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The Cost of Injury to the Australian Army

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March 2009

A thesis submitted for the degree of Doctor of Philosophy
of the Australian National University.

The findings contained in this thesis are my own original work.

A handwritten signature in black ink, reading "S.J. Rudzki". The signature is written in a cursive style with a large, stylized 'S' and 'R'.

Stephan J. Rudzki

31 March 2009

Acknowledgements

I wish to acknowledge the assistance of Dr Victoria Ross in the collection of the operative data on spinal surgery. Victoria spent many hours trawling through medical records to collect data and her efforts are sincerely appreciated.

PREFACE

This thesis has been the result of a long standing interest in injury prevention. As a doctor in the Army, I have been long concerned about the high levels of injury in our soldiers. Much of this was due to errors in the physical training process, with an excessive focus on running and subsequent overuse injuries. Published research highlighting the impact of running distance on injury lead to changes in the training program, and I was instrumental in reducing the run test from 5 kilometres to 2.4 kilometres.

Efforts to introduce effective injury prevention programs have been stymied by the lack of cost data to bolster the case for “investing” in an effective injury prevention system. All government investment decisions are governed by business cases and potential cost savings. The absence of any accurate cost data has hampered effective argument for change. It is the accountants who rule the policy priority world, not clinicians.

Recent developments have been encouraging. In 2002, the Defence Personnel Executive provided funds to establish the Defence Injury Prevention Program. I was intimately involved in its implementation, following the excellent work of Doctor Rodney Pope who developed the program and argued the case successfully on economic grounds. Identifying all the cost components of injury and their quantum is essential to maintain the momentum for change and further investment.

Inappropriate or ineffective treatments are a misuse of scarce funds and can adversely impact on an individual’s ability to continue serving in the Army or even keep a job. Costs matter because they are important to policy makers and accountants who govern public policy. This thesis aims to identify the true cost of injury to the Army and use this data to influence government policy and investment priorities.

ABSTRACT

This thesis is the first study to have determined a comprehensive estimate of the cost of injury to the Australian Army. The approach used was that of a cost of illness study, which summarised the economic burden of injury and provides information for stakeholders, allowing them to make informed decisions on the allocation of scarce healthcare resources. Cost of illness (COI) studies serve a different purpose to that of health economic evaluations which are focused on evaluating the cost of an intervention rather than estimating the cost of a particular disease. A “top down” approach to analysis was adopted utilising high level organisational databases to obtain cost data. This thesis adopted the primary perspective of government, but also considered costs from a societal and individual perspective.

Estimating the economic burden of injury in a defined population is dependant on the availability of data of sufficient quality and scope, which is often lacking. This was the case in this thesis where available datasets contained data of poor quality or insufficient detail to provide accurate injury cost data. A number of assumptions were required in order to develop estimates of the contribution of injury to different sources of cost. There is a clear requirement for Defence to improve its injury surveillance and introduce an electronic health record to facilitate this. Efforts must also be made to link clinical data with cost data to better inform decision makers about the relative benefits achieved from the considerable cost resulting from injury.

The cost of injury has three components; direct costs; indirect costs; and intangible costs. Direct costs considered in this analysis included external medical and compensation costs, as well as compensation liabilities calculated by the Australian Government Actuary. Indirect costs included productivity losses, with invalid pensions also included because they constitute a significant cost to Government not usually included in (COI) studies. An additional analysis of the net present value of lost wages was conducted on those soldiers who were invalided from the Army. A novel approach, termed the Capital Investment Model, was used to estimate the loss of training investment as a result of premature separation from the Army due to injury. Intangible costs were not included in this study because of the difficulty in placing a monetary value on these aspects of injury.

Direct injury costs in 1996 were estimated to be between \$40.75 and \$42.36M with outstanding compensation liabilities of \$270M. Indirect costs were estimated to be \$10.74M with invalid pension liabilities of \$63.82M. Capital losses due to premature separation from the Army due to injury were estimated to be \$10.10M. The total cost of injury to the Australian Army (in 1996 dollars) was estimated to be between \$61.59M and \$63.20M, with estimated pension and compensation liabilities of \$333.82M. Injury causes a significant financial impost.

This is also the first study to compare the cost and outcomes of a range of spinal surgical procedures reflective of general orthopaedic community practice. It adopted a “bottom up” approach to analysis, where detailed data was obtained from individual records and a patient survey. This allowed for outcome and cost analysis by subgroup. A number of findings were consistent with the literature, in particular the dissociation between pain score and functional capacity. Increasing complexity of surgical intervention increased costs with no improvement in clinical outcome and alarming

levels of radiological exposure was found. Radiation exposure could not be compared to other studies as they did not report the distribution of radiological investigations. The decision to undergo surgery appears to be based on the baseline level of pain and the fear of it worsening rather than specific clinical indications. The use of effective non-operative methods of reducing pain offers the prospect of significantly reducing the patient demand for surgery and its attendant cost.

The greatest injury-related cost savings from a societal perspective are obtained from interventions that promote early return to work and minimize lost productivity. Preventing an injury prevents the associated cost, so efforts in the area of injury prevention are critical in reducing the burden of injury. The significant reduction in injury observed from the Defence Injury Prevention Program highlights the benefit of effective primary prevention programs. Equally, once an injury occurs, secondary prevention efforts seek to achieve maximum restoration of function with minimal morbidity and cost. The results of the spinal surgery study have shown that improvement in primary outcome measures are not effected by the cost of the chosen intervention and efforts to achieve pain relief through non-operative means, in order to prevent surgical intervention, should be a high priority for research, not just in Army but in the broader community.

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Chapter 1. The Importance of Injury

“the enormous cost of work-related injury and disease is something with which Australian industry, and the community in general, has not fully come to terms. It is not long ago that the attitude which prevailed was that injury and disease was part and parcel of work, largely a matter of luck, about which little could be done.... Australian workplaces of best practice have shown what can be done and the great gains which can be made through prevention. ... The lack of fervour, evident in some quarters to seize this opportunity appears to stem from the fact that many decision-makers in industry simply remain unaware of the bottom line impact that successful strategies might have, both in economic and human terms.”

Edward A. Emmett, Chief Executive Worksafe Australia (Worksafe Australia 1994).

1.1 Introduction

This chapter seeks to demonstrate the importance of injury not only from a morbidity and mortality perspective, but also from a public health one. As Emmett has stated, many view injury as “a matter of luck”, and this attitude risks becoming a self fulfilling prophesy. Injury has assumed increasing importance as evidenced by it’s inclusion as one of Australia’s top ten health priorities.

1.2 Definition of Injury

Injury has been defined as “unintentional or intentional damage to the body resulting from acute exposure to thermal, mechanical, electrical or chemical energy or from the absence of such essentials as heat or oxygen” (National Committee for Injury Prevention and Control 1989).

The Australian National Injury Surveillance Unit (NISU) uses the following definition of injury: "Disruption of the structure or function of the human organism, resulting from exposure to excessive or deficient energy" (Harrison 1994).

Others argue that the definition of injury is more complex than simply the transfer of energy (Langley 2004). Langley argues that there is no scientific distinction between disease and injury, and that injuries should be defined simultaneously by the causative event and the resulting pathology. For example, bruising can be due to energy exchange or an underlying medical disorder such as sepsis.

In contrast, "disease" tends to be used for pathologies such as cancer which manifest themselves over longer periods following initial exposure to the causative event. Injury is commonly understood in the context of a pathological consequence arising from a specific precipitating event.

In such a context, psychological injury, such as post-traumatic stress disorder, can be included as there is always a specific precipitating traumatic event, despite the lack of any energy transfer. In New Zealand, in 2000/2001, the Accident Compensation Corporation compensated 267 people for psychological injury at a total cost \$NZ2 659 000 (Langley 2004).

Tissue damage due to chronic low energy exposures (e.g. carpal tunnel syndrome or overuse syndromes of the lower limbs) are often excluded by more traditional definitions but as Robertson has pointed out; some have modified the energy definition to include such cases (Robertson 1998).

Langley argues that most injuries are considered to be those pathologies included in the "Injury and Poisoning" chapter of the International Classification of Diseases (ICD 9th revision) and those events coded as Supplementary External Causes (E codes).

Langley considers this range of codes to be anomalous as they are inconsistent with the ICD approach to other injuries. For example, ICD does not have a grouping of codes for "effects of motor vehicle crashes", instead the actual pathology must be coded. Musculoskeletal conditions related to the knee and back fall outside the Injury and Poisoning code range, but many would classify these as injuries. The ICD injury and poisoning codes also do not include psychological injury.

The inclusion or exclusion of "medical" injuries can have a dramatic effect on estimates of injury incidence. In New Zealand, in 1998, there were 67 428 public hospital discharges which had injury (ICD codes 800–999) as the primary diagnosis,

and 17% of these were in the ICD code range 996-999; complications of surgical and medical care, not elsewhere classified (Langley 2002).

One study in New Zealand has shown that 26% of all persons discharged from a public hospital, and whose record was assigned an E code, did not have a diagnostic code within the injury and poisoning range (Pickett 1999).

Langley argues that because of the definitional variations discussed above, estimates of the incidence of injury can vary substantially. Injury is now considered to include pathologies that fall outside of the ICD 9 chapter on injury and poisoning and this has important implications for determining priorities, as the true extent and cost of injuries can be hidden within other categories.

1.3 Morbidity associated with Injury

Wheatley (Wheatley 1989) has described the concept of the injury "iceberg" for conceptualising injury morbidity. Fatalities represent the tip and minor injuries the large submerged mass. Injury researchers alternately describe this as the injury "pyramid", where death and serious injury comprise the tip of the pyramid and the large number of minor injuries constitutes the base. A lot is known about fatalities, less about hospital admissions, and even less about the remainder.

In 1994, it was estimated that the Australian injury burden consisted of 7,489 deaths, 300,000 hospital admissions, 5.7 million doctor consultations and over 10 million recent minor injuries (Department of Human Services and Health 1994).

In Australia in 1991, injury was the 5th leading cause of death, second in years of potential life lost before age 65, second in inpatient episodes, third in hospital bed days, fourth in doctor visits and the fourth leading cause of recent illness. Injury also accounted for 6.5% of deaths and 10% of hospital admissions in Australia during 1991 (Department of Human Services and Health 1994).

Figure 1.1 shows the injury pyramid estimated from morbidity and mortality data obtained for the period 2004/05. The ratio of deaths to hospitalisations to injury events was 1 death to 50 hospitalisations to 454 injury events (Australian Institute of Health and Welfare 2006). Injury prevention and control was declared a National

Health Priority Area in 1997, and is the subject of a national prevention plan (NPHP 2005).

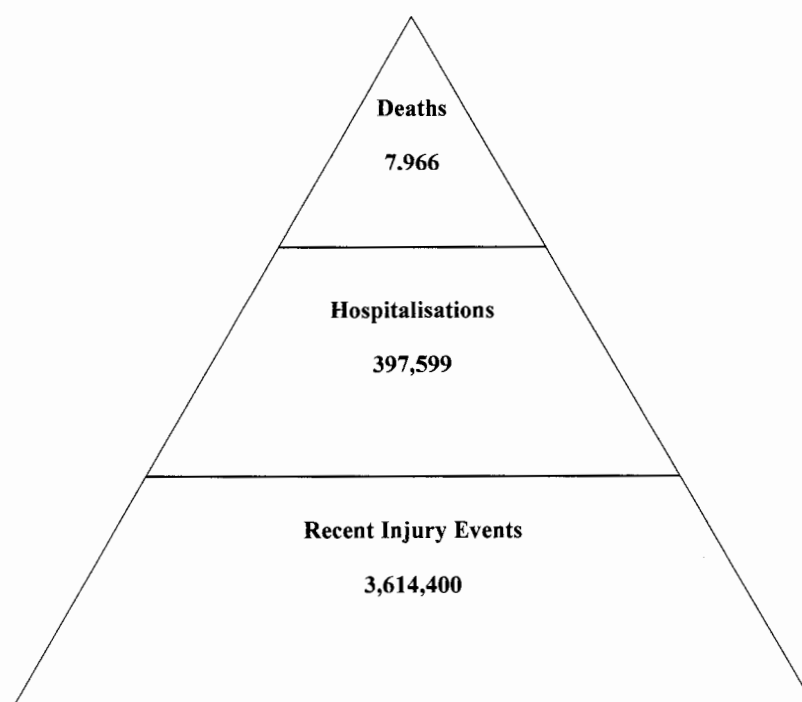


Figure 1.1. The Australian injury pyramid (Adapted from Australian Institute of Health and Welfare 2006).

A set of measures, called disability-adjusted life years (DALYs), has been developed to summarise the burden of disease and injury at a population level. DALYs combine information on the impact of premature death with non-fatal health outcomes. Premature death is measured by the years of life lost (YLL) due to disease or injury and non-fatal health outcomes are measured by years of ‘healthy’ life lost (YLD) due to disease, disability or injury. To combine these two health measures into a summary health measure, the DALY uses time as a common denominator. It is a measure of the years of healthy life lost due to illness or injury—one DALY is one lost year of ‘healthy’ life (Begg 2007).

A recent review by the Australian Institute of Health and Welfare found injuries were the second highest contributor to the burden of disease and injury among young Australians aged 15–24 years. Injury accounted for 36,052 DALYs, or 18% of the total burden, after mental disorders, which accounted for 49%. The burden of injury among young Australians was higher than for all ages, at a rate of 13 DALYs per 1,000 population compared with 9 DALYs per 1,000 population for all ages (Australian Institute of Health and Welfare 2008).

Young males had the highest rate of injury burden of all age groups, with a rate of 20 DALYs per 1,000 population, while the rate for young females (6 DALYs per 1,000 population) was the third highest due to the impact of falls among older women aged 65 and over.

Injuries were the leading cause of premature mortality in Australia —accounting for 27,683 years of life lost (YLL) or two-thirds of the total years of life lost due to disease or injury. In terms of healthy years of life lost (YLD), injuries ranked fourth highest after mental disorders, neurological and sense disorders and genitourinary diseases, with 8,369 YLD or 5.4% of all YLD. Road traffic accidents, suicide and self-inflicted injuries accounted for almost two-thirds of the total injury burden for young people aged 15–24. The total injury burden for young males was more than three times that for young females in 2003 (28,191 compared with 7,861 DALYs) (Australian Institute of Health and Welfare 2008).

In Australia in 2003, twenty specific disease contributors accounted for about 60% of the total burden of disease as measured by DALYs. Back pain (1.1%) and osteoarthritis (1.3%) were the 19th and 16th most common causes of prolonged disability (Australian Institute of Health and Welfare 2006).

Incidence data are useful in providing information on the rate at which people in the community sustain injuries. Incidence data also provides a more complete picture of injury occurrence than hospitalisation or death records, as incidence captures the less severe injuries that do not require hospitalisation or result in death.

The ABS 2004–05 National Health Survey (NHS) asked about the most recent injury sustained by young people in the 4 weeks preceding the survey for which an

action was taken, such as receiving medical treatment or reducing usual activities (Australian Bureau of Statistics 2006a). An estimated 793,400 young people (23% of the population at risk) sustained one or more injuries during this period—accounting for around one-fifth of injuries for all ages. Proportions for young males and females were similar (24% and 22%, respectively). An estimated 6% of 18–24 year olds sustained their most recent injury while under the influence of alcohol or other substances, compared with 2% of the population aged 25 years and over.

The leading causes of the most recent injury for both males and females were being cut with a knife, tool or other implement (29%), followed by a low fall of one metre or less (19%) and hitting or being hit by something (17%). The most common injuries sustained were open wounds (43%), bruising (23%), and dislocations, sprains, strains or torn muscles/ligaments (15%).

It is difficult to determine the severity of these injuries from the NHS data, but treatment outcomes can be used as an indicator of severity. An estimated 6% attended hospital (including admission and emergency department visits), 19% consulted a doctor or other health professional, 10% had days off work or study and 24% cut down on their usual activities due to their most recent injury (Australian Bureau of Statistics 2006a).

There were 86,032 hospitalisations due to injury—a rate of 2,326/100,000. Almost three-quarters of these hospitalisations were for young males (61,072 hospitalisations). The injury hospitalisation rate has increased by 7% since 1996–97, with the male rate consistently more than twice the female rate over this period (3,171 compared with 1,391 per 100,000 young people in 2005–06) (Australian Institute of Health and Welfare 2008).

In 2005, there were 1,401 deaths of young people aged 16–25. Injury was the underlying cause of two-thirds of these deaths, followed by neoplasm and diseases of the nervous system. Injury accounted for 71% of all deaths among those aged 18–24 years, 66% of all deaths for 15–17 year olds and 38% of all deaths among 12–14 year olds in 2005 (Australian Institute of Health and Welfare 2008).

Young people comprised 12% of all injury deaths in 2005—14% among males and 8% among females. The injury death rate in the 12-24 year age group was 26 /100,000 , with the majority of deaths occurring in the 18–24 year age group (80%), followed by those aged 15–17 years (17%) and 12–14 years (4%). Injury death rates in Australia have halved during the past 50 years, from 116/100,000 males in 1955 to 55/100,000 in 2004, and from 51 to 23 deaths per 100,000 females (Australian Institute of Health and Welfare 2006).

From the foregoing review it can be seen that injury is the leading cause of hospitalisation and mortality amongst young adults, in particular young males. This is the demographic from which the Army draws its recruits. Some success in reducing the impact of these injuries has been achieved with the halving of the population death rates from injury , but more targeted efforts in young adults is required.

1.4 International Injury Experience

Injuries are an important cause of death in most countries and are usually the leading cause of premature mortality in most developed countries (Rockett 1989b). Table 1.1 shows various international comparisons of injury mortality rates.

The US National Centre for Health Statistics estimated that in the age group 1-24 years, for every injury death there were 17.4 injury hospitalisations, 356 emergency department (ED) visits and 700 self reported visits (Fingerhut 1994). In Israel, 6% of all short stay hospitalisations were due to injuries with an admission rate of 8.7/1000 (Zadka 1994).

One third of respondents in a US study reported an injury that limited their daily activities, but did not seek formal medical attention. Interestingly, some types of injury with high rates of medical attention did not result in high rates of medical restriction. Skull fractures and lacerations usually received medical attention, yet less than 50% of medically attended skull fractures and 30% of lacerations resulted in any restriction of activity. On the other hand, 60% of strains/sprains resulted in restriction of activity (Overpeck 1994).

Country		Rate
Australia	(combined)	57 /100,000
United States	Male	106 /100,000
	Female	38 /100,000
New Zealand		62 /100,000
United Kingdom	Male	52 /100,000
	Female	37 /100,000
Germany	Male	88 /100,000
	Female	52 /100,000
Sweden		44 /100,000
Norway		46 /100,000

Table 1.1 International comparison of mortality from injury, by Sex derived from WHO mortality tabulations. (Rockett 1989a, Rockett 1989b)

Corso estimated the incidence and lifetime cost of injuries in the United States for injuries that occurred in 2000. In that year, Americans suffered more than 50 million medically treated injuries, with 150, 000 (0.3%) of these being fatal. This equated to injury rates of 200/1000 males and 170/1000 females. The total lifetime cost of these injuries was estimated to be \$406 billion; \$80 billion for medical treatment and \$326 billion for lost productivity (Corso 2006).

Corso compared the findings of his study with a similar one in 1985 to determine any trends in injury incidence. While the overall incidence of injuries declined 15% from 1985 to 2000, the total medical costs of injuries (in real dollars) declined roughly 20%. This decrease in cost, although driven mainly by the decrease in injury incidence, was also considered to be the result of advances in trauma care, a shift toward managed care, and successful injury prevention efforts that minimized the harm resulting from injuries (e.g. safety belts, helmets).

Mulder noted that public health interventions in the Netherlands during the 20th century had added 30 years to average life expectancy (Mulder 2002). In the absence of

disease epidemics, injuries had become more prominent and accounted for 16% of deaths worldwide in the 1990s (World Health Organisation 1999).

Mulder used an incidence approach to estimate the lifetime costs of all injuries that occurred in 1997 (Mulder 2002a, Meerdink 2000). The incidence of injuries treated in emergency departments in 1997, was determined from the Dutch Injury Surveillance System (Dekker 2000). In 1997, 1.1 million injury patients were treated at emergency departments and 104,000 patients were admitted to hospital for injury in the Netherlands. The total direct medical costs of injury was estimated to be 2.2 billion guilders (USD\$110M), with an average of 2000 Guilders (USD\$100) for each injury patient who visited the emergency department.

Home and leisure injuries accounted for over half of all recorded injury presentations, followed by sports (17%), and traffic accidents (13%). Home and leisure also account for the most costs (59%), followed by traffic accidents (19%) and sports (10%).

Injuries to the lower extremities accounted for nearly 50% of total injury costs (1 billion guilders: USD\$50M) but only 15% of injury incidence. Superficial injuries and wounds were the most common (42%), but accounted for only 15% of costs. Home and leisure injuries accounted for lower extremity injury costs (69%), particularly for hip (85%) and pelvic fractures (66%). For sports, the upper extremities dominated injury costs (15%), especially luxations and distortions of the wrist, hand and fingers (28%), and hand and finger fractures (23%).

Mulder argues that this approach combines public health data from various sources under one common denominator: money. Adding cost data to standard epidemiological data provides a greater sense of priority to bureaucrats than more abstract concepts such as DALYs. Epidemiological and cost data should be combined and used to prioritize injuries for prevention. Comparing epidemiological criteria such as magnitude and severity with intervention criteria such as availability of suitable, efficient, and effective interventions, leads to a more transparent discussion on prioritisation (Gillespie 2003).

The total health care costs generated by injuries indicates the relative importance of injuries to the health sector as a whole and may be useful in convincing politicians to put injuries on their agenda.

1.5 Sex Differences in Injury Incidence

Harrison noted that "Injury is predominately a male condition, whether measured in terms of case numbers, population incidence rates, mortality or morbidity" (Department of Human Services and Health 1994).

Age standardized mortality for males in 1990 was 2.7 times greater than in females. Hospital admissions were 1.5 times more frequent and ED visits were 1.8 times greater. Other non-injury causes of mortality do not show a male excess. Hospital, all-age separation rates for injury in 1989-90 were 23/1000 for males and 15.3/1000 for females. The all persons rate was 19.1/1000 (Department of Human Services and Health 1994).

In 1993, eighty two percent of national Australian Emergency Department presentations for injury were male. The main mechanism reported was a graze/laceration in 33% and a direct blow in another 33%. Strains accounted for 11%, injuries to the fingers accounted for 24%, eye injuries 15% and the lower back 4%. This pattern was very different to the claims pattern reported by Worksafe Australia (National Injury Surveillance Unit 1994).

Differences between male and female injury rates are attributable, in part, to differences in exposure to hazards flowing from the continuing gender-segregation of many occupations. For example, in the mining industry, the rate of reported injury in males during 1991-92 was 41.7/million hours worked and 10.5/million hours in females, giving a relative risk of 4 in the males. But this is really a reflection of the greater number of males engaged in the mining industry, and their increased exposure to workplace hazards.

