Authority: Unpublished statistics 1985-1993, 1994.

Larsson, TJ & Rechnitzer, G: *Forklift trucks - analysis of severe and fatal occupational injuries, critical incidents and priorities for prevention.* Safety Science 17 (1994): 275-289.

Larsson, TJ: To register and monitor. In Larsson, TJ & Clayton, A (Ed:s): *Insurance and Prevention; some thoughts on social engineering in relation to externally caused injury and disease.* IPSO Factum 46. Folksam Insurance and the Swedish Work Environment Fund, 1994.

Larsson, TJ: *Local work environment activities in the Melbourne City Parks and Gardens 1992-93.* IPSO Factum 45, Melbourne, 1994b.

Mitchell, T & Larsson, TJ: *Commissioned Study of Occupational Health and Safety in the Australian Coal Industry.* VIOSH, University of Ballarat, 1994.

Petrucelli E., States J.D., Hames L.N., The Abbreviated Injury Scale: Evolution, Usage and Future Adaptability.

Rechnitzer, G & Larsson T.J (1992) 'Forklift trucks and severe injuries: Priorities for Prevention', Monash University Accident Research Centre, Melbourne, Report No. 30.

Tziotis M., Evaluation of Mid-Block Accident Black Spot Treatments, Monash University Accident Research Centre, Melbourne Report 48, 1993.

Vulcan, A.P, The road toll in Victoria-an objective analysis, Road Safety Forum, Aug. 1993, Melbourne.

APPENDIX 1

VALIDATION OF SEVERITY INDEX AND DATABASE

1. Introduction

This paper describes the methods and results of the validation of the proposed occupational injury severity measure and the Victorian WorkCover Authority database used to develop this measure. The investigation covers both validity of the database contents in relation to calculation of the severity index along with tests of the power of severity index in consistently reflecting true injury severity.

The overall severity index is a sum of three components:

MAIM INDEX = (7500 x maim indicator) / average

DAYS INDEX = (Days compensated x 120) / average

HOSPITAL INDEX = [(public hospital days x 400) +
(private day surgery x 200) +
(private hospital costs x 0.8)] / average

The variables from the database used to calculate these three components are:

MAIM_IN	Indicator for a maim claim either payed or pending
DAYSCOMP	Number of days compensation payed
EPDYS_N2	Number of public hospital days
PT_67_CT	Private day surgery presentations
PT_65_AM	Private hospital costs

Calculation of the index is based on the value of these variables for the **39,215** cases in the database which have days compensated greater than zero or a maim payment/claim, and injury date in the range 1/12/1992 to 31/12/1994.

2. Correlation Analyses

Correlation analyses of a set of variables indicates the strength of linear relationship between each variable in the set with correlation of 0 indicating no linear relationship and correlation of ±1 indicating perfect linear relationship. Correlation analysis of the three index components and the total severity index was carried out with the results presented in Table 2.

TABLE 2 - CORRELATION OF INDEX COMPONENTS AND TOTAL INDEX

	MAIM_IX	***HOSP_IX***	***DAYS_IX***	***TOT_IX1***
MAIM_IX	1	-0.01555	-0.06377	0.39945
HOSP_IX	-0.01555	1	0.29578	0.86839
DAYS_IX	-0.06377	0.29578	1	0.49409
TOT_IX1	0.39945	0.86839	0.49409	1

N of cases: 39,215

The low correlations between each of the three index components indicates a high level of independence between the components of injury severity reflected by each index component. The correlation of each index component with the total index indicates the relative influence each component has on the total index. Table 2 shows the hospital component has the most influence on the total index followed by the days and maim index in that order.

3. Index Relation to Other Severity Measures

As a test of the power of the severity index in accurately reflecting relative injury severity it is desirable to compare the index against some direct or surrogate measure of severity which can be found in the database. As no direct measure of severity exists in the database, a surrogate measure must be used.

The first surrogate measure considered was the affliction code. The average value of each index component as well as the total index for each affliction type in the database was calculated and is presented in Table 3. Only affliction types which appear more than 25 times in the database have been included in Table 3 to minimise the possibility of spurious results due to chance variation in the index for affliction types with small numbers of observations. The index value can be compared with a nominal relative severity assigned to each affliction type to asses the index performance. For example, traumatic amputation should exhibit a higher average severity index than say, superficial injury.