In 2005–06, injury was the leading cause of hospitalisation for young males aged 12–24 years, accounting for 30% of all hospitalisations. For females, injury was

the fourth leading cause of hospitalisation among 12–24 year olds, with other causes, such as pregnancy, mental and behavioural disorders accounting for a higher number of hospitalisations (Berry 2007).

Australian male workers were responsible for 68% of all compensation claims lodged in 2004-05. This represented 70% of injury claims and 64% of disease claims (Australian Safety and Compensation Council 2007). Male employees were twice as likely as female employees to make a claim (22 /1000 compared with 11/1000). Males were 2.1 times more likely to have an injury claim and were 1.6 times more likely to have a disease claim.

Males were responsible for over 75% of injury deaths among young adults in Australia in 2005. The injury death rate for young males was 3 times the rate for young females (Australian Institute of Health and Welfare 2008). The data confirms Harrison's original observation; injury is primarily a male phenomenon, especially amongst young adults.

1.6 Sports Injuries

Approximately 1 million sports injuries are reported each year in Australia, and it was estimated that in 1992 these injuries resulted in direct and indirect costs totalling \$1 billion (Egger 1992)(Egger 1991). In 1993, 2,500 Victorians were admitted for sports related injury, and required 5,725 hospital bed days. (Victorian Inpatient Minimum Data set 1992)

Sports injuries represented 12% of all hospital admissions for unintentional injury in Victoria for the age range 10-29 years. (Langlois 1992). Sports related injuries in children in the 10-14 year age group were the single highest cause of attendance at Emergency Departments (ED) contributing data to the Victorian Injury Surveillance System (Victorian Injury Surveillance System 1991).

In 2005/06, sporting and leisure injuries accounted for 49% of hospitalised injuries for young people in Australia (55% for young males and 31% for females). Half of these hospitalisations occurred as a result of playing team ball sports (9,820

hospitalisations). The proportion was much higher among young males compared with young females (54% and 36%, respectively), and was highest among males aged 12–14 years (37%) and 15–17 years (38%). The most common team ball sports leading to injury hospitalisations for 12–24 year olds were Australian Rules football (25%), soccer (18%) and unspecified football (17%) (Australian Institute of Health and Welfare 2008).

1.7 Occupational Injury

"There is universal agreement that work-related injuries constitute a considerable cost to individuals, firms and society as a whole. There is also similar agreement that the extent of these costs is much greater than the size of worker compensation payouts. This is because of the dislocation to family and business life, particularly production, which occurs when employees are injured and the corresponding increase in the demand for state and privately funded medical and rehabilitation services." (Mangan 1993).

The annual cost of work-related injury and disease in Australia has been estimated by the Industry Commission to be A\$20 Billion dollars (Industry Commission 1995). In the United States, it was estimated that there were at least 10 million traumatic work injuries per year with an annual cost of more than US\$83 billion (Satcher 1994).

Occupational injury remains a significant cause of death and morbidity as well as a major social and economic cost. In Australia during the 1990's, there were approximately 500 deaths a year and 200,000 work-related injuries that required time off work longer than 5 days. The cost of these injuries was estimated to be at least A\$9 billion annually (Routley 1993).

Most data on occupational injury is derived from Worker's compensation data (Worksafe Australia 1994). But this data only includes cases that resulted in death, permanent disability or temporary disability of at least 5 working days. A large number of cases are excluded by this definition.

During the period 1991-2, 38.8% of accepted workers compensation claims in the Northern Territory (NT) involved no loss of time from work, and another 24.9% involved less than 5 days of lost time (Work Health Authority 1993). Thus 64% of workplace injuries in the NT fell outside the scope of workers compensation data reports.

Conversely, a New South Wales survey showed that only 47% of those injured on the job applied for workers compensation (Australian Bureau of Statistics 1993). Of those who did not apply, only half said that they had a minor injury or that they did not need to apply. This suggests significant under reporting of workplace injury in that State.

Many occupational injuries are also misclassified as "diseases", and this is due to the traditional definition of injury as the "result of a single traumatic event where the harm or hurt is immediately apparent". Under this definition, hearing loss, activity related soft-tissue disorders and vertebral disc dysfunction are classed as diseases, when in the majority of cases these conditions are the sequelae of injury or repetitive microtrauma.

Musculoskeletal conditions accounted for 44% of all compensated "disease" in South Australia during 1989-90 (Worksafe Australia 1993). Sprains and strains (46.9%) were the most common type of injury reported nationwide, with women having a greater percentage of sprains than men (56.7% vs. 43.8%). The back comprised 25.1% of all injuries, followed by hand/fingers 14.3%, ear 8.1%, knee 6.5%, shoulder 5% and ankle 4.3%. Females had a higher proportion of back injuries than men; 29% vs. 23.8%. (Worksafe Australia 1993).

From an international perspective the burden of occupational disease and injury was estimated by the World Health Organisation to be 10.5 DALYs or 3.5 years of healthy life lost per 1,000 workers every year at a global level (World Health Organisation 2002). But as Eijkemans (Eijkemans 2005) noted, the most important limitation in estimating the burden of occupational disease is "the lack of reliable data".

Eijekemans went on to comment that “under-reporting in existing systems in all countries leads to substantial under-counting of occupational injuries and diseases and shows an inadequate picture of the true magnitude of the problem... Even the best financed systems produce imperfect data, leaving decision-makers with a large underestimate of the problem”.

Biddle (Biddle 1998) estimated that in the US between 9 and 45% of eligible workers file for workers compensation benefits. Leigh (Leigh 2004) estimated that in the US between \$8-23 billion in medical costs was not captured by the workers compensation system. He noted that this shifted “responsibilities and costs from the workers compensation system to individual workers, their families, private medical insurance and taxpayers”.

Concha-Barrientos (Concha-Barrientos 2004) estimated that occupational risk factors were responsible for 8.8% of the global burden of mortality and 8.1% of DALYs due to injury. Punnett (Punnett 2005) estimated that 37% of world wide low back pain (LBP) was attributable to occupation and was responsible for 818,000 DALYs. He argued that occupational exposures to ergonomic stressors were an important source of preventable back pain.

Among the 15–24 age group, work-related injuries are a significant cause of morbidity. This may be due to the types of jobs they undertake, inexperience with the tasks required, or risk-taking (Moller 1995). For young people aged 15–17 years, 7% of hospitalised injuries occurred while working for an income, and this figure increased to 19% among 18–24 year olds, with the proportion among males being much higher than for females (Flood 2007).

The NSW Injury Risk Management Research Centre (IRMRC) estimated the cost of workplace injury in NSW in 2000-2001 to be \$16.9 billion, with an average cost of \$118,540 per incident (Forbes 2005). In 2004-05, there were 140 655 new workers compensation claims raised in Australia, including 214 fatalities. The national claims rate was 17 /1000 employees: comprising 12 injury claims /1000 and 4.4 disease claims /1000 employees (Australian Safety and Compensation Council 2007).

The industries with claims rates above the national average were; transport and storage (32/1000), manufacturing (32/1000), construction (30/1000), Agriculture, forestry and fishing (28/1000) and Mining (27 /1000). The Mining industry had the greatest improvement, reducing its incidence rate by 47% (from 51 / 1000 in 1996–97 to 27/1000 in 2003–04).

Injury-related claims accounted for 74% of all claims, with sprains and strains predominating (44%), followed by open wounds (8%) and fractures (8%). Disease-related claims accounted for 26% of all new claims, with the most common diseases being disorders of muscle, tendons and other soft tissues (6%), mental disorders (6%), disorders of the spine (5%) deafness (3%) and hernia (3%).

Manual-handling accounted for 43% of all new claims, with falls on the same level accounting for 13%. The back was the most common location of injury or disease, representing 24% of all claims, followed by hands (12%), shoulder (8%) and knee (8%).

The Australian Safety and Compensation Council now groups musculoskeletal disease with injuries rather than disease. Table 1.2 shows that this combined grouping was responsible for over 85% of all new claims between 1996-97 and 2003-04. Sprains, strains and musculoskeletal diseases were by far the single most common cause of claim accounting for between 53 and 58% of all new claims during this same period.

	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04
Injury,Poisoning,MS D	143,270	133,740	132,775	133,165	129,385	125,270	123,835	122,865
Total	164,910	153,240	149,630	149,935	147,800	144,005	142,970	144,025
%	86.9%	87.3%	88.7%	88.8%	87.5%	87.0%	86.6%	85.3%

Table 1.2 The number of new claims for Injury, Poisoning and Musculoskeletal Disorders (MSD) by year, from 1996-97 to 2003-04 (Australian Safety and Compensation Council 2007).

Between 1996-97 and 2003-04, total compensated fatalities in Australia decreased by 36%, from 398 to 256. The incidence rate nearly halved from 5.4 to 3.1 compensated fatalities /100 000 employees.

The Mining industry employed 106 000 people in Australia in 2004-05, 1% of the Australian workforce. It has traditionally been one of the most hazardous of industries with high injury and fatality rates. The rate of new claims fell from 51/1000 to 27/1000 between 1996-97 and 2003-04. This represented a 47% decrease in claims, almost double the decrease in claims observed across all industries.

Total fatalities in mining decreased from 24 (29/100,000) to 8 (9/100,000) between 1996-97 and 2003-04. This represents a 69% improvement, well in excess of the decrease in the incidence rate of all claims (43%). However, this death rate remains nearly three times the national rate (3.1/100 000 employees).

These reductions in mining represent the result of determined efforts to reduce injury rates and improve safety within that industry. It highlights the benefits of effective injury prevention strategies. Work injuries in Australia overall have reduced over the last 10 years. The industries with claims rates above the national average are those that bear the closest similarity to the Army workforce; transport and storage, construction and mining.

Musculoskeletal skeletal injury and disease are the leading cause of claims, and efforts to reduce the incidence and severity of these is likely to reduce both injuries and costs significantly.

1.8 Injury Severity and Outcome

Overpeck (Overpeck 1994) has stated that "Injury outcomes of most treated injuries, including severity and activity restriction, are generally unknown."

Injury data is usually available in direct proportion to case severity, and in inverse proportion to frequency. It is important, however, not to underrate the social and economic importance of less severe injuries.

Injury severity has typically been measured using proxies such as death or duration of stay in hospital. Length of stay can be used as an indication of the burden of an external cause or health condition on the hospital system. The value of a severity indicator is dependent on the accuracy of the data on which it is based and its suitability for planning purposes (Australian Institute of Health and Welfare 2008).

Length of stay in hospital however, does not take into account transfers between hospitals and variations in clinical and administrative practice, which can increase or decrease the apparent severity for a given injury cause (Kim 2000, Stephenson 2002). Length of stay also does not account for the long-term consequences of injury. For example, some spinal cord injuries result in life long disability at an enormous cost to the health system, but the average length of stay in hospital may be comparatively short compared to other injuries from which full recovery occurs.

Planning for future needs with respect to rehabilitation and other costs to the health system require the development of more sophisticated indicators of severity. Definitions and measurement of the severity of an injury are important mechanisms in determining the cost of injury (Australian Institute of Health and Welfare 2008).

Zadkha (Zadka 1994) noted that one of the major issues with injury was the long lasting and permanent disability, which arose from serious injury. McClure (McClure 1994) argued that for injury control purposes it is important to divide injury into relevant subsets based on the severity of injury.

A number of methods have been employed to measure the severity of life threatening injury (Baker 1974, Champion 1990). These assessments are made at the time of injury, and do not have any relationship to ultimate outcome. Little work has been done on non-life threatening injury.

In the US, most studies have concentrated on the outcomes of more severe injuries. Several authors however have commented on the high incidence of non-life threatening injuries to extremities that result in long-term disability (Yates 1991, Levine 1987). McKenzie, in a functional study of recovery after trauma, found that only 63% of those with minor injury to the extremities had returned to work within the year

(McKenzie 1988). Bull (Bull 1985), analysed the disabilities suffered by survivors of road traffic accidents in the UK. He found 28% of inpatient and 3% of ambulatory casualties had some form of permanent disability.

Moderate to severe traumatic brain injury often leaves people with intellectual impairments and limitations in activities of daily living (Colantonio 2004). As they are often discharged from hospital within a relatively short time frame, the extent of this morbidity can be hidden. Poor quality of life and poor subjective wellbeing have been shown to persist with little change over time up to 15 years after brain injury (Teasdale 2005).

In Australia in 2005–06, there were 197,865 bed days for hospitalisations with a principal diagnosis of injury with over 70% of these being same-day separations. The average length of stay for injuries with an external cause was 2.2 days including same-day separations and 5.4 days, excluding same-day separations. Complications of medical and surgical care had the longest average length of stay of the leading external causes of injury (3.5 days), followed by transport accidents (3.3 days) and intentional self-harm (2.3 days).

Excluding same-day separations, transport accidents had the longest average length of stay of the leading external causes of injury (7.3 days), followed by complications of medical and surgical care (6.4 days), intentional self-harm (5.8 days) and falls (4.3 days). Assault and accidental poisoning also had high average lengths of stay (4.1 days each).

While recovery from most minor injuries is rapid, some injuries often result in long term disability. These long term sequelae are less well documented than the immediate consequences of injury (Australian Institute of Health and Welfare 2006). An indication of the extent of these problems is provided by the National Health Survey (NHS) conducted by the Australian Bureau of Statistics. In 2001, the NHS estimated that almost 2.1 million Australians (12% of the total population) had a long-term condition caused by an injury (Australian Bureau of Statistics 2006a). The 2003 Survey of Disability, Ageing and Carers estimated that 25,600 persons were living with disabilities due to injury that resulted in profound limitation in the core activities of

communication, mobility and self-care. Another 39,800 reported severe limitations in activity (Australian Bureau of Statistics 2004).

Severity of injury should not simply be judged by the initial nature of the injury. Many seemingly minor injuries resulting in minimal or no days in hospital can have a major impact on morbidity, function and quality of life.

1.9 Predicting Outcomes

"The ability to identify those injuries which result in major morbidity, is an important aid to controlling the burden of injury to the community, and they can be subjected to injury prevention strategies." (Alexander 1992).

The health consequences of non-life threatening injuries can be significant. In one study examining minor "whiplash" injury, 14% of patients were found to have continuing symptoms 5 months post injury. (Pennie 1991). In a Swedish study (Hildingson 1990), 43% of vehicle accident victims who suffered a soft-tissue injury to the cervical spine were found to have residual disability 2 years after their accident.

Alexander argued that there was a need to improve acute medical care and increase rehabilitation support post discharge. The type of injury was found to be the only consistently significant predictor of impairment, and not age or location of injury in an insurance model (Alexander 1992).

Mock (Mock 1993) used regression analysis to predict subsequent disability in patients at a rural hospital in Ghana. Using injury type, mechanism of injury, region, age, sex, referral and inpatient complications, he found that the strongest predictors of disability were body part injured and type of injury.

With advances in medical technology and an increasing number of people surviving a serious injury, studies of the burden and cost of injury need to include long-term morbidity indicators (Sbordone 1995, Murray 1996, Stone 2001). Current estimates of the burden of non-fatal injury have largely been derived from the opinions

of expert panel predictions, but the reliability of these outcomes predictions has been questioned (Schluter 2005).

Cameron noted that there were few population-based studies of long-term outcome of non-fatal injury from which accurate estimates of the burden of injury could be derived (Cameron 2006a). The nature of morbidity and disability outcomes from injury were also poorly conceptualized and difficult to measure (Kuipers 2004, Singh-Manoux 2003).

Cameron analysed the Manitoba health admission database and identified all persons aged 18–64 years, resident in the province of Manitoba, who were hospitalized with an injury between 1 January 1988 and 31 December 1991 (Cameron 2006b). Injury severity scores (ISS) >16 were considered to be a major injury, an ISS of 9–15 a moderate injury, and a mild injury was defined as an ISS of 1–8 (McEvoy 2004, Morris 1990).

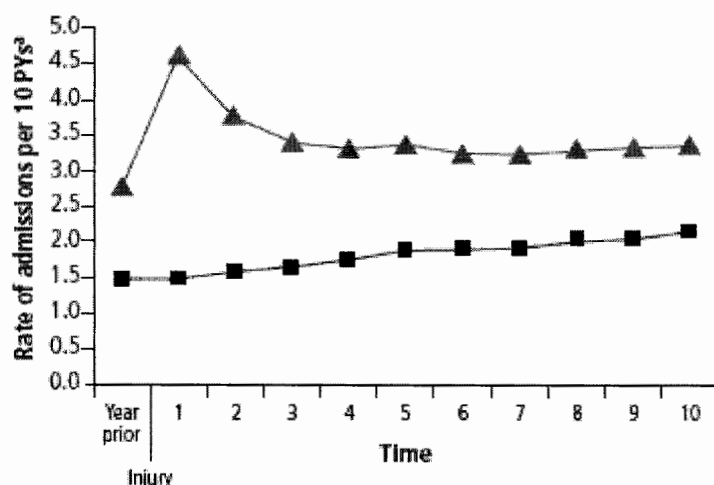


Figure 1.2 Rate of hospital admissions in the 10 years following an initial injury. (From Cameron 2006b) [▲ = injury cohort, ■ = control group]

Outcome measures selected were number of hospitalizations, cumulative length of stay for the 10 years post-injury, physician claims for the 10 years post-injury and first admission to a care home during the 10-year follow up period. Males comprised 63.9% of the sample, with 18–34 year olds representing 54.3% of the 21,032 injured

people. Over the 10-year follow-up period, 8.0% of the injury cohort died ($n = 1677$) compared with 3.6% of the comparison cohort members ($n = 754$).

Figure 1.2 shows that although rates of admission peaked in the first year following injury, consistent rate ratios of 2.0 to 2.6 demonstrated that admission rates remained higher than the non-injured for many years' post-injury. The injured cohort had 1.63 times the number of all-cause post-injury hospital discharges (95% CI, 1.59–1.68), 3.22 times the number of days' post-injury in hospital for all causes (95% CI, 2.96–3.50), 1.28 times the post-injury physician claims rate (95% CI, 1.26–1.30) and 4.37 times the rate of placements in care homes than the comparison cohort (95% CI, 3.18–6.02).

Hospital discharge rates were similar for each of the three levels of severity of injury, measured by the ISS. In contrast, LOS rate ratios increased with the severity of the injury in the 10 years following injury. Those with minor injury had LOS of 2.08 days/person-year (RR = 2.53; 95% CI, 2.34–2.74) compared to 5.07 days/person-year in those with moderate injuries (RR = 5.52; 95% CI, 4.37–6.99) and 10.49 days/person-year in those with an ISS score of >16 (RR = 11.54; 95% CI, 6.34–21.02). Rates of all-cause post-injury physician claims increased with increasing severity of the injury, but fewer of the post-injury physician claims were found to be attributed to the original index injury (between 20.0% and 36.7%).

The predictors of disability post injury are poorly understood. Age and pre-existing illness need to be considered, while body part injured and injury type appears to be the most consistent predictors. Initial severity of injury has been shown to be a reasonable predictor of subsequent health service utilisation.

1.10 Rehabilitation

Rehabilitation is defined by the WHO as "the physical and behavioural processes used to limit handicap and disability in patients who have impairments as the result of injury or illness". (World Health Organization 1990) Rehabilitation services

have the ability to produce significant benefits on two levels; early return to function and reduced hospital stay costs.

The Industry Commission noted that "Overall,Rehabilitation has generally been proven to be cost-effective, although the returns compared to outlays appear to vary widely" (Industry Commission 1993).

There were clear regional differences in rehabilitation outcomes noted in the Industry Commission report. In 1990-91, NSW workers returned to work on average 9.6 weeks after injury, while in Victoria it was 28 weeks. Nearly four times as many Victorians stayed on benefits for 12 months or longer (Industry Commission 1993).

Failure to rehabilitate and return injured workers to the workplace was identified as the single most important factor in the longer duration of absence in Victoria. Both Workcover (NSW) and COMCARE achieved reductions in average absences through a program that emphasized workplace rehabilitation. As a result, they were able to significantly reduce premiums (Industry Commission 1993).

Wood (Wood 1996) conducted a study investigating the outcomes of rehabilitation programs undertaken by 3,211 injured workers. He concluded that every dollar spent on rehabilitation yielded a reduction in system costs of \$2.31.

1.11 The Epidemiology of Injury in the Army

A major review of injury in the Army was conducted in 1994 (Rudzki 1994). This study determined the number, type and causes of injury in the Australian Army during the period 1987-91. Data was obtained from databases of Defence Directorate of Occupational Health and Safety (DOHS) and the Soldier Career Management Agency (SCMA).

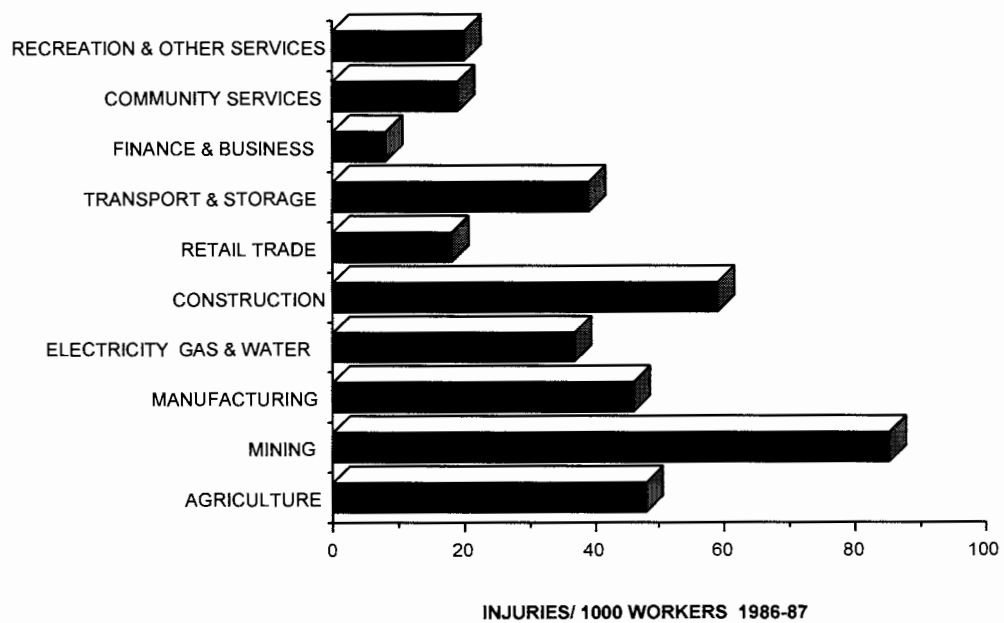


Figure 1.3 Reported rates of compensable injuries within Australian Industries 1986-87.

Approximately 5000 injuries were reported annually between 1987 and 1991. The 1991 reported injury rate of 161/1000 soldiers was twice that of the most dangerous civilian occupation of mining (85/1000). Figure 1.3 shows the comparable reported compensation claims by Australian Industry for the period 1986-87 (Worksafe 1991). Reported rates of injury derived from the Defence Occupational Health and Safety Database are shown in Figure 1.4.

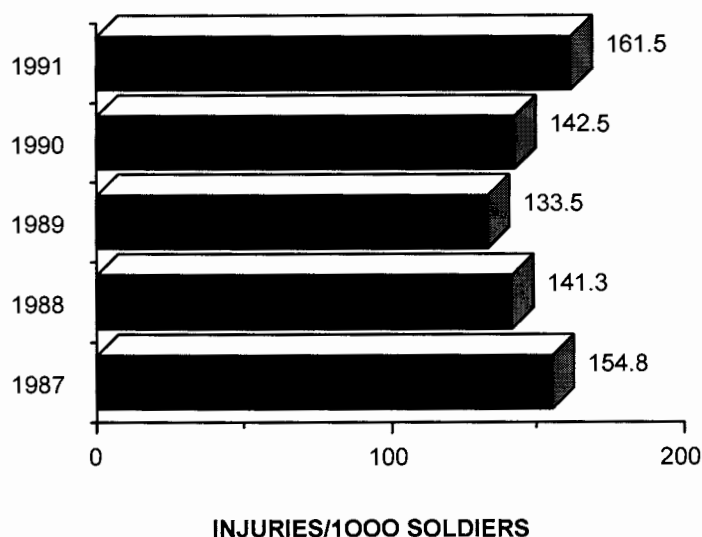


Figure 1.4 Reported rates of injury in Army soldiers 1987-1991.

These figures are not directly comparable, as the Army figures are self-reports of any injury considered to be potentially compensable, the majority of which resulted in less than 5 days absence from the workplace. The Worksafe data only represents lost-time injuries that caused 5 or more day's absence from the workplace.

In 1994, the mining industry had reduced its claims rate to 64.4 injuries/1000 workers (Worksafe Australia 1996). By contrast the Occupational Health & Safety (OH&S) database for the Australian Army reported an increased injury rate of 247 injuries/1000 soldiers in 1995/96. Research in US Army trainee populations found annual injury rates of between 160-320/100 soldiers (Knapik 1993, Jones 1988, Jones 1992, Reynolds 1993)

Injury accounted for 32% of all admissions to Australian Defence hospitals in 1991, compared to 18.5 per cent in the general population. This represented an annual injury admission rate of 106/1000 soldiers. Knee injuries were responsible for 10% of all admissions, with an admission rate of 32.5/1000 (Rudzki 1994).

Lower limb injuries were by far the most frequent injury reported, accounting for 39.6% of the five year average for all injuries. Upper limb injuries (19.4%) and injuries to the spine (15.2%) were the other major injury sites reported. This pattern of

injury contrasts with the civilian workplace where back injury was the most commonly reported injury (25%) followed by other injuries (37%) and the hand 14.3%. Lower limb injuries only comprised 10.8% of workplace injuries (Workcover Authority 1998).

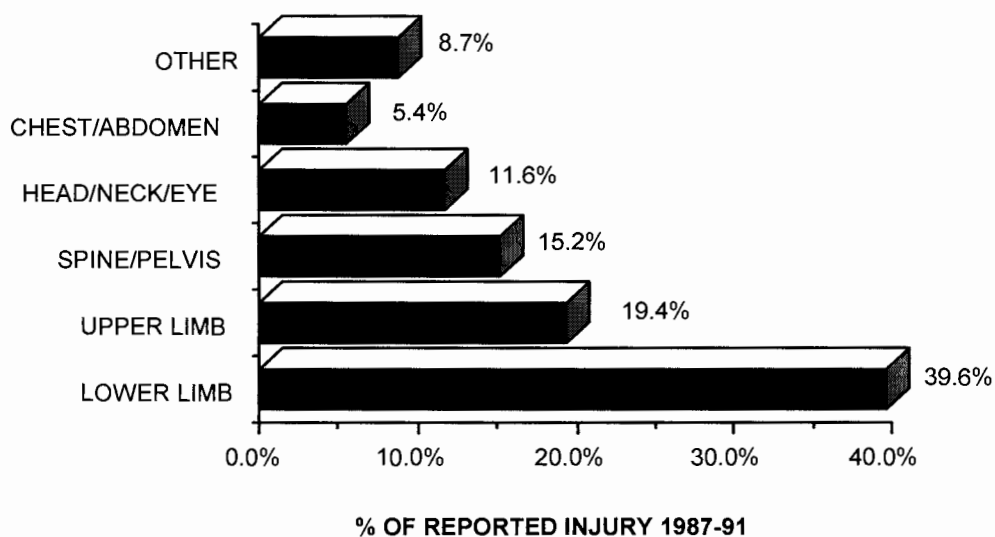


Figure 1.5 Five year average incidence of reported location of injury, Australian Army, 1987-91.

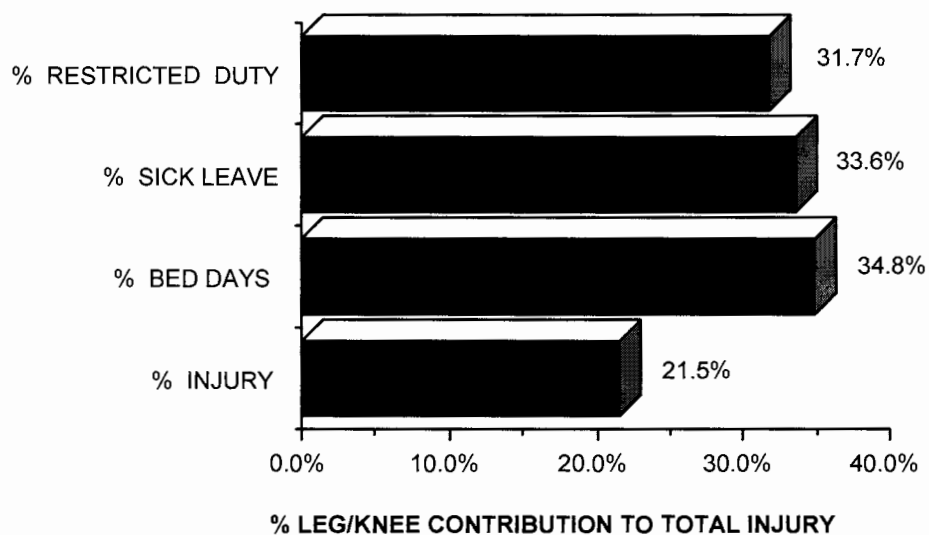


Figure 1.6 The 5 year average relative morbidity of leg/ knee injuries, Australian Army, 1987-91.

Lower limb injuries comprised a five year average of 40 per cent of all reported

injury, but were responsible for 50 per cent of bed days, 48 per cent of sick leave and 51 per cent of restricted duty. Lower limb causes were responsible for 82% of all medical downgradings, to an employment standard requiring permanent restrictions in the workplace. The cumulative incidence of non-FE personnel rose from 13 % of Army strength in 1987 to 17.1 % in 1992. Figure 1.6 shows that leg/knee injuries had the greatest morbidity. These injuries represented a five year average of 21.5 % of all reported injury, but were responsible for 35 % of bed days, 34 % of sick leave and 32 % of restricted duty.

Athletic activities (sport/physical training/running/marching) were the cause of 41 per cent of all reported injuries, and accounted for 37% of bed days, 40% of sick leave and 52% of restricted duty. Tables 1.3 and 1.4 show the causes of reported injury and their relative contribution to morbidity.

CAUSE	INJURIES	BED DAYS	SICK LEAVE	RESTRICTED DUTY
Lift/Bend	4.3%	3.0%	3.6%	5.0%
Physical Training (PT)/PT Test	12.6%	10.6%	12.3%	15.9%
Physical Exertion	3.5%	4.0%	4.4%	5.0%
Run/March	7.1%	7.8%	7.3%	9.1%
Fall/Slip	14.4%	9.3%	11.0%	12.0%
Motor Vehicle Accident	7.8%	17.2%	13.9%	7.2%
Struck	6.0%	3.8%	7.6%	3.5%
Sport	21.4%	18.5%	19.9%	27.2%
Other	22.9%	25.6%	20.1%	15.2%

Table 1.3 The four year average (%) contribution to morbidity of each cause of injury, 1988-91

CAUSE	BED DAYS/ INJURY	SICK LEAVE/ INJURY	RESTRICTED DAYS/ INJURY
Lift/Bend	1.4	1.6	17.0
Physical Training (PT)/PT Test	1.7	1.9	18.9
Physical Exertion	2.3	2.5	21.5
Run/March	2.2	2.0	19.0
Fall/Slip	1.3	1.5	12.5
Motor Vehicle Accident	4.4	3.5	13.8
Struck	1.3	2.5	8.6
Sport	1.7	1.8	19.0
Other	2.2	1.7	9.9
All Causes	2.0	2.0	14.9

Table 1.4 The four year average associated morbidity per injury cause, 1988-91.

Musculoskeletal/injury causes accounted for 46 per cent of Defence Force Retirement and Death Benefits (DFRDB) invalidity retirements between 1987 and 1992.

From the data presented it can be seen that lower limb injuries predominate in the Army, which contrasts with the civilian workplace where back injury is the most commonly reported. Athletic activities, primarily physical training, running, marching and sport are the leading causes of both injury and morbidity.

1.12 The Importance of Injury in a Military Setting

Reducing injuries allows a greater number of soldiers to be available to do their job. This becomes an important consideration in the light of workforce shortages and the competition for skilled labour.

Athletic injuries are the leading cause of injuries in the Army and injuries to the leg/knee have a disproportionate morbidity. The literature has consistently shown that overtraining, and in particular, excessive running distance, is the most significant underlying cause of lower limb injuries in athletic populations (van Mechelen 1992).

A number of intervention studies have been conducted in Australian Army recruits to examine the effectiveness of a variety of injury prevention interventions. A randomised controlled study was conducted in 1989, which compared the standard running program with one that reduced running distance during formal physical training and replaced it with backpack marching (Rudzki 1997a).

This study found the incidence of injury to be 37.6% and 46.6% in the Walk and Run groups respectively, but this was not a statistically significant difference. The rate of injury was 52.9/100 recruits in the Walk group and 61.7/100 in the Run group. The exposure incidence was 12.8 injuries/1000 hrs PT in the Walk group and 14.9/1000 hrs in the Run group (Rudzki 1997a). There were significant differences in the number of lower limb injuries and knee injuries between the two groups. Table 1.3 summarises the results.

	WALK	RUN	
Number injured	64	85	$\chi^2 = 2.90$ $p=0.09$ RR=1.24 (0.98 - 1.61)
Number of injuries	90	111	
Rate of injury (/100 recruits)	52.9	61.7	
Rate of injury (/1000 hrs PT)	12.8	14.9	
Number of Lower Limb			
injured	43/170 (25.3%)	75/180 (41.7%)	$\chi^2 = 9.77$ $p=0.0018$ RR=1.65 (1.21 - 2.25)
injuries (Excl. blisters)	55/90 (61.1%)	87/109 (79.8%)	
Number of Knee injured	15/170 (8.8%)	34/180 (18.8%)	$\chi^2 = 6.54$ $p=0.011$ RR= 2.14 (1.21 - 3.79)

Table 1.5 Number and rate of injuries observed in the Run and Walk groups. (Rudzki 1997a)

The run group had a consistently higher incidence of both lower limb and knee injuries, the two types of injury which are predominant within the Army population as a whole. Foot (18.9%), knee (16.7%), ankle (13.3%) and shoulder (8.9%) were the commonest sites of injury in the Walk group. In the Run group, the commonest sites were knee (32.1%), ankle (18.3%), foot (11.9%) and shin (7.3%). There were two tibial stress fractures in the Run group and none in the Walk group, giving the Run group a stress fracture incidence of 1.1%.

This reduction in injury was achieved with no detrimental effect on the performance of the then Army Physical fitness test which consisted of a 5 km run. Table 1.6 shows the 5 km run time performance of the recruits at different stages of the 12 week training course (Rudzki 1996).

5 Km Run time (mins)	Walkers	Runners	Difference (R-W)
Week 3	21.78 (21.49-22.06) (n=148)	21.83 (21.41-22.26) (n=80)	+0.29 NS
Week 6	22.14 (21.88-22.40) (n=146)	21.88 (21.58-22.18) (n=155)	-0.26 NS
Week 11	21.85 (21.49-22.22) (n=36)	22.90 (21.86-23.95) (n=32)	+1.05 * t= 2.03 p=0.049

Table 1.6 Five kilometre run time (mins) for the Run and Walk groups at weeks 1, 6 and 11 of training. (Rudzki 1996)

Recorded cause of Injury	Walk	Run	
Running	5 (5.5%)	28 (25.2%)	$\chi^2=26.58$ p=0.0001
5 Km Run	0	12 (10.8%)	$\chi^2=10.35$ p=0.0035
Marching	27 (30.0%)	7 (6.3%)	$\chi^2=19.85$ p=0.0001
Physical Training (PT)	23 (25.5%)	21 (18.9%)	NS
Obstacle Course	10 (11.1%)	16 (14.4%)	NS
Field Training	5 (5.5%)	6 (5.4%)	NS
Trauma/Fall	3 (3.3%)	8 (7.2%)	NS
Other	5 (5.5%)	2 (1.8%)	NS
Not Specified	12 (13.3%)	11 (9.9%)	NS
Total	90	111	

Table 1.7 The identified causes of injury in the walk and run groups.(Rudzki 1997b)

Table 1.7 shows the identified causes of injury during the study. Marching (30.0%), physical training (25.5%), and the obstacle course (11.1%) were the most frequent causes of injury in the Walk group. In the Run group, the leading causes were Running (36.6%), physical training (19.2%) and the obstacle course (14.6%).

Table 1.8 shows the cause of knee, other lower limb and back injuries. The table shows quite clearly that running was the leading cause of both knee and lower limb injuries, consistent with other studies in the literature (van Mechelen 1992).

	RUN			WALK		
	Knee	Other Lower Limb	Back	Knee	Other Lower Limb	Back
Physical Training	5	11	2	5	10	0
Running	13	12	0	1	4	0
5 Km Run	4	7	1	0	0	0
Marching	0	6	1	3	19	5
Obstacle Course	8	7	0	2	4	0
Field Training	2	4	0	3	2	0
Other	3	11	2	1	11	3
Total	35	58	6	15	50	8

Table 1.8 The activity causing lower limb and back injuries during training.

	WALK	RUN
Restricted Duty days	356	600
Not fit Duty days	44	87
Hospital Bed days	42	82
Restricted Duty (Days/injury)	3.96	5.40
Not fit Duty (Days/injury)	0.49	0.78
Hospital Bed days (Days/injury)	0.47	0.74

Table 1.9 Morbidity associated with the Walk and Run groups. (Rudzki 1997a)

Injury morbidity in the Run group was nearly double that of the Walk group in terms of the number of days restriction, hospitalization and not fit for duty. Table 1.9 shows the absolute and relative morbidity in the two groups. Reduction of running distance in the PT programme resulted in significant reductions in both the incidence of lower limb injury and the overall severity of injury.

There were 10 medical discharges in the Walk group and 16 in the Run group. Ten (62.5%) of the Run and 2(20%) of the Walk discharges were due to lower limb causes. Of these 1(10%) of the Walk and 4 (25%) of the Run injuries were considered

to be new injuries, and not related to pre-existing conditions. The disproportionate morbidity of injury is illustrated by a study which compared the illness and injury medical presentation rates for male and female US Army recruits (Jones 1988).

	Gender	Injury Rate	Illness Rate	Injury/Illness Ratio
Sick Call Visits /100 recruits/month	Male	22	26.4	0.8
	Female	40	37.2	1.1
Days Limited Duty /100 Recruits/month	Male	16	3.1	5.1
	Female	77	6.0	21.5

Table 1.10 The relative incidence and morbidity of illness and injury in a population of US Army recruits (from Jones 1988).

Table 1.10 shows that while the incidence of injury and illness were roughly comparable, the morbidity of injury was much greater, especially in female recruits. The cost of this disproportionate morbidity was not calculated.

British Army data based on medical attendances show a similar picture (British Army Medical Directorate 1996). For the period January-July 1996, injury or the sequelae of injury were responsible for 39.4% of all initial and 48.6% of all review presentations to British Army medical facilities. The rate of illness presentations was 100/1000/ month compared to 65.1/1000/month for injury. When training units were examined, initial illness rates were 249/1000/month and initial injury rates were 196/1000/month. The picture is somewhat different for review consultations where the injury rate was 98/1000/month compared to the illness rate of 8.9/1000/month. Injury consultations comprised 91.7% of all review consultations.

Using lost workdays as a marker of morbidity, the British Army rate of lost days was 219/1000 soldiers/month for injury and 81.9/1000/ month for illness. In training units, injury was responsible for 353 days/1000 soldiers/month while illness accounted for only 130 days/ 1000/month. In both groups, injury accounted for 73% of all days lost from the workplace.

The British Army lost on average 26,215 days per month due to injury, compared to 9,803 days per month due to illness. Allowing a nominal wage cost of £30 per day lost, there was an indirect loss of £786,450 per month due to injury or £9.437M per year. The equivalent figures for illness were £294,090 per month and £3.529M per year.

Injury rates in recruit training rose alarmingly in 1995 and there was an urgent demand for changes to the physical training program to reduce the attrition due to injury. Male medical discharge rates had increased from 57.6/1000 in 1992-93 to 81.1/1000 in 1994-95, while female medical discharge rates had increased from 45.5/1000 to 101/1000 over the same period.

At the request of the Commander of the recruit training establishment, an uncontrolled observational study was conducted to examine the effect of changes to the recruit physical training programme on injuries and medical discharge (Rudzki 1999). A number of changes were made and it was not possible to control for any one intervention. The changes included cessation of road runs, introduction of 400-800 metre interval training, a reduction in test run distance from 5km to 2.4km, standardisation of route marches and the introduction of deep water running as an alternate aerobic activity.

Soldiers who entered 1st Recruit Training Battalion during FY 1995/96 were divided into three groups. The platoons which arrived during the 3 month period July-September 1995 (n=708) represented Group 1 or the pre-change sample. Group 2 [1 Oct 95 - 17 Jan 96 (n=667)], entered training when the 2 physical training programmes were in concurrent use. Group 3 [24 Jan 96 - 6 May 96 (n=579)] commenced training when the new programme was universal. It was assumed that the 3 month period prior to the change was representative of the pre-existing training cycle.

This analytical approach was adopted because the staff needed to adapt to the new physical training regime. Because of the concurrent physical training systems in place it was felt that there may have been some "lapses" into old ways. Table 1.11 shows the incidence of or recorded injury during these three time periods.

There was a 46.6% reduction in the rate of total injury presentation ($\chi^2 = 14.31$ $p=0.0002$) between the pre and post change groups. The annual rate of male medical discharges fell 40.8% from 81.1/1000 in 1994/95 to 47.0/1000 in 1995/96 ($\chi^2 = 26.33$ $p=0.0001$). Female rates, however, increased 58.3% from 104/1000 to 164.2/1000 ($\chi^2 = 6.09$ $p=0.014$).

	Group 1	Group 2	Group 3
	Jul - Oct 95	Oct - Jan 96	Jan 96 - Mar 96
No of Platoons	16	14	13
No of Recruits	708	662	577
No of Injured	179	112	78
Injury Rate	253/1000	169/1000	135/1000

Table 1.11 The crude number and rate of Recruit injuries July 1995 - March 96

Because of the limitations of the study design, it was not possible to hypothesise about causation. The changes to the PT programme were introduced together and there were no control groups. The significant reduction in injury rates indicates the need for further controlled studies to determine which changes had the greatest impact on injury rates.

Table 1.12 shows the rate of injury for each period by gender. The changed physical training programme appeared to have a differential effect; with the reduction in male injury rates being much greater than in females. The reduction in male injury rates was reflected in the medical discharge rates, with a 40% reduction between 1994/95 and 1995/96. During this same period however, female medical discharge rates increased by 60% (Figure 1.3).

	Group 1	Group 2	Group 3
	Jul - Oct 95	Oct - Jan 96	Jan 96 - Mar 96
No of Males	554 (78%)	578 (86%)	502 (87%)
No of Females	154 (22%)	89 (14%)	75 (13%)
Male Injured	125(22.5%)	87 (15%)	61 (12.2%)
Female Injured	54 (35%)	25 (28%)	17 (22.7%)
Female Relative Risk	1.55	1.87	1.86

Table 1.12 The number and Relative Risk of Male and Female injury, July 95 - March 96.

Part of this increase may have been attributable to a change in the rehabilitation holding policy, with a limit of 8 weeks set for recovery. If a condition was deemed to

require a longer recovery period, then the recruit was discharged. However, this policy did not impact the males, and suggests that the changed programme may have had a beneficial effect on males, but not females.

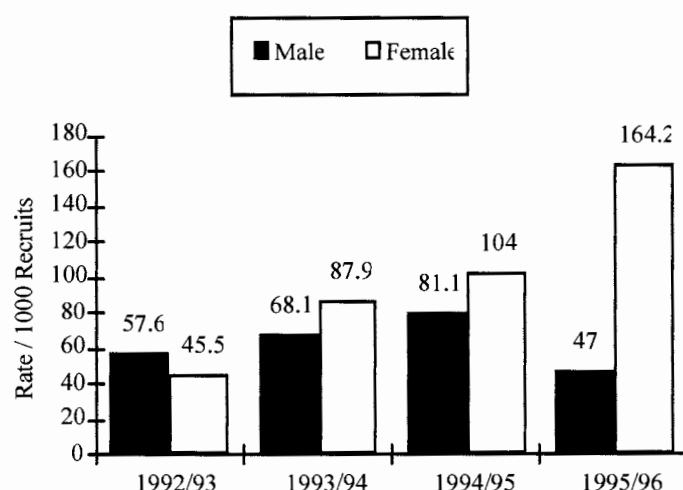


Figure 1.3 The rate of recruit medical discharge, by sex, 1992/93 to 1994/95.

Other potentially confounding factors are time of year and changes in training staff. Anecdotally, the best recruits are attracted in the January-March period (Australian Summer) and these are school leavers who wish to join the Army as a career. Training staff claim that the worst recruits arrive mid-year, when after exhausting all other options they choose a military career. Training staff also rotate during the January period, so at least one third of staff will have been new during the January period. These factors are however constant and regular; the large and statistically significant decrease in the annual medical discharge rate suggest that the changed PT programme, rather than cyclical events were responsible.

The relative risk of female recruit medical discharge in 1995/96 was 3.38. This risk increased steadily from 1992/93 when the discharge rates were comparable. There is evidence that suggests different levels of initial fitness may be the cause of this differential rate of injury and consequent medical discharge. Pope found that initial levels of aerobic fitness (as measured by a 20m shuttle run) were highly predictive of subsequent recruit injury (Pope 1999).