TABLE 3 - AVERAGE INDEX BY AFFLICTION CODE

Affliction	Cases	Maim	Hospital	Days	Total
TRAUMATIC AMPUTATION, ENUCLEATION AVULSION	451	3.74	2.90	1.15	7.79
ISCHAEMIC HEART DISEASE	41	0.08	5.30	2.39	7.77
MULTIPLE INJURIES	276	0.56	5.33	1.85	7.74
DISLOCATION OF VERTEBRAE	52	0.59	3.12	1.80	5.51
DISPLACEMENT OF INTERVERTEBRAL DISC	53	0.25	2.49	2.33	5.08
EFFECTS OF WEATHER, EXPOSURE AND RELATED CONDITION	25	0.91	3.23	0.63	4.77
DISLOCATION - UNSPECIFIED	53	0.96	2.53	1.21	4.70
BURNS AND SCALDS - UNSPECIFIED	31	0.36	3.14	1.11	4.61
EFFECTS OF ELECTRIC CURRENT	27	0.54	2.48	1.31	4.34
ALL FRACTURES	3427	0.38	2.53	1.26	4.18
DEAFNESS - NOISE INDUCED	6370	4.08	0.00	0.00	4.09
OTHER DISLOCATION	154	0.50	1.95	1.49	3.94
OTHER & UNSPECIFIED DISORDERS OF BACK	35	0.34	1.80	1.63	3.77
DISEASES OF EYE AND MASTOID PROCESS	33	3.62	0.08	0.04	3.74
OTHER INFECTIVE AND PARASITIC DISEASES N.E.C.	79	3.38	0.13	0.16	3.68
OTHER BURNS AND SCALDS	56	0.26	2.57	0.73	3.55
BURNS AND SCALDS - CONTACT WITH OBJECTS/SUBSTANCES	432	0.26	2.59	0.50	3.35
OTHER DISEASES OF NERVOUS SYSTEM N.E.C.	52	0.69	1.02	1.64	3.34
HERNIAS ICD (550-554)	1395	0.01	2.01	0.78	2.80
MENTAL DISORDERS (PSYCHOSES-NEUROSES-RETARDATION)	845	0.22	0.71	1.77	2.70
OPEN WOUND - UNSPECIFIED	48	0.42	1.34	0.72	2.47
ALL SPRAINS & STRAINS OF JOINT & ADJACENT MUSCLES	18163	0.30	0.80	1.34	2.44
CONTUSIONS AND CRUSHINGS NEC	1919	0.49	1.11	0.83	2.42
SYNOVITIS, TENOSYNOVITIS & BURSITIS	681	0.34	0.50	1.54	2.38
CONCUSSION	123	0.06	1.04	1.20	2.30
OTHER LACERATION, OPEN WOUND, CUT OR BITE	3131	0.62	0.99	0.63	2.25
OTHER INJURIES	94	0.55	0.64	0.97	2.16
ABRASION, FRICTION BURN AND/OR BLISTER	93	0.56	1.06	0.49	2.12
OTHER SUPERFICIAL WOUND	49	0.16	1.44	0.45	2.05
OTHER INFECTIONS OF SKIN & SUBCUTANEOUS TISSUE	31	0.00	0.89	0.86	1.76
SUPERFICIAL INJURY - UNSPECIFIED	35	0.19	0.77	0.44	1.40
SUPERFICIAL FOREIGN BODY (SPLINTER) OPEN WOUND	445	0.40	0.70	0.23	1.33
OCCUPATIONAL DERMATITIS	111	0.06	0.00	1.15	1.21

Table 3 shows a clear increase in the seriousness of affliction with increase in average severity index value. The more superficial injuries such splinter wounds and strains and sprains have low average severity indexes whilst the serious and permanently debilitating afflictions such as ischaemic heart disease or traumatic amputations have high associated severity index values as would be expected.

The final surrogate severity measure considered was the total claim cost. As total claim cost is a continuous variable, the methods used in the two cases above can not be employed here. Instead a linear regression approach has been used with a multiple regression of total cost against each index component being carried out. A stepwise approach was used as it allowed each index component to be included or excluded from the regression equation based on its predictive power. A component being excluded from the regression equation would indicate no relationship between that component and total cost.

4. Index relation to total claims cost

The final regression equation reached by the stepwise procedure contained all three index components indicating each has explanatory power against total cost. The final regression output is given in Figure 1. The standardised regression coefficient (Beta) indicates the relative explanatory power each index component with a larger coefficient representing greater explanatory power. The regression output shows the days index to have the most bearing on total cost followed by the hospital and maim indexes respectively. This is the reverse order of influence than found in the correlation analysis of the individual index components with total index. This indicates that the total index gives a much higher weighting to maim claims and time spent in hospital in reflecting injury severity than does total cost.