A US Army study found that the risk of injury was the same for males and females when stratified by 1 mile run time tertiles. The highest rate of injury occurred

in the lowest tertile (Jones 1992). The most notable finding was that 50.7% of the women were in the lowest tertile compared to 1.2% of the males. This suggested that levels of fitness varied significantly between the sexes, and that women of equivalent fitness had the same risk as their male counterparts.

This view was supported by a study of female Officer candidates at West Point in 1977. This study found that women who scored highest on the initial fitness tests incurred few injuries during the training period. The researchers concluded that the female's initial level of fitness affected their susceptibility to injury. The study also commented on the preponderance of young adult women with poor fitness levels who had never been physically challenged (Tomas 1977).

The reduction in male recruit medical discharges demonstrates the potential cost savings that can be achieved with effective injury prevention interventions. The cost of acquiring and transporting a recruit to 1RTB has been calculated at A\$9,000, and if discharge occurred after 10 weeks, the net cost was estimated to be A\$14,245 (Australian Army 1996). This figure takes into account salary, housing, food and training resources, but not medical, rehabilitation and compensation costs.

With a male recruit throughput of 2700 in 1995/96, the reduction in medical discharge rate represented a saving of 89 recruits, resulting in an estimated cost saving of A\$1,267,805. For the females, the increase in rate was 60.2/1000 in 1995/96. With a throughput of 481 recruits this represented an increased loss of 29 recruits or an additional cost of A\$413,105.

	Jun-Sep 95	Nov-Feb 96
No of Recruits	834	674
No of Bone Scans	119	48
Rate of Bone Scans / 100 Recruits	14.4	7.1

Table 1.13 The number and rate of bone scans pre and post changes to the PT programme.

Table 1.13 shows that the number of bone scans ordered post intervention fell by 50% from 14.4 /100 recruits to 7.1/ 100 recruits. ($\chi^2 = 19.33$ $p=0.0001$) This reduction represented a saving of 7.3 scans /100 recruits , which at A\$281 per scan represented a saving of A\$13,770. With a recruit throughput of approximately 3,000 per year, this equalled a saving of 220 bone scans per year or A\$61,539 per year.

The study authors questioned the benefits of integrated physical training for men and women during Army recruit training. There was likely to be a significant difference in initial fitness levels between the genders and this was not taken into account when applying a physical training regime which had fixed and not relative demands.

The system of variable start point and fixed endpoint was a recipe for injury, particular given the low levels of initial fitness seen in females (Jones 1992, Pope 1999). As a result of this research, a screening aerobic fitness test was introduced at all Australian Army recruiting centres in October 1997, and a minimum level of acceptable aerobic fitness introduced. . The rate of male recruit medical discharge between 1 Oct 97 and 30 April 98 fell to 22.5/1000 (n=1334) while the female rate fell to 50.4/1000 (n=218) .

Running is popular with military trainers because it is a simple activity requiring little preparation and no equipment. There is the strong belief that running is an essential means of acquiring aerobic fitness. Consequently, attempts to reduce the frequency and duration of running activities have met with varying degrees of success. Based on the Australian Recruit studies outlined above, the distance of the Australian Army physical training test was reduced from 5km to 2.4km, with the assumption that reducing the test distance will reduce the training distances and result in a concomitant reduction in overtraining.

A US Army Task Force recently evaluated military physical training (PT) injury prevention programs, policies, and research. The research group reviewed 286 papers on military physical training and recommended interventions based on the strength of the supporting evidence (USACHPPM 2008).

The Task Force considered the essential elements of an injury prevention program to be: (1) Education of Service members, especially leaders, in injury prevention principles and evidence-based strategies, (2) Leadership enforcement of injury prevention policies and programs, (3) Unit injury surveillance reporting and (4)

Investment of greater resources in research and program evaluation of training related injury prevention interventions. Table 1.13 summarises the Task Force Findings.

Recommended interventions (*Based on Sufficient Scientific Evidence*).

- (1) Prevent overtraining (strongly recommended).
- (2) Perform multiaxial, neuromuscular, proprioceptive, and agility training.
- (3) Wear mouthguards during high-risk activities.
- (4) Wear semi-rigid ankle braces for high-risk activities.
- (5) Consume nutrients to restore energy balance within 1 hour following high-intensity activity.
- (6) Wear synthetic blend socks to prevent blisters.

Interventions not recommended (Due to Evidence of Ineffectiveness or Harm).

- (1) Wear back braces, harnesses, or support belts
- (2) Take anti-inflammatory medication prior to exercise

Interventions without sufficient evidence to recommend at this time.

- (1) Stretch muscles before or after exercise
- (2) Reinitiate exercise at lower intensity levels for detrained individuals
- (3) Target specific muscles to strengthen
- (4) Replace running shoes at standard intervals
- (5) Warm up and cool down before and after activity
- (6) Place shorter Service members in front of formations to set the running pace.
- (7) Manipulate stride length.
- (8) Participate in a standardized, graduated marching program
- (9) Gradually increase load-bearing during marching
- (10) Avoid hazardous exercises or exercise machines
- (11) Separate body weight assessment and maximal effort physical fitness tests
- (12) Wear shock-absorbing insoles
- (13) Wear running shoes based on individual foot shape
- (14) Wrap ankle with athletic tape prior to high-risk activity
- (15) Run on improved surfaces that minimize injury risk
- (16) Improve obstacle course landing surfaces
- (17) Adjust training loads by seasonal variations
- (18) Encourage smoking cessation programs to prevent musculoskeletal injuries
- (19) Educate Service members on safe lifting
- (20) Apply ice to injuries early to prevent re-injury
- (21) Take oral contraceptives to decrease injury
- (22) Standardize the unit reconditioning program after rehabilitation
- (23) Predict injury risk through use of an injury risk index

Interventions without a completed review.

- (1) Provide pre-basic training fitness assessment and fitness programs for the least fit
 - (2) Individualize PT versus training as a group or unit.
 - (3) Wear knee braces.
 - (4) Wear forearm or elbow straps.
 - (5) Utilize allied health professionals in a pre-military treatment facility care setting.
 - (6) Accommodate for psychosocial issues related to injury.
-

Table 1.13 Summary of US Task Force recommendations for injury prevention.

Of the 31 injury prevention interventions identified in the literature, only 6 (20 %) had evidence strong enough to be recommended for widespread implementation. Two interventions (6 %) were not recommended due to evidence of ineffectiveness or

harm. Twenty-three (74 %) of the interventions reviewed in the scientific literature could not be recommended because of lack of evidence, poor quality evidence, conflicting evidence, or evidence of harm. A further 6 interventions had not received a complete review. Physical training is necessary to condition soldiers for their occupational tasks. The authors noted “In classic military tradition, however, efforts to exceed the standards have contributed to the injury epidemic present today.”

The biggest presumed impact on the prevention of overtraining in the military population is a reduction in running distance. The authors state “Military and civilian research indicates that high running volume significantly increases the risk for lower extremity injury. During initial military training, about 25 percent of men and about 50 percent of women incur one or more PT-related injuries. About 80 percent of these injuries are in the lower extremities and are of the overuse type—a condition brought about by PT volume overload (generally excessive running relative to initial fitness level and running capability of the individual).”

The USACHPPM review cited 3 US studies which examined the effect of reducing running distance on injury. The first study examined US Marine Corps recruits during a 12 week course. Table 1.15 summarises the results. Three groups of recruits each undertook different amounts of organized running. The group with the greatest (40 %) reduction in running distance had a 54% reduction in stress fracture incidence no significant change in physical fitness test run time. In this study, reducing running mileage reduced stress fracture incidence with no effect on aerobic fitness.

No of Marines (n)	Total run distance over 12 weeks (miles)	Stress fracture incidence (%)	Final 3-mile run times (min:sec)
1136	(High) 55 miles	3.7%	20.20
1117	(Medium) 41 miles	2.7%	20.44
1097	(Low) 33 miles	1.7%	20.53
	22-mile reduction	54% reduction	NS

Table 1.15 Mileage, Stress Fracture Incidence, and Average Final 3-Mile Run Times Among Three Groups of Male U.S. Marine Corps Recruits. (USACHPPM 2008)

In 1995, it was estimated that the reduction in running mileage saved \$4.5 million in medical care costs and nearly 15,000 training days annually by preventing stress fractures (USACHPPM 2008).

A 1994 study examined US Army soldiers during a 12 week recruit course, and divided the recruits into a low mileage group (56 miles) and a high mileage group. The low mileage group had a 24 % reduction in injuries and maintained their aerobic fitness. It is important to note that while they decreased their running mileage, they increased the miles marched (the high mileage run group marched 68 miles; the low mileage run group marched 117 miles). The results are summarised in Table 1.16.

Running Mileage	Injury Incidence	Final 2-Mile Run Time (min:sec)
(High) 130 miles	54%	13:45
(Low) 56 miles	41%	13:28
74 mile reduction	24% reduction	NS

Table 1.16 Mileage, Injury Incidence, and Average Final 2-Mile Run Times Among Two Groups of Male and Female U.S. Army Recruits. (USACHPPM 2008)

The third study compared male Naval recruits ran either 12 - 18 miles or 26 - 44 miles during formal physical training.. The lower mileage group had lower injury rates and 1.5-mile run time improvements that were the same as the higher mileage divisions. In other words, a reduction of 20 miles of running during US Navy recruit training reduced injuries by 20 percent, again without negatively affecting physical fitness. The results are summarised in table 1.17.

Running Mileage	Injury Incidence	Average Improvement in 1.5-Mile Run
High (26-44)	22.4%	1:02
Low (12-18)	16.4%	1:00
Average 20-mile reduction	27% reduction	NS

Table 1.17 Mileage, injury incidence, and average improvement in 1.5-Mile run times among two groups of male U.S. Navy recruits.

In summary, it is clear that overuse injuries of the lower limb are the signature injuries of military populations. The evidences supports the view that excessive running distances during physical training is the main cause and that reductions in running distance will reduce injuries without an adverse impact on aerobic fitness.

1.13 Injury Data Collection

Surveillance is defined by the World Health Organization as the ongoing systematic collection, analysis, and interpretation of health data necessary for designing, implementing and evaluating public health prevention programs (World Health Organization 2001).

Injury surveillance has been hampered by a lack of readily available information on injury cause or mechanism. Hospital discharge records frequently do not have complete International Classification of Disease (ICD) E (external cause) code data. Without the ability to identify patterns and types of injuries in the population, epidemiological studies of injury risk cannot be conducted. Since risk factors and patterns for fatal and non-fatal injury frequently differ, both mortality and morbidity data are essential. One problem with most systems is that there is no one unique identifier, which serves to link all records (Dischinger 1994).

ICD 10 coding has moved to an alpha numeric-coding of external injury events. L'Hours (L'Hours 1994) noted that "The traditional ICD approach to the classification of external causes, while perhaps relevant to mortality uses was, in many respects, considered inadequate for the needs of injury prevention programmers and policies."

Many significant categories of injury cannot be distinguished easily in the Australian mortality and morbidity data; occupational and sports injuries for example. These defects reflect the past national reliance on ICD 9. The aim of injury data collection is to identify problems and prompt causal hypotheses. Target setting for injury reduction goals is hamstrung by the lack of adequate baseline data. In New Zealand, the Injury Prevention Unit has established a hospital based database with the aim of documenting resource utilization, determining incidence of injury and undertaking analytical epidemiological studies.

The New Zealand surveillance system identified that 20% of admissions were re-admissions for ongoing rehabilitation and management. Langley (Langley 1994) noted that while New Zealand had almost universal E code usage, they had several

shortcomings, and were not critical from an injury prevention perspective. The use of free text narratives was felt to provide greater benefit.

Sherman (Sherman 1994) noted, "A surveillance system that is not used is useless. In the risk assessment/ risk management model, surveillance data can and should be used at many points including hazard identification, risk estimation, option development and monitoring evaluation".

Population based data is necessary to perform risk factor assessment according to either population or exposure characteristics in order to target interventions appropriately. Tursz (Tursz 1985) noted the methodological difficulties of only collecting data from public hospitals. Limiting data collection to public hospitals alone would have produced an injury rate of 51/1000 subjects instead of the rate of 83/1000 observed. This difference was due to the high percentage of sports injuries seen in private clinics. In another study, 22% of all injuries presented to the offices of private physicians (Spyckerelle 1984).

1.14 The Public Health approach to Injury Prevention

Pointer argues that a public health approach to injury prevention provides a framework in which national priorities for injury prevention can be developed. (Pointer 2003) This public health approach is characterised by 4 steps; surveillance, risk factor identification, intervention evaluation and implementation (National Center for Injury Prevention and Control 1998).

Australian surveillance systems have a number of limitations. The databases containing basic morbidity and mortality data do not link with external injury factors from hospital separations data and the lag-time between injuries occurring and data becoming available is too long. Most identified risk factors for injury are not subject to routine data collection or are collected by other agencies in different systems in different policy areas (Pointer 2003). Surveillance systems underpin injury prevention and intervention. Surveillance data is fundamental to priority setting, but is dependent on reliable and valid data collection and dissemination.

Current surveillance systems are also not well placed to evaluate the effectiveness of specific interventions. Pointer argues that there is a pressing need to identify injury specific indicators of success and delineating the type and level of evidence required to establish the success or failure of an intervention. Cost will always be a factor in any health intervention. Identifying proven and effective interventions should become a priority

The public health approach involves the selection of population-based priorities, because within each population group there are different injury profiles. Examining population based groups allows for the targeting of different injuries e.g. hip fractures in the elderly, and lower limb overuse injuries in military populations. The population-based approach allows for a range of targeted strategies to be introduced for particular injury areas.

One of the five priority populations identified by the National Injury Surveillance Unit (NISU) was young adults aged 15 to 24. This group accounts for a disproportionately large number of injuries in both males and females, accounting for 16% of all hospitalisations and 14% of all deaths from injury in Australia. Young adults are over-represented in a number of injury areas including transport, violence, and pharmaceutical poisoning and self-harm (Kreissfeld 1996, Moller 1995)

Key factors that influence the observed injury patterns in young adults include risk taking behaviour, alcohol and workplace injury. Prevention strategies targeting young adults have the potential to reduce the high injury burden seen in for age group (Australian Institute of Health and Welfare 2008).

One of the important aspects of monitoring and maintaining successes in injury reduction is the development of surveillance systems that provide accurate and valid data. Without such data it is nearly impossible to measure the impact of interventions.

Coupled with the difficulties in surveillance is the difficulty in measuring severity. Injury in young adults can have an enormous impact on the individual, their family and society (via health care costs). Pointer argues that developing a predictive model for the health and financial needs of injured patients is an important goal which requires more valid and reliable indicators of severity (Pointer 2003).

1.15 The Defence Injury Prevention Program

The Defence Injury Prevention Program (DIPP) is an attempt to apply the public health model of injury prevention to an Army Population. The key elements of DIPP are outlined below.

Surveillance. Traditional workers compensation datasets are too broad in nature and do not assist in the identification of specific and unique areas of military risk, such as physical training, obstacle courses and field training. The DIPP system required all recruits who presented to the medical centre with an injury to complete a simple injury report form, which was based on that developed for sports injury surveillance by Finch (Finch 1999).

Diagnostic details were added by treating medical staff and injured recruits added details on circumstances of the injury incident such as venue, activity, action, and mechanism of injury. Data was entered into an injury surveillance database, with medical imaging and orthopedic specialist reports used to update diagnostic. Injury surveillance reports detailing the type, frequency and causes of injury were produced quarterly. Developing a military specific surveillance tool was essential to gain face validity with the senior military management.

Risk factor identification. The DIPP delivered a 2 day training program for local staff of a military unit to enable them to analyse and interpret the injury surveillance reports. The principles of risk assessment and management were also taught.

Intervention evaluation. The DIPP training also included injury counter-measure development for many of the most commonly identified risk factors. The risk factor analysis and proposed countermeasures were then presented to the organisation's quarterly Occupational Health and Safety committee meeting for review and endorsement by senior leadership/management.

Implementation. Once scrutinised and approved, the proposed counter measures were implemented. The effectiveness of the intervention was assessed by continued monitoring of the injury surveillance database.

The DIPP program is founded on the key principles of (1) Education of key staff and leaders, in injury prevention principles and evidence-based strategies, (2) Leadership enforcement of injury prevention policies and programs and (3) Unit injury surveillance reporting.

Population	Time Period	Injury Rate (Incidence) (Injuries per 100 per month)	Reductions in Injury Rates Achieved
Staff - Australian Federation Guard (Canberra)	1 Jan 2003 to 31 Mar 2003	8.2	15% reduction 2001-2003
Officer Cadets - Australian Defence Force Academy (Canberra)	1 Jan 2003 to 31 Mar 2003	11.3	32% reduction 2002-2003
Recruits – 1 st Recruit Training Unit (Royal Australian Air Force, Edinburgh)	1 Jan 2003 to 31 Mar 2003	27.3	71% reduction 2001-2003
Recruits – Army Recruit Training Centre (Kapooka)	1 Jan 2003 to 30 Jun 2003	22.3	70% reduction 1995-1999 & further 13% reduction 2001- 2003
Officer Cadets - Royal Military College (Canberra)	1 Jan 2003 to 31 Mar 2003	15.8	13% reduction 2002-2003

Table 1.18 DIPP Injury Surveillance System Injury Statistics Jan-Jul 2003.

The key aim of DIPP was to provide leaders with accurate and reliable information on the type, nature and cause of injury, in conjunction with well-thought out injury prevention interventions. There is an old Army dictum “Do not come to me with problems, just solutions”. Table 1.18 summarises the effectiveness of the DIPP in regional organisations where it has been implemented. Reductions in injury incidence of between 13-70% demonstrate the effectiveness of this approach.

Pope described the use of DIPP in identifying and eliminating ACL ligament ruptures at the Army Recruit Training Centre. (Pope 2002a, Pope 2002b). In June 1998, six unexpected anterior cruciate ligament ruptures within the preceding 12 months were

detected by routine injury surveillance in a cohort of Australian Army recruits.

Only one ACL rupture was able to be identified in previous years, therefore an incidence of 6 cases was of concern to the supervising staff (Pope 1992a). Australian Army recruits who sustained an ACL rupture were medically discharged from the Army, because their rehabilitation timeframe of 12 months exceeded the recovery limit of 3 months for retention in the Army. So every ACL rupture was a career terminating injury.

Review of the individual injury reports and clinical case histories indicated that all _{six} injuries occurred on an outdoor obstacle course. Five of the six ACL ruptures occurred while landing after jumping a horizontal distance of 2 m over an open pit. The sixth occurred on landing from a 1.8 metre high log wall. The pit jump activity was observed by the health staff, who noted that the recruits landed on newly installed rubber matting, and it became apparent that recruits rapidly decelerated when their feet hit the matting. The rubber matting had been laid on both the takeoff and landing areas of the wall and the open pit.

The supervising staff commented that the matting had been laid at the end of June 1997. The prevailing view was that ankle sprains occurred as a result of ground wear at the landing site and that the new rubber matting would provide a level surface, prevent slipping, and provide for shock absorption. The time at which the rubber matting was laid coincided with the time at which the series of ACL ruptures began to occur. No other changes had been made to the obstacle course at this time.

A review of the medical literature was conducted to ascertain the likely mechanisms of ACL rupture. Combined valgus and external rotary forces applied to the lower leg relative to the thigh was the most commonly described mechanism (Jarvinen 1994, McConkey 1986).

The rubber matting had a friction rating of 0.68 to 0.72, which was considerably higher than the minimum recommended friction rating of 0.40 for pedestrian surfaces. This suggests when the recruits landed on the matting their lower legs "stuck" Pope concluded that this could put the knee at risk if there was any

external rotation of the knee on landing.

The commanding officer was notified of the findings and a recommendation was made that the rubber matting be removed from the landing area of the open pit only and be replaced by raked, 20-mm river pebbles. The river pebbles allowed the foot to decelerate more slowly after landing and prevent the foot from being rigidly fixed in one position in the presence of rotational forces in the transverse plane. Raking of the pebble surface ensured an even landing surface to minimize the risk of ankle sprain.

The commanding officer accepted this initial recommendation, and required that subsequent injury surveillance confirm that the cause had been correctly identified, by evaluating the effect of removing the rubber matting on the incidence of ACL ruptures.

The initial recommendation did not involve the removal of the rubber matting from the takeoff and landing areas of the 1.8 m wall, because only one ACL rupture had occurred at the wall at that time. In the subsequent 9 months of injury surveillance, two additional ACL ruptures occurred at the 1.8 m wall, but none occurred at the 2m open pit. As a consequence it was recommended that the remaining rubber matting be removed. No further ACL ruptures were observed in the 12 months following removal of the remaining rubber matting. The difference in the incidence of ACL rupture pre and post removal of the rubber matting was statistically significant ($\chi^2 = 5.91$ $p = 0.015$).

Combined with the temporal relationships between removal of the matting and the observed reduction in the incidence of injury, this provided highly suggestive evidence of a causal relationship. Compensation payments made to each of the eight individuals with ACL rupture ranged from zero to A\$66,719 and averaged A\$26,317. Direct medical costs paid by the Army averaged A\$3,310. The costs of training was calculated at A\$2,000 per week and the cost of recruiting each recruit was AU\$9,000.

Because of a typical a 5-week delay between rupture and departure, and given that injuries occurred, on average, 3 weeks into the training program (range, 2-5 weeks), the estimated average training cost associated with each injured recruit was AU\$16,000. The total estimated average personnel cost was A\$25,000 per recruit with

an ACL rupture. The total estimated average cost for each case of ACL rupture was A\$54,627; This cost is borne entirely by the Army and is likely to be conservative because it includes only compensation payments made within the first 2-3 years post injury. Recruits remain eligible for reasonable medical and associated costs related to their injuries for the term of their lives. This means that the total cost to the ADF of each of these injuries is likely to continue to increase steadily as time passes. Based on the costing outlined above, preventing 6 ACL ruptures in the 12 months following removal of the rubber matting provided a cumulative saving of A\$328,000 per annum.

These results highlight the high cost of injury to the military and draw attention to the benefits to be gained from efficient injury surveillance and preventive processes. One of the key aims in identifying the scope and severity of injury is to develop the impetus to establish prevention programs. In many ways this is little different from anti-smoking or anti-obesity campaigns.

But as Emmett noted at the beginning of this chapter the area of injury prevention is hamstrung by views that “injury and disease was part and parcel of work, largely a matter of luck, about which little could be done”. Work on this thesis began in 1996 and has been a long and slow process. While the epidemiological evidence in support of injury prevention has been clear, the organisational / bureaucratic support has not been present. This thesis sought to examine and quantify costs as a means of providing organisational impetus for the development of an effective injury prevention system.

Despite receiving strategic defence endorsement and funding, the original project plan was not implemented because a civilian employment freeze was imposed on the department. It had been intended that regional data entry clerks be employed in regional areas to assist medical staff in the laborious task of data entry.

Attempts to outsource data entry were hampered by the significant cost of this service compared to the employment of APS level 2 data entry staff. Only in the Townsville region was a local data entry staff member employed, and their employment ceased on 30 June 2006.

The effect of the DIPP can be illustrated by the results achieved within the 3rd Brigade based at Lavarack Barracks in Townsville. The Defence Injury Prevention Program was implemented with full support of the Commander, and most importantly it had a full time data entry clerk and a full time injury prevention advisor. The injury prevention advisor's job was to ensure that all local units reviewed their quarterly injury reports and assisted in the analysis of injury trends and injury counter measurement development.

The DIPP was instituted in the Australian Army 3rd Brigade in March 2004. Injury surveillance data including the location, activity, time of day, type of injury and morbidity were collected. Data from 2005 was compared to 2004 data for the same month to assess the effectiveness of the program.

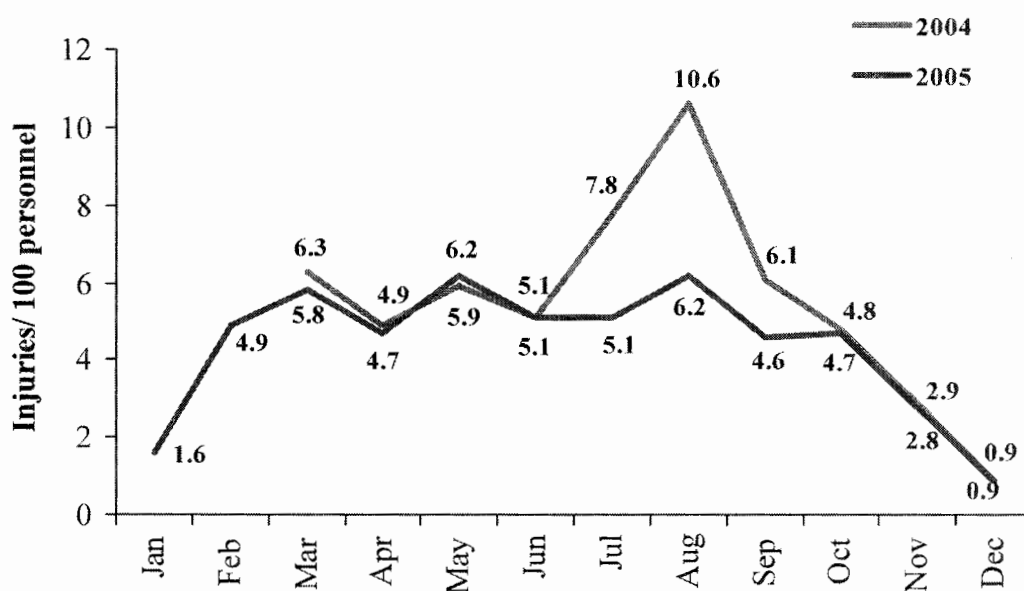


Figure 1.7 Rates of injury /100 soldiers/month recorded by the Defence Injury Prevention Program at the 3 rd Brigade Townsville.

In 2004, monthly injury rates ranged from 2.9/100 to 10.6 /100 /month, with injury incidence peaking in the winter sports season (July-September). In 2005, this injury peak was abolished with injury rates falling from a high of 10.6/100 in August 2004 to 6.1/100 in August 2005. July and September saw smaller but significant reductions.

With a military population of approximately 3,000, the reductions in injury rate of 2.7/100/month, 4.4/100/month and 1.5/100/month equate to injury reductions of 81, 132, and 45. This means that the program prevented 258 injuries during the peak winter season. Other factors may have been at play, but this demonstrates the effectiveness of prevention programs backed up by effective surveillance systems.

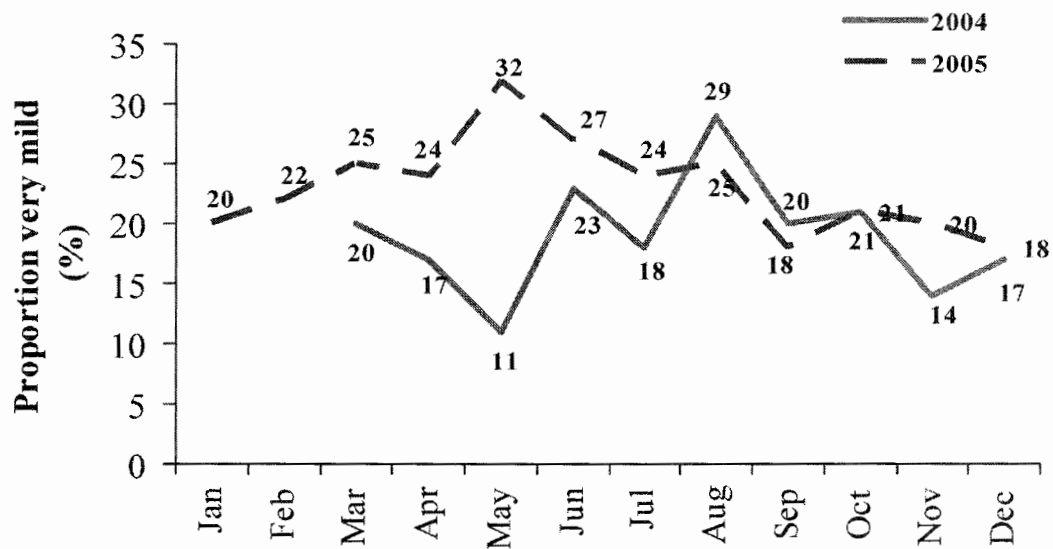


Figure 1.8 The percentage of injuries rated as mild per month, 2004 and 2005.

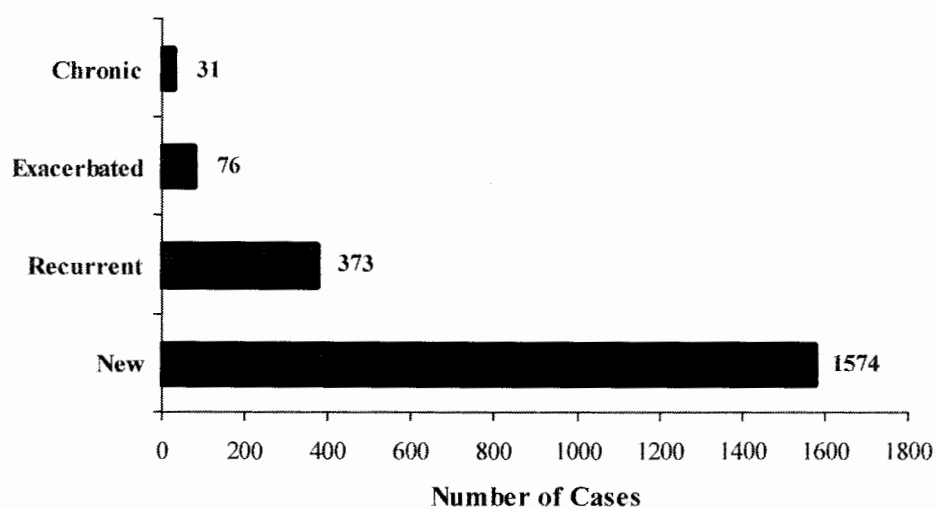


Figure 1.9 The nature of injuries sustained April 2004 – March 2005.

In addition to the reduction in incidence, there was also a reduction in the severity of the injuries reported in 2005. In May 2004, 11% of injuries were recorded as mild (requiring no further care); while in May 2005 32% of injuries were recorded as being mild. Smaller reductions in severity were seen in other months. Figure 1.9 shows that the majority of injuries were new (77%), with 18% being recurrent injuries, 3.7% being exacerbations of old injuries and 1.3% described as chronic injuries.

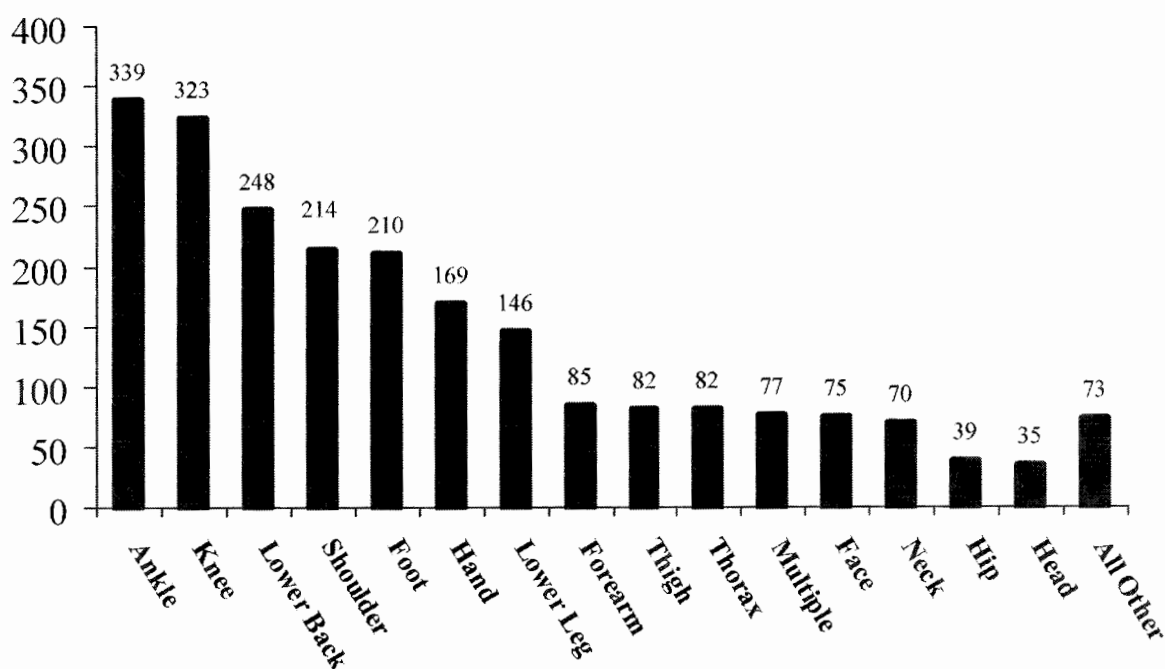


Figure 1.10 Bodily location of reported injuries April 2004 – March 2005.

Figure 1.10 shows the bodily location of the reported injuries. Ankle injuries were the most common (15%), followed by knee (14.2%), back (11%), shoulder (9.4%) and foot (9.3%). Lower limb injuries comprised 50.2% of all reported injuries.

Figure 1.11 shows that sport was the leading cause of injury being responsible for 24% of all injuries followed by physical training not supervised by a qualified physical training instructor (PTI) (17%) and military skills training (9%). Figure 1.12 shows that running was the leading activity which resulted in injury responsible for 22% of all injuries followed by walking (10.4%) and jumping (8.2%).

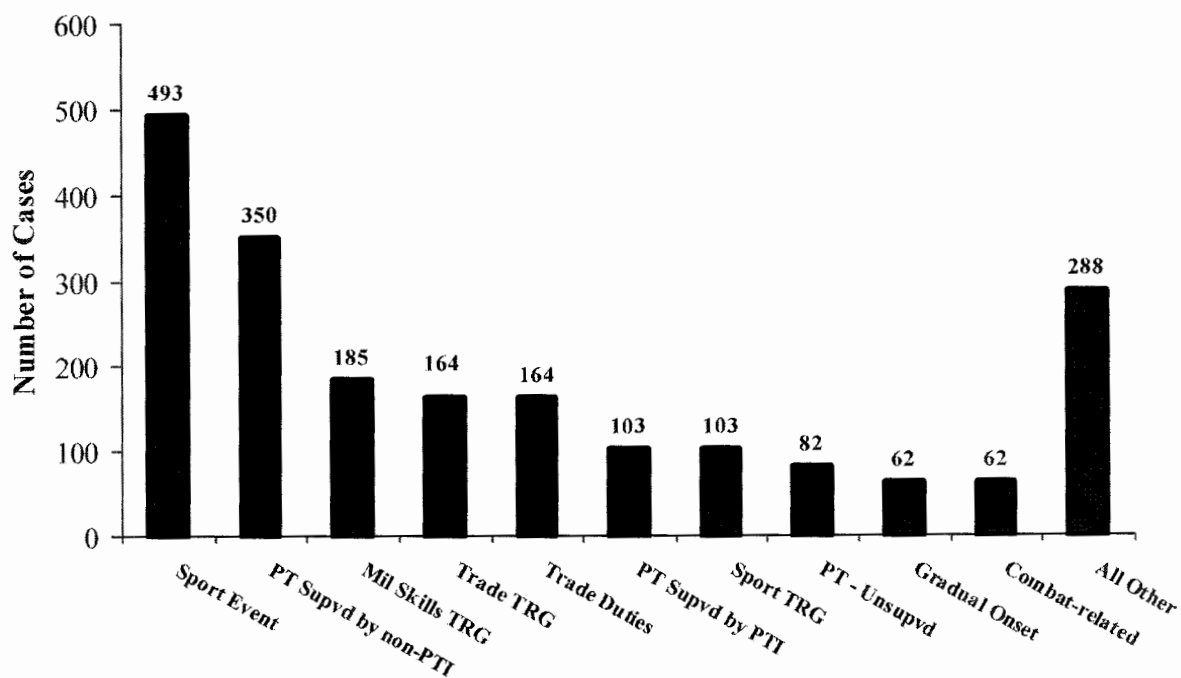


Figure 1.11 Causes of recorded injury April 2004 –March 2005.

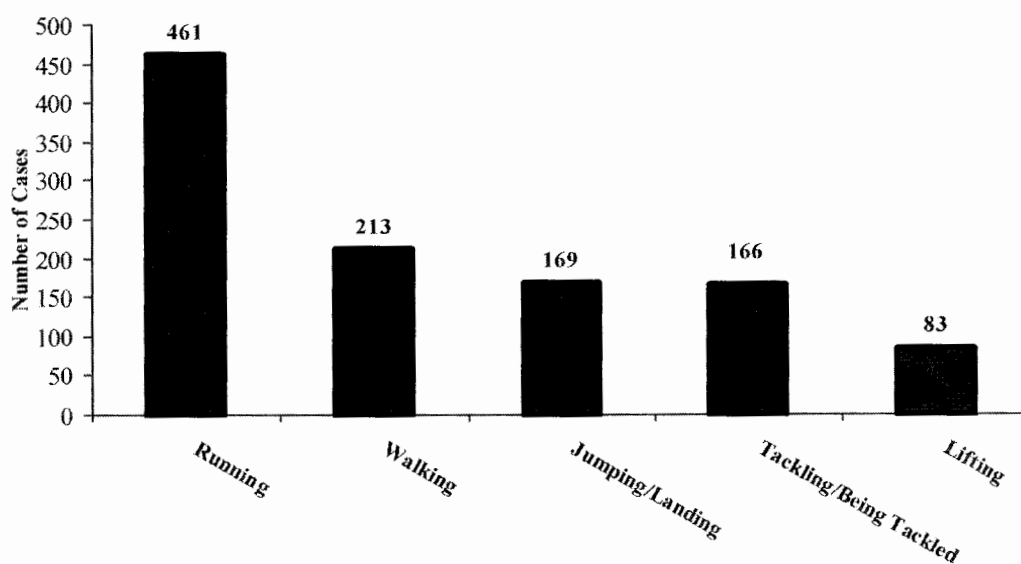


Figure 1.12 Activity during which injury occurred April 2004- March 2005.

The demonstrated reduction in both the incidence and severity of injuries had a positive effect on the local commanders. Commanders were also willing to engage in injury prevention activities because they considered that they had ownership and influence over the process. These results indicate that the DIPP is an effective means of reducing both the incidence and severity of injuries in a Military setting.

1.16 Conclusion

Injury is a leading cause of death and premature mortality, especially in young adults. Injury is predominately a male event, especially in the workplace, motor vehicle and sporting field. Work injuries have been estimated to cost Australia \$20 billion dollars annually, while sports injuries have been estimated to cost over \$1 billion per year. Back pain is the leading type of occupational injury accounting for 25% of all work-related injuries.

Injury is a major problem for western armies. In Australia, the reported rate of injury in soldiers is four times higher than the mining injury, although the reporting criteria are different. In contrast to industry, lower limb injuries predominate in the Army, mainly due to the heavy emphasis placed on physical training.

The US Army has demonstrated that injury rates in female soldiers are twice that of males, with days of restriction five times greater. The British Army has shown that while the incidence of illness was greater than of injury, injury resulted in two and a half times greater morbidity (days lost).

Systematic data on injury outcome is surprisingly scarce and it is of note that severity of initial injury is not automatically related to residual disability. The best way of improving injury incidence and outcome is through a comprehensive system of injury surveillance. There is a clear imperative to improve the surveillance, prevention and management of injury.

Chapter 2. Costs of injury and economic evaluation of interventions.

"One way to assess the importance of a health problem to a society is to calculate its costs". (Langley 1989)

2.1 Introduction

Economics has been defined as the study of the consequences of resource scarcity. (Jacobs 1980) The major consequence of resource scarcity is the necessity to choose between competing alternatives. The aim of this thesis is to identify the cost to government of injuries in the Army. This section seeks to review the various costing approaches used in the literature with the aim of influencing public policy makers.

Levin (Levin 1985) defines a cost as "a sacrifice equal to the value of something that is given up by using resources in a given way.... the cost to us is what we must give up by using the ingredients in this way rather than in their best alternative use". Using resources for one purpose denies them to another. The alternative use of these resources is termed the opportunity cost.

In health care, choices are often made based on values or moral sentiment rather than economic rationality. Markets are assessed in terms of the principles of perfect competition; a large number of suppliers and purchasers, no single controlling price, free entry and exit of suppliers, free substitution of products and services and perfect information accessible to all suppliers and purchasers.

Unfortunately these principles have little applicability to health-care markets, where free exit and entry of suppliers and purchasers rarely exists, despite the best efforts of government to create such a market.

2.2 Determining and defining Costs

"Costs arise in one community sector but are financed partly or entirely by other sectors. This fragmentation of community expenditure on accidents constitutes a

dilemma,...since the scope of the economic consequences of this health problem is hidden. Only when the total cost is known can we become aware of the extent of the problem." (Lindqvist 1996).

Health Costs have traditionally been divided into three categories;

- (1) **Direct costs.** These are costs that reflect resource use or direct monetised payments within the health sector for patients and families. They include all costs attributable to service provision, e.g. detection, treatment and care. They also include non-health components such as travel and time spent by family members caring for patients.
- (2) **Indirect Costs.** These are the costs associated with lost production and usually focus on the lost production attributable to sickness or premature death. These are losses or foregone transactions and can include costs that impact outside of the healthcare system, and
- (3) **Intangible costs.** These are changes in the quality of life for patients and families. The burden of illness diminishes the quality of life resulting in reduced emotional well-being and the inability to relate to and support others. By their nature they are difficult to identify and measure.

In traditional economic terms, costs can be determined in a variety of ways including:

- (a) Market prices - when markets are perfectly competitive, the equilibrium price established by the market will represent the value of that good. This is a simple method and a set of prices will be readily available to determine the cost of inputs, and
- (b) Shadow prices - Where the market does not meet the criteria for perfect competition, the market price may not reflect the true cost. The scarcity of talent may generate a higher cost for qualified people, as demand for that talent increases. It is therefore necessary to estimate the value of an ingredient as if

there were a market. This estimated value is called the shadow price. Each case has a time component, and a specific time period must be used in all costs estimated. The annual cost is the most common.

The theoretically correct price to use in the costing of a service is the opportunity cost of the resources that are involved. In practice, market forces are taken as a reflection of these. When cost savings are considered, the extent of change required and the period of time the savings are to be counted, should be specified.

When dealing with capital, the commonly accepted method of determining the cost of ownership is to calculate the depreciation and the interest on the remaining (undepreciated) value. Depreciation of an item is the amount that is consumed in a year. This is calculated by determining the economic life of the item and then dividing this into the replacement cost. For example, if a defibrillator has an expected life of 10 years, then one tenth would be consumed each year, yielding a depreciation rate of 10% per annum.

In the commercial sector, depreciation is not the only cost involved. The undepreciated portion of the defibrillator represents an investment in resources that could have been used in another way. If invested in an interest bearing account it would have produced a return consistent with the prevailing rate of interest. The annual cost is therefore the value of the undepreciated portion times the prevailing interest rate plus the annual cost of depreciation.

Annualisation factors have been calculated for given rates of interest. For example, for a given building with a 20-year life span, with a prevailing interest rate of 10%, the Annualisation factor is 0.1175. Multiply the factor by the replacement cost and you arrive at the annual cost.

2.3 Cost of Illness Studies

Cost of Illness (COI) studies were among the first economic studies to appear in the literature, with the first study appearing in the literature in 1920, and increasing in popularity during the 1950s and 1960s (Jefferson 1996). Jefferson describes the aim

of COI studies as “descriptive: to itemise, value and sum the costs of a particular problem with the aim of giving an idea of its economic burden”.

In the public health context a problem is usually defined in terms of its incidence, prevalence, mortality and morbidity. COI studies are not complete economic evaluations, but they aim “to inform choices in resource allocation by estimating resource consequences of health problems in relation to each other” (Jefferson 1996).

Jefferson notes that COI studies have a number of common elements including the

- (1) recognition
- (2) identification
- (3) listing
- (4) measurement, and
- (5) valuation of costs generated by an illness.

The first stage of COI methodology is to identify all cases of illness, usually based on national statistics if available or extrapolating from a smaller sample. This step suffers from the limitations of the data upon which it is based. The second stage involves identifying the costs generated by all cases of the illness. This is traditionally along the lines of direct, indirect and intangible costs.

Two alternate strategies are used to determine cost: the incidence and prevalence methods. The incidence method estimates costs from their onset until their disappearance for whatever reason (usually death or cure). The prevalence method estimates costs of all cases in a short period, irrespective of the stage they are at.

The incidence method is more precise but has greater information needs, is costly, and is used mainly in those diseases that are of short duration and with a fluctuation in incidence, traditionally infectious diseases. The prevalence approach relies on more assumptions, but is the only practicable way to cost chronic diseases such as rheumatoid arthritis.

COI studies focus on defining the value of resources consumed by an illness. But some argue that direct costs such as hospital days are fixed costs, consumed

irrespective of the nature of the illness. The use of “avoidable costs” is applied to overcome this concern. Avoidable costs are those generated by the illness and would be avoided if the illness did not occur.

Avoidable costs are usually gross estimates and Jefferson notes that they are inadequate, particular when attempting to value indirect and intangible costs. COI studies are interested in values, but a number of historical studies failed to focus on the methods of deriving those values, relying on average costs which led to unreliable or over-inflated cost estimates (Jefferson 1996).

Currie has questioned the value of COI studies; she notes that the rationale for these studies is to provide data for priority setting, through the expression of the cost of injury in dollar terms to illustrate the importance of the problem and therefore its high priority for resources (Currie 2000). Some authors argue that high cost injuries should be made a priority for treatment and prevention programs (Bonnie 1999, Moore 1997).