FIGURE 1 - FINAL STEPWISE REGRESSION OUTPUT

**** M U L T I P L E R E G R E S S I O N ****

Equation Number 1 Dependent Variable.. PAYMTALL ALL COSTS

---------- Variables in the Equation ----------

Variable	B	SE B	Beta	T	Sig T
DAYS_IX	4159.70981	15.980640	.678381	260.31	.0000
HOSP_IX	889.736597	5.812540	.1411	153.14	.0000
MAIM_IX	617.274327	10.218807	.0219	60.40	.0000
(Constant)	536.043796	32.079064		16.71	.0000

5. Summary

Validation of the severity index for occupational injury claims calculated from the Victorian WorkCover Authority was carried out in this paper. The database variables used to calculate the severity index all appeared to be complete and had means, standard deviations and ranges within expected bounds. Correlation analysis showed each component of the index to independently describe different measures of severity with the total severity index to be most strongly related to the hospital index component ahead of the days and maim index components in that order. The total severity index showed good relationship to the relative severities of coded claimant afflictions. Claim total cost showed strong relationship with all three index components with the days component being strongest followed by the hospital and maim component in that order. This suggested the index gave much more weight to the hospital and maims components in reflecting total claim severity than did total cost.

APPENDIX 2

SUMMARY OF GROUPINGS FOR "ACCIDENT TYPE/MECHANISM" USED FOR MANUAL COMPILATION FROM THE CASE MATERIAL, FREE TEXT FIELDS 'CLAIMS DESCRIPTION', 'ACCIDENT TEXT',

Occupation Group:			WIC Codes:
(N=)			
Accident type /mechanism	**Tot**	No.	**Case ID**
Traumatic contact with-materials			
-hand tools			
-substances/burns/chemicals			
-dropped items onto limbs			
-hit by animal			
Traumatic contact with machines, power tools			
-electric equipment			
Traumatic contact with vehicles, cranes etc			
Overexertion- lifting pulling pushing & tools			
Overexertion- movement, sport			
Overexertion-repetitive, other			
Slip, trip, fall- same level			
-on to tools, object			
Slip, trip, fall -lower level			
-off ladders/stairs			
-off horse			
Slip, trip, fall- associated with vehicles, machinery			
Motor vehicle accident			
Motor vehicle-rough ride			
Other -stress			
-disease etc			
-assault			
Unknown			
TOTAL N			

APPENDIX 3

LIST OF DATAFILE VARIABLES

The following variables were selected for the formation of the analysis file of claims for the period 1.12.92 to 31.12.94.

Variable Name	Description
CLAIMID	Claim identification number
ORGNID	Organisation responsible for the claim
ESTABID	Establishment claim is recorded against
CLSTATUS	Status of claim
AFFDATE	Affliction date
AGTDATE	Date claim was lodged
BIRTHDT	Claimant birth date
SEXCODE	Sex of claimant
OCCODE	Claimant occupation
WICCODE	Workcover industry code
SEVERITY	Injury severity
INCPDYCT	Number of weekdays incapacitated
EXCESS	Claim excess
DAYSCOMP	Number of days compensation
TYPE	Type of accident
AFFLIC	Affliction code
BODY1	First body region coded
AGENCY	Object/action causing injury
MAIMPAY	Maim payment amount
COMPALL	Compensation payment
HOSPALL	Hospital fee payment
LEGALPAY	Legal fee payment
MEDICALL	Medical expense payment
NCOMPALL	Non compensation payment
PAYMTALL	Total payment
BAF_CT	Number of benefits applied for
BAFS1_CD	Benefit applied for 1 code
BAFS1_PC	Benefit applied for 1 percent
BAFS2_CD	Benefit applied for 2 code
BAFS2_PC	Benefit applied for 2 percent
HEP_CT	Number of hospital episodes
DRG_CT	*not specified*
DRG_RT	*not specified*
FDIAG_CD	First diagnosis
FPROC_CD	First procedure
EPDYS_NB	Number of days in hospital (public)
ORGNNM	Organisation name
CLAIMDS	Claim description
ACCNT_TX	Description of accident
INCDT_TX	Description of incident location
AFLIC_TX	Description of affliction
BODY_TX	Description of body location
PT_65_CT	Number of payments type 65
PT_66_CT	Number of payments type 66
PT_66_AM	Amount of payments type 66
PT_67_CT	Number of payments type 67
PT_67_AM	Amount of payments type 67
PT_300_CT	Number of payments type 300
PT_300_AM	Amount of payments type 300
HOSP_AM	Hospital units calculated for index
AGE_NM	Claimant age in years
DAYS_AM	Days units calculated for index
OCGP_CD	New occupational groups
MAIM_AM	Maim units calculated for index
MAIM_IN	Maim indicator
MAIM_IX	Maim index
DAYS_IX	Days index
HOSP_IX	Hospital index
IX_IN	Indicator of case valid for study
OBS_IN	Case number in database

Variable names given above are the text names – each has an associated database label.

APPENDIX 4

DEFINITION OF THE BALLARAT REGION

Post codes defining the 'region' for the study:

3330	3460
3333	3461
3334	3465
3341	3467
3342	3468
3345	
3350	
3351	
3352	
3355	
3356	
3357	
3360	
+3361	
3363	
3364	
3370	
3371	
3373	
3375	
3377	