Sheill argues that COI studies “are not helpful in the context of setting priorities for resource allocation and research priorities”. She goes on to state that “cost of injury studies add little to what is already known.” In the context of motor vehicle accidents she notes that routinely collected hospital and mortality data provide “direct and meaningful information about the size of the problem” (Sheill 1987).

An alternative method of estimating costs is the “willingness to pay” (WTP) approach. This estimates the burden of a disease by measuring what society would be prepared to pay in order to avoid that disease or problem. Jefferson considers this approach appealing because “both opportunities and values are simultaneously considered”, but the practical application of WTP is full of difficulties relating to the questions asked and the interpretation of the answers given.

While the usual viewpoint for COI studies is a societal one, estimates of WTP are purely individual. As Jefferson noted “It is unlikely that individuals have enough information to weigh up the value to them of avoiding the disease, and they certainly do not have the information to assess the same value to society.”

2.4 Cost Components for Injury in the Army

In classic 'cost of illness' studies "the economic burden is assessed in terms of all costs that occur within the health system and outside." (Sheill 1987). The total cost of illness or injury represents the benefit of eliminating the illness or injury. This thesis will adopt a government viewpoint to identifying costs. Within the Australian Army context these costs can be broken down into a number of discrete components. These include:

- (1) Direct Costs
 - (i) Medical payments for professional services
 - (ii) Compensation Costs
- (2) Indirect Costs
 - (i) Military Invalid Pension Costs
 - (ii) Lost Work Days - (Restricted duty & Sick Leave)
 - (iii) Loss of future earnings
 - (iv) Lost Capital Investment in Training due to premature separation
- (3). Intangible Costs
 - (i) Loss of skilled manpower and operational readiness
 - (ii) Pain and suffering
 - (iii) Loss of career opportunity
 - (iv) The impact of vacancies on remaining soldiers

Of these costs, only some are borne by the Army, the remainder are borne by the Government and the individual (society). Pensions and benefit payments are not usually classed as indirect costs, because they are not considered to represent a loss of production. They are usually classed as transfer payments because they represent a transfer of purchasing power from one group to another. They are included as indirect costs in this thesis because they are not health related costs, but still represent a real cost to Government that can be avoided by reducing the incidence of injury. This approach uses a direct government cost to place a value on an indirect cost.

2.5 Direct Costs

Direct health costs are the costs of providing medical services and the patients' out-of-pocket expenses. Direct costs account for approximately 30% of the total lifetime cost of injury (Rice 1989), but for some groups this may be much lower.

Hospital and medical costs are thought to represent only a small proportion of the total cost of injury. Estimates from the Bureau of Transport and Communications Economics (Bureau of Transport and Communication Economics 1992) suggest that hospital, medical and rehabilitation costs account for only 2.4% of the total cost of road accidents. Lost earnings, family and community losses, pain and suffering and property damage accounted for the majority of total injury cost.

The authors noted that the estimation of hospitalisation costs was problematic. Most studies use an average per day cost, but the average cost may not reflect the costs of a particular treatment of interest. Average hospital costs are a poor guide to resource savings if hospital stays are shortened, because resource use is typically higher during the early part of a patients hospital stay, thus preventing the assessment of marginal cost savings.

Many studies use billing costs provided by institutions, but some specialist centres may charge higher fees for reasons other than resource use by particular patients (Bureau of Transport and Communication Economics 1992). Billing costs do not allow for the distinction between professional fees and the costs of reagents, supplies or the capital cost of equipment. Another factor is the issue of price differences for the same resource in different locations. There is a strong case for presenting costs not only in their financial amounts, but also in terms of the physical amount of input used e.g. number of tests, number of days, number of nurse visits etc.

One estimate of the total direct cost attributable to road accidents in Australia put the figure at \$239 million (Bureau of Transport and Communications Economics 1994). Langley estimated the total direct cost of motor vehicle accidents in New Zealand to be NZ\$425 million in 1983, or NZ\$133 per person (Langley 1989). This included Emergency Room care, bed days and Accident Corporation costs.

The direct cost of injury in Australia is difficult to calculate because the data is either poor or incomplete. Watson (Watson 1995) estimated that in 1991/92, the total cost of unintentional injury in Australia was \$1.323 billion. This comprised coronial costs of \$11.6M, hospital inpatient costs of \$910.9M, emergency department visit costs of \$216.5M, and GP attendance costs of \$184.1M.

McClure (McClure 1994) estimated that the cost of attendance for injury and radiology at a selected sample of Australian emergency rooms (ER) was \$1.5M in 1992. When GP costs were added, the figure came to \$2.5M for a sample population of 296,000. General practice care was found to be much cheaper than ER care.

The Australian Bureau of Statistics (ABS) estimated the total outlay for direct hospital and medical treatment of all non-intentional injury to be \$1.79 billion in 1995 (Australian Bureau of Statistics 1995). Worksafe Australia published two estimates of the cost of Workers compensation in Australia in 1991-92. The first estimate based on national accounts data was \$4.6 billion, while the second estimate based on the ABS Major Labour Costs survey data was \$3.8 billion (Worksafe Australia 1994).

2.6 Indirect Costs

Heinrich documented the first systematic study of injury costs (Heinrich 1931) where he classified costs as direct and indirect. He concluded that indirect costs were about four times greater than direct costs, with the ratio being higher in hazardous occupations such as construction.

Heinrich coined the term "iceberg theory", to describe the propensity for indirect costs to be far larger than direct costs, but largely hidden. Since the 1970's, the US Bureau of Labour Statistics has worked on a ratio of 7:1 between indirect costs and direct costs. In an Australian study (Mangan 1993), the ratio of compensation costs to total costs was found to be between 6.3:1 and 6.9:1, which was close to the ratio of 7:1 used by the US National Safety Council.

Hammer (Hammer 1984) noted that even though Heinrich stated that his 4:1

ratio did not hold true for all injuries and industries, many safety investigators adhered to it as a "magic ratio". Grimaldi (Grimaldi 1984) has argued that the Heinrich ratio for indirect costs should be abandoned because of methodological flaws. Heinrich included direct medical and wage costs but not the overhead insurance premium costs. This cost is the difference between the premium paid and the costs incurred, and is between 30-50% of premium costs. Including these costs reduces the ratio to as low as 2:1.

Grimaldi described costs as either insured or uninsured, reflecting the US work environment. Uninsured costs were broken down into three major categories:

- (1) costs due to lost labour time,
- (2) costs due to wages being paid to the injured while absent and
- (3) costs due to incidental property damage.

His study of 2000 accidents (Grimaldi 1984) showed no correlation between direct and indirect costs. He also argued for the change from indirect to uninsured costs as an important psychological move, focusing management on the reality that indirect costs are real rather than intangible.

Laufer (Laufer 1987) argued that current approaches to indirect costs failed to provide sufficient incentive to managers to change their attitudes and behaviour. He favoured a division into controllable and uncontrollable costs. By identifying costs, which could be reduced through management intervention, he believed that behaviour would be influenced.

Laufer argued that workers compensation insurance should be determined by a company's injury record, but he noted that current systems did not closely link safety performance with financial reward. The long lag time between a company's safety record and its workers compensation premium "obscures the relationship between performance and reward and makes it a poor incentive" (Laufer 1987).

To counter the perceived deficiencies of existing approaches, Robinson (Robinson 1979) proposed the use of accident cost accounting as a means of improving workplace safety. This approach involved the development of a matrix of fixed accident costs classified by type of injury and body part injured. Laufer (Laufer 1987) argued that such an approach is a great incentive to management because of the

"instant, clear and accurate linkage between performance (i.e. safety level) and result (i.e. accident cost)".

However, this link is only relative and not absolute, as noted by the US Department of Labour (National Committee for Injury Prevention and Control 1989) " frequency is a much more valuable indicator of safety performance than severity, since blind chance usually plays a greater part in determining the seriousness of an injury than it does in determining how frequently accidental injuries occur".

Laufer argued that a much better system of recording cost data would be a much more potent motivator of behaviour. He noted that in the Israeli construction industry, there was no incentive for direct cost data collection because the insurance premium for workplace injury was a constant 2.7% of labour costs, with safety records having negligible influence. Lost day data was used as an indicator of accident severity instead. Laufer believed that one of the reasons managers were unaware of high cost data was that because of the great variance in accident costs, they were perceived as exceptional events and unrelated to management actions. He also argued "In order to change entrenched ideas regarding the magnitude of costs, it is necessary to restrict oneself to the use of proven conservative values i.e. the lower limits of costs."

Lindgren (Lindgren 1981) estimated the total cost of illness in Sweden. Of the total cost components, health care costs accounted for 30%, morbidity for 52% and premature death for 17%. The four most common categories of illness were circulatory, musculoskeletal, psychiatric and accidents/injuries, which together accounted for over 50% of total costs.

Yelin (Yelin 1979) looked at the costs of chronic illness in a cohort of Rheumatoid Arthritis (RA) patients. He found that RA patients spent 3 times the national average on medical and social services, and lost on average 61% of their expected earnings.

2.7 The Human Capital Approach to estimating Indirect Costs

The Human Capital model states that when an individual devotes time and money to studying or acquiring skills, he is acquiring "human capital" (Addison 1984). This "human capital" resides within an individual and cannot be purchased except in the form of another human with the same requisite skills or training. Such training is considered as work, which was not being undertaken for present benefit, but for future monetary and non-pecuniary gains. (Addison 1984). Individuals can therefore increase their potential future income by investing in training in the present.

The Human Capital model states that during schooling, all potential earnings power or capacity is directed to the production of human capital. This investment can continue through life with continuing education, and allows for increased earnings in later life. The logic implies that training investments will continue to be made until the marginal cost (tuition plus foregone earnings) exceeds the present value of expected returns. Eventually investment will not offset depreciation, and the stock of human capital and consequently earnings capacity, will shrink.

The concept of depreciation is important, for it helps to explain an observed decrease in earnings profile in later life. Those who undertake no post-school training will experience a horizontal wage path that may even deteriorate as human capital depreciates over time. Johnson (Johnson 1974) estimated that human capital depreciated at a rate of 1-3% per annum, with an indication of a higher rate of depreciation in the higher schooling groups.

The period over which educational investment costs can be amortised reduces as a person approaches retirement; therefore it is reasonable to expect such investments to decline over the life cycle. At the end of a working life, the only time an investment would be considered would be if it were free. Central to this is the link between education and production. Earnings are the return on investment in human capital. Based on likely earnings outcomes, individuals are supposed to choose how much to invest and which occupation to choose. Investment is chosen so as to maximise future earnings net of training costs e.g. the choice to study high earning professions such as medicine, law, and business. The decision to commence training is primarily one of

investment. The factors that affect the decision are the magnitude of the investment, its rate of return and its relationship to the age earnings profile.

Investment in education is dependant on the supply and demand for skills in the workplace. The greater the demand, the more likely additional training will increase the value of earnings. The greater the supply, the more likely there will be a depressive effect on earnings. Therefore skills in short supply such as pilots and doctors are worth the investment because they are likely to generate increased earnings.

Personnel account for approximately three-quarters of most organisational costs, especially in the area of education. The services of most personnel are purchased in the marketplace and although there is a general market for personnel, skills in short supply may be difficult to acquire.

Human capital theory is predicated on an individual making investment decisions for their own benefit. Within the Army context, it is the organization which determines the level of investment in training for organisational purposes, and there are little, if any, foregone earnings. Hence the individual internal rate of return is high, with an increase in earnings related to the increase in skills acquired at little or no cost. Investments in on-the-job training are also important. In the British model of apprenticeship, the training provided led to the expectation that the trainee would tend to bear part of the cost of training in the form of reduced wages.

Addison (Addison 1984) argues that the social costs and returns for education should also be considered because they differ from those of the individual. Social costs are generally higher than private costs, because there is usually a subsidy element in education, and what is free to an individual is not without cost to society. Within the Army context, certain military skills are deemed essential for national security, and therefore the cost of this training is heavily subsidised by society, through the government budget process.

Some economists have argued that in the US, increases in per capita income are directly attributable to quality improvements in labour due to education. This "advance of knowledge" is considered to represent 50% of the increase in National income and represent a rate of return of 25% from a social perspective (Becker 1975). Educated

individuals embody higher productivity. Despite their higher cost, companies usually seek to retain them, rather than maximising profit by undercutting its competitors by employing less well educated and hence cheaper labour.

Addison (Addison 1984) studied post-school investment in training and added two additional variables to a regression equation; years of experience and weeks worked per year. The results showed that people with the same level of schooling could earn widely differing amounts. When schooling alone was considered, the percentage of the total variance explained by the regression (R^2) was only 6.7%. But when years of experience were added to the equation R^2 rose to 30%. This means that schooling only accounted for 6.7% of the variation in wage difference while experience accounted for 30%. The value of experience in organizations has been difficult to quantify and consequently most methodologies focus on the costs of training.

2.8 General and specific training.

General training increases the marginal product of an employee, by the same amount as it would in other firms. Specific training raises the productivity of an employee only in the firm providing the training. Most training falls somewhere in between these two extremes.

Specific training is an investment by the firm and not the individual. The firm pays all the costs and receives all the returns. But if the worker were to quit at the end of the training, the firm's investment would be wasted. The willingness of firms to pay for specific training will closely depend on the likelihood of turnover. The optimal strategy for the employer is to share some of the costs of specific training with the employees.

It is common to observe a close relationship between specific training and wage rates. (Addison 1984) The employer is likely to raise the wage rate of the trained employee so as to reduce the probability of quitting. This raises the implication that the quit rate will be higher in industries which require mainly general rather than specific

training. Professional workers who tend to have more general training appear to have higher quit rates than other industries. (Addison 1984)

2.9 Loss of lifetime earnings as a result of Injury or Illness.

The loss of wages expressed as the net present value (NPV) of lost future earnings potential, is the oldest and most common method of estimating the cost of an individual's absence from the workforce for a permanent or prolonged period (Alter 1985). Estimates obtained are sensitive to the values of the discount and productivity rates chosen. There are a number of methods for deriving an appropriate discount rate. These include the rate of growth of Gross National Product and the average pre-tax, inflation adjusted rate of return on private investment.

The most common method is to use the long-term Commonwealth Bond rate as a guaranteed rate of return. During the period the data in this study was collected, the 10 year bond yield ranged from 6.99 per cent in July 1997 to 5.31 per cent in June 1998 (Australian Office of Financial Management 1997). The 5 year bond rate in June 2005 was 5.25% (Australian Office of Financial Management 2006).

In calculations of NPV, it is assumed that 60% of those with permanent injury would be only partially impaired, and therefore not suffer the full loss of a fatality. (Miller 1987) It is also assumed that each permanent partial impairment experienced 30% of the loss of a total impairment or fatality (National Highway Traffic Safety Administration 1983).

Using these assumptions Mangan (Mangan 1993) derived the following cost estimates for industrial illness and injury in Queensland (QLD) for the period 1986-87. Temporary wage losses were obtained by multiplying the number of temporary disabilities by the average number of days lost by the estimated average daily earnings. This analysis indicated that temporary injuries resulted in wage losses of approximately \$100M. For the same period the Compensation Board paid out \$90M, indicating that compensation payouts were achieving a high coverage of the actual wage losses involved.

	Accidents	Diseases	Ratio
Males	\$111.50M	\$87.23M	1.3: 1
Females	\$14.75M	\$1.76M	8.4: 1
Total	\$126.25M	\$88.99M	1.4: 1

Table 2.2 Present value of wage loss from fatal and permanent industrial injuries and diseases in QLD 1986-87.

Social security costs will be impacted if there is under-compensation for those suffering fatal or permanent impairment. In 1987-88, \$54M was paid out in lump sums for fatalities and permanent impairment. Mangan's estimate of the NPV of the lost future earnings was \$215M. If the victim or their surviving dependants want to maintain a similar standard of living, they will need to seek additional income elsewhere. This shortfall will inevitably be subsidized by the social security system, which in the worst case would be \$161M. This cost was not included as part of the cost of industrial accidents, because they represent transfer payments rather than new costs.

One main criticism of the human capital approach is that it only counts earnings, and excludes intangibles such as pain and suffering and places a low value on low income earners and children (Max 1990).

2.10 Burden of disease studies

The World Health Organisation has estimated the global burden of fatal and non-fatal occupational injury to be 10.5 million disability-adjusted life years or DALYs (World Health Organization 2002). Eijkemans argues that these findings require an "integrated, coordinated and strategic response" and "collaborative development of national policies by the major stakeholders: health and labour ministries, employer and worker representatives, occupational health professionals and the public health community."

Burden of disease studies seek to influence policy makers by attempting to quantify previously intangible costs. These costs relate to an individual's pain, suffering and lifestyle degradation. It has been stated that "the true value of the lives and the physical and mental capabilities which are destroyed in motor vehicle accidents can never be adequately measured because the pain, suffering and frustration felt by the individual accident victim cannot be expressed in monetary terms" (National Highway Traffic Safety Administration 1983).

The DALY is a qualitative measure which seeks to capture the consequence of disability in a quantifiable manner. Closely aligned is the quality adjusted life year or QALY. A QALY takes into account both quantity and the quality of life generated by healthcare interventions. It is the product of life expectancy and a measure of the quality of the remaining life years (Phillips 1998). The quantity of life is expressed in terms of survival or life expectancy and has few problems of comparison; people are either alive or not.

Quality of life considerations however, cover a wide range of areas, not just health status. Even restricting the focus to a person's health related quality of life will result in a number of dimensions relating to both physical and mental capacity. A number of approaches have been used to generate these quality of life valuations, referred to as health utilities.

The utilities that are produced represent the valuations attached to each health state on a continuum between 0 and 1, where 0 is equivalent to being dead and 1 represents the best possible health state, although some health states are regarded as being worse than death and have negative valuations. There are many methods of eliciting utility weights and it is important to compare analyses that have used the same utility-weightings otherwise the comparisons will be invalid.

The EuroQol group, a consortium of European researchers, developed the EQ-5D instrument to determine health utilities. (EuroQol group 1990, Essink-Bot 1993, Brooks 1996). The EQ-5D has five functional dimensions; mobility, pain/discomfort, self-care, anxiety/depression and usual activities. Each of the five dimensions used has three levels; no problem, some problems and major problems, providing a total of 243 possible health states, to which unconscious and dead are added to make 245. For each

of the possible 245 health states utility scores were constructed from responses to a random sample of 3,000 people in the UK (Dolan 1996).

The EQ-5D utilised a time trade-off method, developed by Torrance (Torrance 1972). For chronic conditions and individual is offered two choices;

- a. condition state i for time t (life expectancy) followed by death, or
- b. healthy for time x, (less than t) followed by death

Time x is varied until the individual is indifferent between the two alternatives, at which point a preference score is determined (Drummond 1997).

QALYs provide a common basis for the assessment of benefits gained from various interventions in terms of health-related quality of life and survival. When combined with the costs of providing interventions, a cost–utility ratio can be generated which indicates the additional costs required to generate a year of perfect health (one QALY).

Comparisons can then be made between interventions to assess their relative worth from an economic perspective, and a cost –utility analysis is the result. A cost-utility analysis the incremental cost of a program is compared to the incremental health improvement as measured in QALY's gained. The results are usually expressed in terms of cost per QALY gained. Priorities can be established based on those interventions that are relatively inexpensive (low cost per QALY) and those that are relatively expensive (high cost per QALY) (Drummond 1997).

The use of QALYs in resource allocation decisions allows for choices between patient groups competing for medical care to be made explicit and health bureaucracies are given an insight into the potential benefits from investing in new technologies or therapies. QALYs and cost utility analysis provide additional information and is another piece in the complex decision making process of health service resource allocation (Drummond 1997). Another qualitative measure of injury cost is the Potential Years of Life Lost (PYLL). This measure places greater emphasis on the assessment of disability and permanent impairment.

Hussey (Hussey 1988) however, argues against the use of cost-utility analysis. "By this means we are, it is claimed, provided with a fair and rational means of making health care choices; we can maximise technical efficiency by producing the best possible outcome from any given input. It is also claimed that these calculations enable us to choose our priorities or goals by seeing which produces the most QALYs per pound spent."

Hussey questions whether quality of life can be measured at all, and takes issue with the Rosser index "which purports to give an index of disability and distress to three decimal places..... Questions arise not just about what should be measured and whether measurement is possible, but who should do the measuring. An estimate about post-operative quality of life made by a surgeon and that made by a patient might be wildly different."

Robine (Robine 1998) argues that the QALY is excessively complex, because it simultaneously raises issues of demography, epidemiology, health measures, economics, philosophy and psychology. To aggregate these measures, equivalence's between various health states have to be drawn up, and this is fraught with difficulty. Robine also disputes the assertion that indicators of burden of disease can simultaneously enable measurement of a population's health status, quantification of ill health, definition of priorities, assessment of the effectiveness of interventions and the allocation of resources.

Bonneux (Bonneux 1998) showed that the elimination of fatal diseases would increase health costs because of the medical expenses that would be incurred during the added life years. He argues that this demonstrates that health status and burden of disease cannot be expressed in a single figure.

Andrews (Andrews 1998) on the other hand, argued that qualitative measures of disability had greater importance in developed countries where medical advances and affluence have reduced premature mortality to very low levels. Rankings of health problems produced by DALYs differed markedly from mortality statistics, with mental disorders accounting for only 0.4% of years lost due to premature death, but represented 26% of premature disability. Andrews also noted that non-fatal conditions comprised a

much greater share of the total burden of disease in developed countries and therefore deserved higher priority in national goal setting.

Most burden of disease studies aim to provide information that will shape priorities in public policy, but Holterman (Holterman 1981) argues that these studies appear to have had little impact on UK health policy. He states that "studies of burden of disease and policy priorities can be useful in decision making, provided that they tackle problems that policy makers are aware of, but that they are having less effect on what gets put on the policy agenda".

2.11 Presentation of injury cost data

Balas (Balas 1998) critically reviewed the literature dealing with clinical interventions in reducing injuries. He reported poor methodology in most of the studies examined and noted that appropriately categorising all costs represented the first step in improving quality and comparability of cost information. His assessment was made difficult because of the diverse and conflicting interpretations of cost found in the published studies.

Barber (Barber 1998) performed a similar review of 45 papers and found that the cost of competing treatments were usually estimated using information about the quantities of resources used. The economic data was either unit cost data or from direct charges for health care. Barber argued that "For cost data, the crucial information is the arithmetic mean.....This is because policy makers, purchasers and providers need to know the total cost of implementing the treatment. This total cost is estimated as the arithmetic mean cost in the trial, multiplied by the number of patients to be treated...The fact that the distribution of costs is often highly skewed does not imply that the use of the arithmetic mean is inappropriate."

In his review sample, Barber found only 44% of papers reported one or more measures which described the spread of cost data. Standard deviations were only reported in 20% of the papers. Barber argued that all cost data should be supported by a measure of precision (standard error or confidence interval) of the difference in mean costs between groups. The t test allows for an inference to be drawn between two

different mean costs of treatment. This method however assumes normality, which may not be present in highly skewed distributions of cost data.

Any conclusion that could be extrapolated to future public policy needs to be justified in terms of the confidence interval and P value for the mean cost difference. Without any information about the precision of the mean cost difference observed, Barber argues that you cannot justify any conclusion. Because of the skewness of some data, the standard deviation alone is often not ideal. It is useful to present the inter quartile range, i.e. the range containing the central 50% of the cost data, or a 95% reference interval, which excludes the 2.5% of the cost data at each extreme.

Barber considered the use of non-parametric tests and log transformation of data to be inappropriate, because they do not allow proper comparison of the difference in mean costs. Because of these limitations, only 36% of the papers studied drew conclusions that Barber believed were justified. He commented "Reporting inappropriate conclusions for either clinical or economic outcomes is potentially misleading and unethical".

2.12 Other Methodologies

Guria (Guria 1990) found that disability is a common outcome of road accident trauma. In the worst cases the victim has no productive future, and the costs of medical care may continue indefinitely. He noted that there was no systematic way of costing disability for inclusion in economic evaluations of accident prevention measures. He noted that there were difficulties in obtaining a measure of the spectrum of disabilities and in measuring the resultant economic cost.

He noted that the social cost of disability included the opportunity costs of resources required e.g. emergency services, hospitals and other medical treatment. It also includes the individual's loss of productivity and legal costs imposed. The loss of productivity comprises temporary incapacitation and long-term disability. The costs attributable to pain and suffering and loss of quality of life were the most difficult to estimate in monetary terms.

Arthur (Arthur 1981) argued that a “willingness to pay” methodology may be appropriate in estimating these costs. Using this technique, estimates are developed to approximate the value a person places on their own life, rather than expected annual earnings. Some argue that this approach is the best way to value human life (Schelling 1968). It is claimed that the NPV of earnings calculated using the human capital approach estimate the lower range of costs as estimated by willingness-to-pay (Linneroth 1979).

The "social consumption equivalents" approach is also put forward as preferable to the human capital approach (Miller 1987). This approach includes transfer payments that are affected by changes in injury rates, especially fatalities. The value of a life saved is defined as the enjoyment value of the extra additional years and the value of additional labour input, minus the additional consumption of resources. This method is really only appropriate for fatalities.

The friction method attempts to estimate the actual production loss in a workplace. (Koopmanscap 1995). The assumption underlying this methodology is that all workers who become the victim of premature death or disability will be replaced in the economic process after a so-called ‘friction period’. This approach confines the cost of lost production to this friction period (usually put at 3 months). In most cases, this is considerably less than the loss from death or disability to time of retirement.

In the Netherlands, both the human capital and friction methods indicated that 8% of indirect health costs were due to injury. (van Beeck 1996) Using the human capital approach, traffic accidents were the greatest cause of indirect costs, while the friction method indicated that occupational accidents were the most costly. Van Beeck (van Beeck 1996) found that the human capital approach tended to over-estimate the loss of economic production as a consequence of disease or injury at a specific age until retirement. He considered that the human capital estimate was one of potential production loss, rather than the actual production loss.

The friction method explicitly takes into account the economic processes, which reduce losses compared to the Human Capital model, which tends to estimate the potential upper limit. With this method, indirect costs will be lower in countries with high unemployment and higher in those with low unemployment. While seeing merit in

other approaches Miller (Miller 1987) argued, "the only approach that has been sufficiently developed at this time for use in a cost framework is the human capital approach."

2.13 Costs of Employee Turnover

Abbott (Abbott 1997) examined the organisational costs of managerial staff exiting a large professional services organization because of family pressures. She estimated that the total direct and indirect costs associated with the separation, training and replacement of new employees approximated to A\$75,000 per employee.

Cascio (Cascio 1991) has argued that there are three key costs associated with staff turnover: separation, replacement and training costs. He argued that it was also important to measure the dollar value of the performance difference between departing employees and their replacements.

Competitive advantage in an enterprise depends upon the calibre of its employees, and it is essential for organizations to become the employer of choice in an environment where personnel are increasingly more selective in their choice of work environment. Failure to retain key staff results in a loss of competitive advantage and perhaps brings the survival of the organization into question. (Cox and Blake 1991)

Costs associated with recruiting, training and replacing employees are a major expense for most organizations. It has been estimated that the cost of turnover per person may range from between 93 and 200 percent of an exiting employees salary (Johnson 1995), depending on their skill and responsibility level. In the Australian hospitality industry, where turnover ranges from 40-60%, it has been calculated that the turnover of a supervisor would cost a 5-star hotel approximately \$13,000 (Deery 1996).

Organizations seek commitment from their employees; this commitment is revealed in their attitudes, acceptance and belief in organisational goals and a willingness to exert effort on behalf of their organization and a desire to remain a member of the organization (Porter 1974).

Separation costs include lost productivity. Senior executives surveyed by Abbot believed that productivity dropped to 50% of previous levels as outstanding performers prepare to exit the organization. Abbot noted that this was a “subjective” assessment, as limited factual data was available. It was estimated that it took a new employee between 6 and 12 months to reach a level of productivity comparable to an exiting employee. Employees new to the industry or from smaller firms appeared to take longer to assimilate as they were not familiar with the quality controls, administrative processes and systems within the business.

Abbott costed the replacement of a business manager with 7-10 years experience. She noted that this individual would have had extensive training in the organization’s way of doing business and in technical training. Although a lateral replacement may have the technical skills, understanding and acceptance of the culture can take between 3 months and 3 years. Senior executives noted that some experienced recruits never fully integrate into the culture and leave after 3-5 years, particularly if their previous employment was not in competition.

Abbott noted the requirement for considerable training of new recruits, as this would mainly be in the first year. These training costs equated to an average of 37% of total turnover costs. Replacement Costs included the cost of selecting a new candidate, entry procedures, and productivity of the new employee. Replacement costs and lost productivity accounted for 47% of turnover costs. Abbott argued for a standardised methodology for estimating turnover costs as this would allow different firms to benchmark against each other. The difficulties arise from a lack of hard data on the lost productivity associated with turnover, as data for her study was derived from subjective interviews.

Voluntary turnover is in many cases a healthy and functional part of any organizations development as new employees enter who are better suited to the organizations' needs and those in conflict move on. However Cascio (Cascio1991) noted that the loss of valued employees can directly affect bottom line profits. In some cases, employees cannot be replaced with individuals of similar skills due to a lack of applicants. To retain competitive advantage, employers are reliant on a committed and productive workforce (Pfeffer 1977).

2.16 Conclusion

This chapter has reviewed a number of methodologies currently utilised to estimate the resultant costs arising from injury or illness. Cost of illness studies assess costs based on their viewpoint. Most COI studies have adopted a societal viewpoint, but this thesis will assess costs from a governmental viewpoint. This choice was shaped by the economic realities of the government resource allocation processes. Investment decisions are usually determined by potential savings, either in the form of productivity gains or direct cost reductions.

Other Armies have conducted cost analyses looking only at days of lost production due to work absence (British Army Medical Directorate 1996). This approach excludes other significant costs such as compensation payments, direct medical costs and invalid pensions.

While QALYs and DALYs are useful and commonly used tools, there are conflicting views regarding their influence on policy makers or the budgetary process. (Robine 1998) They have little applicability within the military context because the population is generally young and quality of life concerns usually only become a significant issue once the member has transitioned to civilian life. In these circumstances, any health related outcomes become an issue for society and not the Defence organisation

The human capital model relies in investment by the individual in their own education or training, whereas the Army is that rare employer who pays for all job related training, while providing a salary. As such, a “pure” human capital approach to estimating indirect costs would not be applicable, as the individual bears no investment costs. As outlined in Chapter 5, an approach that focuses mainly on known training costs will be utilised.

As noted by Balas (Balas 1998) correctly categorising all costs represents the first step in improving the quality and comparability of cost information. Diverse and conflicting interpretations of cost make it difficult to compare between published studies.

Barber (Barber 1998) argues for more rigour in the presentation of cost data, with the use of arithmetic means, standard deviations and measures of precision (standard error or confidence interval). He strongly advocates the use of simple statistical analysis to determine any significance between two different mean costs of treatment. This approach is followed in the data presented in Chapters 6 and 7.

The following chapters will seek to categorise the available data on the costs associated with injury in general and surgically treated injuries of the spine in particular. These areas were chosen because cost data was available. As will be detailed in subsequent chapters, the depth of analysis is governed by the quality of the available data.

Chapter Three. Direct Costs of Injury for the Australian Army

3.1 Introduction

This chapter will estimate the direct cost of injury to the Army, through a review of medical and compensation costs. The limitations of the datasets utilised and suggested improvements will be discussed. In order to fully understand the direct medical payments system, a brief review of the previous Army financial management system follows.

3.2 Army Financial Arrangements.

Army funding is derived from the Defence Vote or appropriation within the Federal government budget. Within the Department of Defence there were 13 programs; Army, Navy, Air Force, Defence Estate, Personnel Executive, Training and Education, Corporate Services, Acquisition and Logistics, Budget and Management, Strategy and Intelligence and Science and Technology.

Direct funding allocations were made to each program, which was responsible for its own financial management. Funds were accounted for using a cash based expenditure system, but accrual accounting is progressively being introduced. In 1996, Health funding was provided directly to the Army. Following the Defence Reform Program in 1997, health funding for all three Services was centralized to the Defence Personnel Executive.

Free medical and dental care is a condition of service for all members of the Australian Defence Force (ADF), and funds were allocated to the Defence Health Services to pay for the provision of medical services to Defence personnel. These funds were allocated to what is termed Account Group 39 (AG39) - Medical and Dental Services. Funds from AG39 were used to pay for all medical treatment costs that resulted from injury or illness in serving members.

Health regions were created in different states and each region was allocated a set amount of funding for the purchase of health services and paid providers directly on the presentation of invoices. In this way, the regional health agencies acted as fund holders and made decisions regarding the appropriate expenditure of funds and sought value-for-money services.

Some other direct costs were incurred internally; for example, pharmaceuticals, wages for uniformed staff and facilities (hospital and medical centre running costs). These costs were met through different appropriations in the Defence budget, and were managed through the allocation of funds to a central management organisation. Salaries for uniformed members were fixed costs that were met irrespective of the workload or clinical demand. They were not considered in this analysis because it was not possible to attribute a proportion of this cost to injury, as the employment of uniformed members of the Defence Force in effect constitutes an insurance policy, for use in time of war or natural disaster.

There has also been a deliberate strategy of replacing uniformed personnel involved in direct patient care, as it was considered that uniformed manpower was a more expensive option than civilianisation of the health workforce. Policy guidance on expenditure was provided via the medium of Health Policy Directives issued from the Office of the Surgeon General Australian Defence Force.

3.3 External Medical Costs - Account Group 39 (AG 39)

Where services are not provided internally, Army (Defence) must purchase them in the marketplace. These services included fee-for -service specialist providers (surgeons, physicians, and optometrists), sessional services and contract services (General Practitioners, nurses and physiotherapists working full-time in Service facilities). Public and private hospital services were also used.

Each medical facility was given a budget to manage over a 12-month period. These funds were used to pay invoices received from service providers under normal terms of trade i.e. bills paid within 30 days of receipt. All invoices were subjected to a

verification and proving system which was in accordance with the Audit Act in order to minimise the possibility of fraud and double billing.

ACCOUNT CODE NUMBERS AND CATEGORY DESCRIPTIONS		
20800 MED FEES -GP	20831 FEE SERV MED - ANEST	20862 FEE PROF-PODIATRIST
20801 MED SESS FEES-SPECST	20832 FEE MED-GEN SURGEON	20863 FEE PROF-PSYCHOLOGST
20802 MED SESS FEES - OTH	20833 FEE MED-OPHTHALMGST	20867 PUBLIC HOSP-MEDICAL
20803 DENT FEES-GP	20834 FEE SERV MED - ORTHO	20868 PUBLIC HOSPTL-DENTAL
20804 DENT FEES-ORAL SURG	20835 FEE MED-PSYCHIATRIST	20869 PRIVATE HOSP-MEDICAL
20805 DENT FEES-OTH SPECST	20836 FEE SERV MED - GENER	20870 PRIVATE HOSP-DENTAL
20806 DENT FEES-DENT ASSNT	20837 FEE SERV MED-RADIOGT	20871 SPECS/CONTACT LENSES
20807 DENT SESS FEES - OTH	20838 FEE SERV MED - AMO	20872 OPTICAL MISCLLANEOUS
20808 REGISTD NURSE FEES	20839 FEE SERV MED-PATHLGT	20873 RADIOLOGY
20809 ENROLLED NURSE FEES	20840 FEE MED-PLASTIC SURG	20874 DENTAL RADIOLOGY
20810 PHYSIOTHERAPIST FEES	20841 FEE MED-OTH SPEC SRG	20875 PATHOLOGY
20811 RADIOGRPHR SESS FEES	20842 FEE MED-OTH SPECLST	20876 ROAD AMBULANCE
20812 SCIENTFC OFFCER FEES	20843 FEE SERV MED-OBS/GYN	20877 OTHER HEALTH ITEMS
20813 OTH HEALTH PROF FEES	20844 FEE MED-NUERO SURG	20878 AIR AMBULANCE
20814 PHARMACIST SESS FEES	20845 FEE MEDICAL-ENT SURG	20879 PHARMACEUTICAL
20815 GP-CONTRACT	20846 FEE SERV DENT - GP	20880 HEARING
20816 MED CONTRACT-SPECLST	20847 FEE DENT-ORAL SURGN	20881 RNDM URINALYSIS PROG
20817 OTH MEDICAL-CONTRACT	20848 FEE DENT-ORTHODONTST	20882 OH&S - SIGHT SCREENG
20818 DENT-GP-CONTRACT	20849 FEE DENT-PERIODONTST	20883 OH&S - OTHER SCREENG
20819 DENT SPECLST-CONTRCT	20850 FEE DENT-PROSTHODNT	20884 OH&S - OTHER
20820 DENT ASSTNT-CONTRACT	20851 FEE DENT-ENDODONTIST	20885 CIVLN-FEE PYMTS GP
20821 DENT HYGNT-CONTRACT	20852 FEE DENT-LAB FEES	20886 CIV-FEE SRV PAY SPEC
20822 DENT TECHN CN-CONTRCT	20853 FEE SERV DENT - OTH	20887 CIVILIAN - OCCUP HLT
20823 REGTD NURSE-CONTRACT	20854 FEE DENT -RADIOLGST	20888 CIVILIAN - OPTICAL
20824 ENROLLED NURSE-CONT	20855 FEES SERV - RN	20889 CIVILN-PHARMACEUTICL
20825 PHYSIOTHPST-CONTRACT	20856 FEE PROF-PHYSIOTHPST	20890 CIVILIAN - HEARING
20826 RADIOGRAPHER-CONTRCT	20857 FEE PROF-PHARMACIST	20891 CVLN-OTH HEALTH SERV
20827 SCIENTFIC OFF-CNTRCT	20858 FEE PROF-RADIOGRAPHR	20893 CIV-CMO-PERM APPOINT
20828 PHARMACIST-CONTRACT	20859 FEE -SCIENTFIC OFFCR	20894 CIVLN-REHAB PROVIDRS
20829 OTH HLTH PROF-CONTRT	20860 FEE PROF-OPTOMETRIST	
20830 FEE SERV MED - GP	20861 FEE SERV PROF - OTH	
20800 MED FEES -GP	20831 FEE SERV MED - ANEST	20862 FEE PROF-PODIATRIST
20801 MED SESS FEES-SPECST	20832 FEE MED-GEN SURGEON	20863 FEE PROF-PSYCHOLOGST

Table 3.1 DEFMS Account Code numbers and category descriptions.

All accounts were entered onto the Defence Financial Management Information System (DEFMIS). This was a computer system developed by the Department of

Defence to record all financial transactions. Financial transactions were recorded using account and cost centre codes. Data for this chapter was obtained from the DEFMIS database. The DEFMIS database recorded total annual expenditure against specific account codes. Cost centre codes were used to identify different medical centres. The account codes reflected categories of Service provider e.g. general practitioner, general surgeon, and type of payment either contract, sessional or fee-for-service. A spreadsheet detailing the expenditure against each account code was obtained from the finance cell of Defence Health Service Branch and used to determine direct medical expenditure. Table 3.1 shows the account codes and the category description.

Figure 3.1 shows that between 1992/93 and 1995/96 external medical costs for the ADF rose from \$16.28M to \$26.89M. This represents increases of 33%, 13.8% and 8.5% respectively in the years after 1992/93. These cost increases were well above the prevailing rates of inflation for the corresponding periods which were 2.4%, 3.1% and 3.2% respectively (Australian Bureau of Statistics 2006).

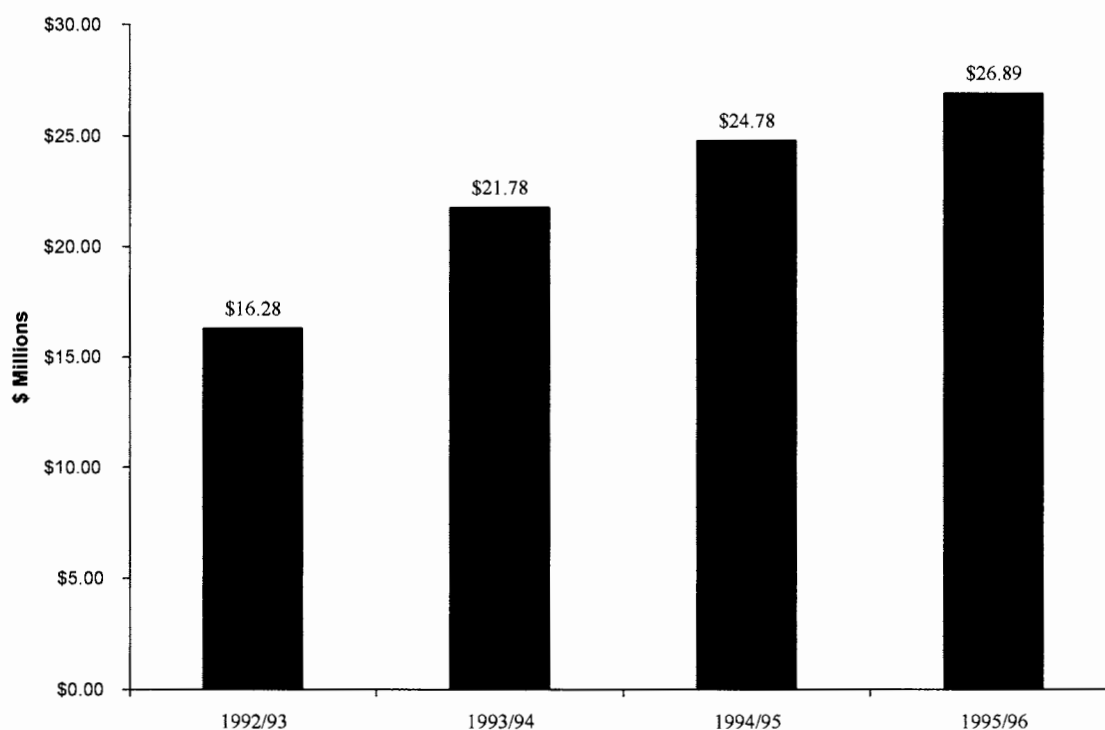


Figure 3.1 Direct Medical Costs (AG 39) for the ADF 1992/93-1995/96

Account codes only allowed for crude grouping of expenditure into broad categories. Whilst the total payment to individual providers was available, it was not possible to break these figures down into episodes of care.

The author was commanding officer of the Canberra Area Medical unit for the period 1997-1999. Because costs on DEFMIS could not be apportioned between injury and illness, a dedicated database system was developed in 1997. This system involved the creation of referral numbers for every referral to an external service provider, which allowed individual episodes of care to be costed. The referral number was used as payment authorisation for any bill related to the same episode of injury or illness.

An electronic invoice system was created using a lotus approach database. Each referral number screen had a field for whether the referral was for an injury or illness. The clerical staff, based on the doctor's referral and questioning the patient, determined if the referral was for injury or illness. This determination of injury or illness was then added to the financial system when the invoice was paid. For example, where a patient was referred to an orthopaedic surgeon, all subsequent activity such as radiology, pathology, anaesthetic, hospitalisation and ancillary costs were recorded against the one referral number. This system was not utilised at any other military health facility, so the data is unique within Defence.

There was potential for ascertainment bias as the assignment to either injury or illness category reflected the assessment of the payments clerk. This assessment however, was informed by the original referral and feedback from the patient, reducing the possibility of bias.

Using the referral number database, a 2-year sample of hospital and outpatient costs was obtained from the Canberra Area Medical Unit. To develop an Army estimate it would have been preferable to have had a total Army breakdown of injury and illness cost. Because this data did not and still does not exist in 2008, this thesis will rely on an estimate obtained by extrapolation from the Canberra dataset.

Canberra is not representative of the rest of the Defence Force, as it has a greater percentage of senior and therefore older ADF members. This reflects the large number

of senior positions located within the Headquarter elements in Canberra. Twenty percent of the total Army is over the age of 35, while in the Canberra region 50% of the Army is over 35. The sample in this dataset comprised Army, Navy and Air Force personnel.

This older group has a greater preponderance of medical as opposed to traumatic surgical problems. The percentage of injury episodes is likely to be higher in the younger and generally more active ADF populations in other parts of Australia, because they are engaging in physical training on a daily basis. With the exception of the Royal Military College Duntroon and the Defence Academy, Army members do not have organised daily physical training in Canberra. Nor do they engage in strenuous or demanding activities related to combat training. Consequently, the contribution of injury in this population is likely to be an underestimate, and therefore conservative.

Table 3.2 displays fee-for-service costs only, as it was not considered possible to apportion contract hours or sessional periods. Injury episodes accounted for between 16-18% of total external care episodes, but between 26 and 28% of total cost. The average cost of a payment for an injury-related episode was over 80% greater than that for illness.

	No	Cost	% No	%Cost	Cost/episode
<u>1997-98</u>					
INJURY	1344	\$1,159,528	15.8%	26.1%	\$862.74
ILLNESS	7136	\$3,287,065	84.2%	73.9%	\$460.63
TOTAL	8480	\$4,446,593			\$524.36
<u>1998-99</u>					
INJURY	1289	\$1,114,590	18.4%	27.8%	\$864.69
ILLNESS	5710	\$2,888,218	81.6%	72.2%	\$505.82
TOTAL	6999	\$4,002,808			\$571.91

Table 3.2 Recorded external costs (AG 39-fee for service) by injury and illness for the years 1997/98 and 1998/99, Canberra Area Medical Unit.

Younger soldiers generally do not require treatment for medical conditions such as hypertension, kidney stones or gastro-intestinal dysfunction. These conditions predominate in the older group and the ratio of injury to illness episodes is likely to be greater than 27: 73. Therefore using the mean of 27% can be considered to be a very conservative figure when applied to the younger and more physically active group of soldiers outside of Canberra.

That this proportion is likely to be an underestimate is supported by the experience of the US and British Armies as detailed in Chapter 1. Jones (Jones 1988) found that injury and illness presentations in US Army recruits were almost equal in number, with illness predominating (illness to injury ratio of 54:46). But when morbidity outcomes were compared, injury caused a 5 times greater loss of time from work than illness in males and a 21 times greater loss of work time in females.

British Army population data based on medical attendances for the period January-July 1996 showed a ratio of illness to injury presentations of 61:39. The rate of illness presentations was 100/1000/ month compared to 65.1/1000/month for injury. When training units were examined, initial illness rates were 249/1000/month and initial injury rates were 196/1000/month, with an illness to injury presentation ratio of 56:44 (British Army Medical Directorate 1996). The picture is somewhat different for review consultations where the injury rate was 98/1000/month compared to the illness rate of 8.9/1000/month, providing an illness to injury ratio of 92:8. Injuries caused 2.7 times more lost work days than illness in the whole British Army (219/1000 soldiers/month versus 81.9/1000/ month). Injury accounted for 73% of all days lost from the workplace.

Unfortunately, Defence collected Occupational Health and Safety (OHS) data are not helpful in developing an estimate of the relative contribution of injury to overall morbidity and cost. The OHS data are heavily skewed towards injury, as soldiers tend to raise a claim as evidence of a work related injury and illness is rarely claimed as there is a need to demonstrate an occupational link. As a measure of injury or illness incidence, the data is not accurate or reliable.

The British Army figures were population based, and derived from their organisational health surveillance tool termed "J95". This tool recorded attendances as

either initial or review, due to injury, illness or other reasons and recorded the days of restricted duty or sick leave granted. This was a simple tool that recorded attendances under an ICD-9 chapter category, without any specific diagnostic coding. This allowed for simple categorisation at the clinic level by medical assistants. The British and US data did not include direct costs; they simply recorded the incidence of presentations and measured morbidity through days lost from the workplace.

Limited data on the ratio of injury to illness is available from Australian Epitrack data. Epitrack is a health surveillance system modelled on the British "J95" programme which is now called EPINATO and is used by all NATO forces for measuring medical workloads at primary care facilities. Epitrack was not adopted uniformly across all Defence medical centres in Australia, but has been used on operations overseas.

Data was collected in 1998 at the Canberra Area medical centre using the Epitrack system. Unfortunately this was for a very small period of time, but provides an indication of the incidence of injury and illness presentations in first year officer cadets at the Australian Defence Force Academy (ADFA).

(n=391)	Jan	Feb	Mar	Apr	Mean
Illness	39	124	201	131	
Rate per 100	10.0	31.7	51.4	33.5	31.6
Injury	48	66	123	61	
Rate per 100	12.3	16.9	31.5	15.6	19.1

Table 3.3 Number and rate of injury and illness presentations in first year ADFA cadets for the period Jan-April 1998.

Table 3.3 shows that for a young and active population of Officer cadets, the illness to injury presentation ratio was 62:38, similar to the ratio observed in the larger British population sample.

The contribution of injury to health costs in the broader Army is likely to be greater than that observed in the Canberra sample, but the 27% figure can be taken as a reliable lower bound. Based on the US and British data, the contribution of injury is likely to be of the order of 40% of total health costs and this figure will be used as an upper bound for the estimation of direct costs. In the absence of any other reliable data, the true proportional contribution of injury cannot be ascertained with any certainty.

In a review of the cost of injury (Mathers 1999, more detail in section 3.5), injury and poisoning and musculoskeletal conditions accounted for 18% of recurrent health expenditures in the Australian population during 1993/94. This review provided a comprehensive breakdown of injury costs by age groups within the Australian Community. This is summarised in table 3.4.

Age group	Injury Costs (\$M).	% by age group	MSK Costs (\$M).	% by age group	Injury+ MSK Costs (\$M).	% by age group
0-14	362.7	13.9%	91.8	3.1%	454.5	8.1%
15-24	450.6	17.3%	178.1	5.9%	628.7	11.2%
25-34	362.5	13.9%	305.8	10.2%	668.3	11.9%
35-44	281.4	10.8%	372.0	12.4%	653.4	11.7%
45-54	225.1	8.7%	385.3	12.8%	610.4	10.9%
55+	919.2	35.3%	1668.9	55.6%	2588.1	46.2%
Total	2601.3		3001.8		5603.1	

Table 3.4 Absolute and relative distribution of injury and Musculoskeletal (MSK) direct costs, by age in the Australian Population 1993-94. (From Mathers1999)

This data shows that the majority of injury and musculoskeletal costs were generated by those 55 years and older, with 35% of injury costs and 56% of musculoskeletal costs generated in that age group. The 15-24 year group had the second highest injury cost, while the 45-55 year group had the second highest musculoskeletal costs. Mathers argued that many of these musculoskeletal conditions were the late consequences of injury and should be considered as part of the injury spectrum.

There is no Australian Army data that examines medical costs by age group as was done by Mathers. There is age related data on medical invalidity discharge and this is discussed in more detail in Chapter 4 (Tables 4.12 and 4.13). From this data it is

Table 3.5 compares the age distribution of Australian population costs with the age distribution of medical invalidity within Army. The majority of injury related costs occur in the population older than 55, reflecting the high injury morbidity and cost of falls in the elderly. For the Army population, injury and musculoskeletal invalidity peaked in the 25-34 age group, where half of all invalidity occurred, but the relationship between invalidity rates and health costs is not clear. The compulsory retiring age for the Army was 55, with the majority of members retiring well before that age and seeking second careers. Not surprisingly, there were very few invalid retirements in the older age groups.

Age group	Injury and MSK Costs. (\$M)	% by age group in Australian Population	% invalidity for Injury and MSK reasons, by age group, Australian Army
0-14	454.5	8.1%	0%
15-24	628.7	11.2%	25.8%
25-34	668.3	11.9%	50.0%
35-44	653.4	11.7%	19.7%
45-54	610.4	10.9%	4.5%
55+	2588.1	46.2%	0%

Table 3.5 Age related costs of injury in the Australian Population compared to age related invalid discharge rates in the Australian Army 1996/97. (From Mathers 1999)

A breakdown of direct medical costs by nature of expenditure is detailed in figures 3.2 and 3.3. This data was derived from the DEFMIS database with fee for service data combined with other categories to produce aggregated groupings. Figure 3.2 shows the total dollar cost to the ADF for external medical costs broken down by provider group. It can be seen that specialists and GP costs are the two major drivers of external expenditure followed closely by private hospital costs. The GP costs represent full-time contract medical officers who provided services in Army facilities. Figure 3.3 shows that Specialists and Private Hospital costs accounted for 45% of all external ADF medical expenditure in 1995/96.

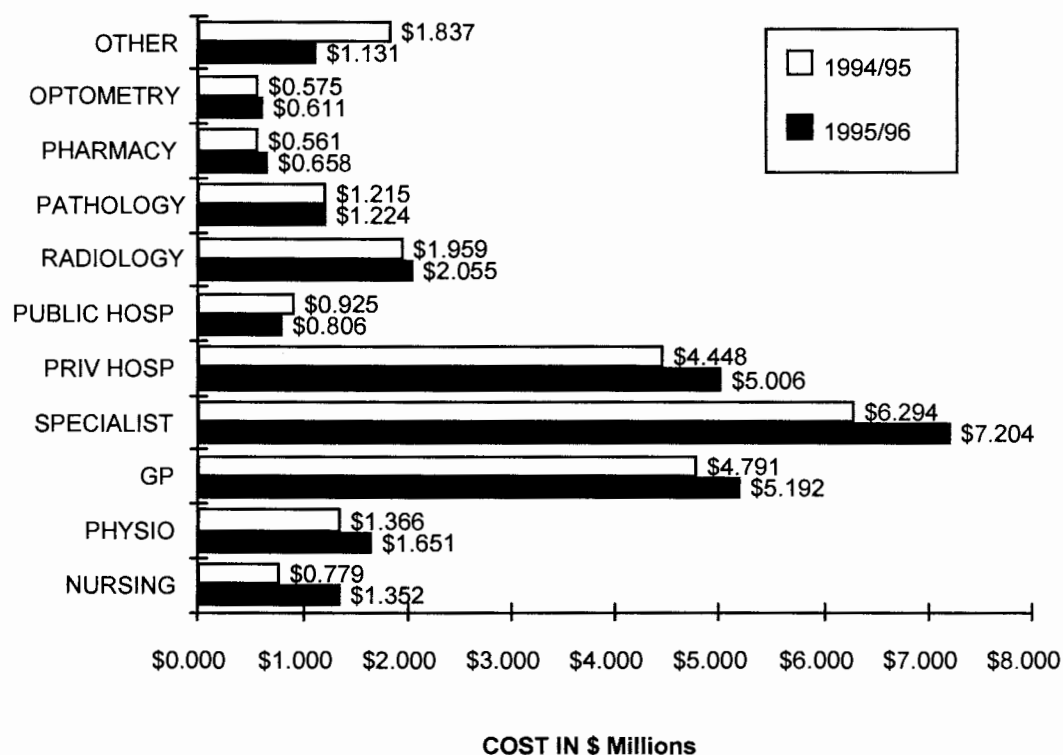


Figure 3.2. The distribution of external medical costs for ADF, 1994/5 to 1995/6.
(Includes contract salaries and sessional payments)

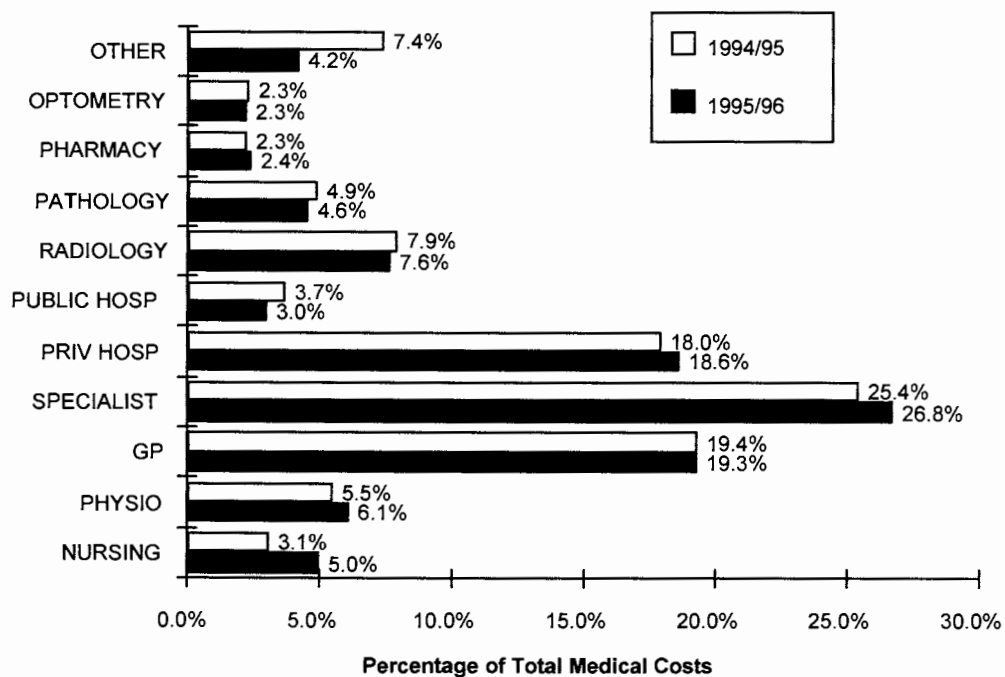


Figure 3.3 The percentage contribution of various services to total ADF medical costs.

Using the 27% injury contribution figure with the total values shown in Figure 3.1, Table 3.6 shows the estimated direct costs attributable to injury in the ADF. Given that the 27% figure is highly likely to be an underestimate, a 40% figure, consistent with incidence figures noted in other Armies, is also included to provide an upper estimate. Army represents approximately 50% of the ADF population, and therefore a proportional estimation is made. It is likely that Army would be responsible for a disproportionately higher percentage of the total injury cost.

	AG 39 Cost	Estimated Injury Cost at 27%	Estimated Injury Cost at 40%	Estimated Army Cost at 27%	Estimated Army Cost at 40%
1992/93	\$16.28M	\$4.40M	\$6.51M	\$2.20M	\$3.26M
1993/94	\$21.78M	\$5.88M	\$8.71M	\$2.94M	\$4.36M
1994/95	\$24.78M	\$6.69M	\$9.91M	\$3.35M	\$4.96M

Table 3.6 Estimated direct cost of Injury for the Army 1992/93-1995/96 (\$Millions).

Year	Cost difference between two estimates. \$M	Cost Difference as a percentage of total cost	Cost Difference as a percentage of initial 27% cost estimate
1992/93	\$1.06M	6.5%	48.2%
1993/94	\$1.42M	6.5%	48.2%
1994/95	\$1.61M	6.5%	48.1%

Table 3.7 The absolute and relative increase in Army costs arising from a 40% injury contribution estimate compared to a 27% injury estimate.

Tables 3.6 and 3.7 show that an injury contribution estimate of 40% leads to an absolute increase in Army injury direct costs of between \$1 million and \$1.6M between 1992/93 and 1994/95. In relative terms the upper bound produces a nearly 50% increase in the direct injury cost estimate.

3.4 Injury Surveillance and cost data deficiencies

An understanding of where, when and how injuries occur and who they occur to is critical for the development of interventions designed to prevent and control injuries (Cusimano 2007). The establishment of injury surveillance systems is widely considered a pre-requisite for injury prevention activities at a local level (Stone 1998). The WHO, in defining injury surveillance systems, state that “the final link of the

surveillance chain is in the application of these data to prevention and control” (Holder 2001). Lund argues that “the most important aim of an injury surveillance system is to provide information useful in the prevention of injuries” (Lund 2004). However, many reported studies refer to surveillance as simply a data collection activity, rather than the first step towards the prevention of future injury (Holder 2001, Peden 2002). This is a crucial deficiency in the surveillance process for “information has value only if it is used for decision-making” (Frerichs 1991).

In order for information to be used for decision making purposes it must be available in the first place. The major finding from the proceeding section was the paucity and poor quality of both health surveillance and cost data within the Australian Army at an organisational level. This is due primarily to the lack of an effective electronic health record within the Defence Health Services.

Attempts has been made to introduce a Defence electronic health record (called HEALTH Keys) since 1996, but the proprietary software chosen has met with a number of technical and customer difficulties. Its lack of user friendliness and complexity has meant that there has been strong resistance from the user community. This is especially marked in civilian medical practitioners, who have unfavourably compared it with the commercially available software packages currently in use within the Australian general practice environment. The software is cumbersome and can require up to 20 minutes to complete a simple primary care consultation; an unacceptable outcome when steady patient throughput is required.

A recent review of injury surveillance in the ADF highlighted a number of deficiencies in injury data collection within the ADF. McKinnon (McKinnon 2008) described three key characteristics of an effective injury surveillance system: the ongoing, systematic collection of data, the analysis and interpretation of that data and the dissemination of information for prevention purposes.

McKinnon noted that there was a scarcity of critical research directed at optimising the performance of injury surveillance systems and their utility for injury prevention purposes. The available research has focused on the technical design, construction or subsequent evaluation of these systems. McKinnon identified two areas that impacted negatively on the performance of injury surveillance systems: (1) the

impact of human interaction with such systems i.e. the willingness of staff to use the system (Ashby 2003, Marson 2005); and (2) a lack of knowledge regarding optimal injury surveillance methods (Driscoll 2004, C. Finch, 2006).

McKinnon (McKinnon 2008) argues that Injury surveillance systems provide the foundation for priority setting by identifying problem areas. He also noted that there are currently few formal tools for establishing injury priority in society or the ADF. Any criteria adopted to prioritise injury issues identified by surveillance data should ultimately reflect the ADF context – the internal policies, ADF goals and objectives, the tolerability of the risk and the interests of stakeholders (Standards Australia/Standards New Zealand, 2004a).

McKinnon (McKinnon 2008) recommended that the ADF adopt a two-stage injury surveillance process. This process was initially described by Lund (Lund 2004) and is characterised by two formal stages of data collection. The first step involves the collection of a minimal data set, as defined by the WHO (Holder 2001), on all injuries within a given context (i.e. an ADF establishment). The second step involves selected expansion of data collection on injuries of interest (e.g. ankle injuries), injured individuals (e.g. all recruits in week 3 of training) or places of particular interest (e.g. an obstacle course). This secondary form of data collection is aimed at identifying factors associated with particular injuries and aiding the development of prevention efforts (Lund 2004). Data collected by routine injury surveillance is unlikely to be able to describe all injury scenarios in sufficient detail to implement preventive initiatives. Moreover, surveillance systems are unlikely to be able to anticipate all of the possible correlates of injury (e.g. injury sites, events, causes / mechanisms, conditions and other contributing factors).

McKinnon argues that the two stage approach is likely to capture the vast majority of injuries, even those unaccounted for at system inception, through a comprehensive secondary exploration of injury type, location and cause. (McKinnon 2007). A large and comprehensive data collection process would likely produce a similar outcome as the two stage approach, but this would probably result in low data quality due to health staff being resistant to the effort required for expanded data collection (Marson 2005). It is also possible that much of the data would not be used,

representing a poor return on investment, while secondary data collection provides a more efficient use of resources directed at injury surveillance.

By prioritising injury concerns based on a minimal data set, users of the surveillance data are not overwhelmed by information. Subsequent effort can then be directed at obtaining more data where the need is determined. The Defence Injury Prevention Program adopted a two-stage approach to surveillance data collection, but McKinnon argues that the second stage is considered part of the injury prevention process rather than an integral part of the injury surveillance process. He observes that “The importance of secondary data collection to inform prevention has been highlighted, but it has been viewed as an adjunct to injury surveillance in both OH&S risk management approaches of the ADF and within the Defence Injury Prevention Program – not as part of the surveillance process. Injury surveillance is the foundation of injury prevention. Once adopted by the ADF, the two stage framework will likely produce a higher quality information outcome through the systematic application of second stage collection measures and thereby optimise the reduction of preventable injuries” (McKinnon 2008).

Attempts to improve injury surveillance in the ADF are underway, with the proposed incorporation of injury surveillance data into the Defence Occupational Health and Safety (OHS) reporting system. The current ADF injury/incident report (form AC563) contains a minimalist data set required for legislative compliance, but no data about contributing or potentially causative factors. These areas are well covered in the Defence Injury Prevention Programme (DIPP) surveillance form. Both forms are currently paper based only and require significant administrative effort to convert into an electronic form for analysis.

A new form AC 563-2 has been developed by the Directorate of Occupational Health and Safety –Army which incorporates the DIPP injury surveillance minimum data set into the routine reporting of injury. The new form is electronic and can be sent via email and directly incorporated into a database. The report form was previously initiated by the individual, but the new form will be initiated at medical treatment centres. Once adopted the quality of injury surveillance data will improve markedly. To accurately capture costs will require a unique episode identifier to be appended to

medical bills. The referral number serves this purpose well and should be adopted across the Defence Health Services.

3.5 Australian Health Costs

Mathers and Perm (Mathers 1999) performed a cost analysis on the health system costs of injury, poisoning and musculoskeletal diseases (MSD) in Australia during the period 1993-94. The direct health system costs of injury and poisoning amounted to \$2,601 million in 1993-94, or 8.3% of total recurrent health expenditure. Musculoskeletal disorders (MSD) accounted for \$3,002 million or 9.6% of total expenditures in 1993/94.

Musculoskeletal disorders were not a major cause of death, but were responsible for significant morbidity and disability. Chronic MSD were reported by 29% of Australians aged 15 years and over and in 56% of Australians aged 60 years and over. Costs were even across age and gender bands with two exceptions; males aged 15-34 where system costs were 2-3 times higher and women over 75 years where falls were a major source of costs.

Cardiovascular and digestive diseases were the two most expensive groups, with digestive diseases boosted by the high cost of dental services. Musculoskeletal Disorders and Injury/poisoning were the third and fourth most expensive conditions, accounting for 18% of total health expenditure. Injury also accounted for 22.5% of all potential years of life lost (PYLL) before age 75.

Mathers noted that "Injury is a major factor in the aetiology of certain musculoskeletal conditions, particularly joint disruptions and osteoarthritis and perhaps back problems (although this connection may be more complex), and to some extent, some of the costs attributable to musculoskeletal conditions are late effects of injury. In addition, there is a somewhat arbitrary boundary between acute musculoskeletal damage (injury) and chronic musculoskeletal damage resulting from long term microtrauma or old injury. Costs associated with the latter are generally classified to musculoskeletal disorders. It is not possible to quantify the proportion of musculoskeletal disorder costs that are attributable to injury as an underlying cause".

One indication of the importance of prior injury comes from the 1993 ABS Survey of Disability, Aging and Carers (Australian Bureau of Statistics 1993a). Injury was stated to be the underlying cause by 27% of those who were disabled with a musculoskeletal condition. This is much higher than the proportion for all disabling conditions (17%).

In his study Mathers elected not to measure indirect costs because in his view, "methodologies for measuring indirect costs are either contentious and/or at an early stage of development". Mathers noted two issues that needed to be considered when reviewing this direct cost data;

- (1) expenditure per se, does not indicate the loss of health involved or the priority for intervention, and
- (2) while the data provides a broad picture of the health system, it needs to be interpreted with caution in specific disorders. Analysis of actual costs incurred will yield more accurate results.

Table 3.8 shows that back disorders were the most expensive musculoskeletal condition followed closely by osteoarthritis. In terms of external causes, accidental falls were the most expensive at \$806M (31%) followed by adverse effects of medical treatment with \$401M (15.4%) and road traffic accidents \$370M (14%).

Cause	Cost
Back problems	\$700M (23%)
Osteoarthritis	\$601M (21%)
Muscle, tendon, soft tissue problems	\$519M (17%)
Joint derangement and disorders	\$430M (14%)
Neck problems	\$160M (5%)

Table 3.8 The 5 leading causes of Musculoskeletal Disorder (MSD) cost in the Australian population 1993/94.

Age Group	Males	Females	Persons
<u>Total Musculoskeletal</u>			
15-24	\$101.4M (8.0%)	\$76.7M (4.4%)	\$178.1M
25-34	\$171.0M (13.6%)	\$134.8M (7.7%)	\$305.8M
35-44	\$179.0M (14.2%)	\$193.0M (11.1%)	\$372.0M
<u>Back Disorder</u>			
15-24	\$12.2M (3.8%)	\$17.6M (4.7%)	\$29.8M
25-34	\$56.6M (17.5%)	\$40.7M (10.8%)	\$97.3M
35-44	\$61.7M (19.1%)	\$54.7M (14.5%)	\$116.4M

Table 3.9 The cost distribution by the age group of total musculoskeletal disease and back disorders.

Table 3.9 shows that males aged 15-44, accounted for 36.8% of total musculoskeletal costs, compared to 23.2% in females of the same broad age group. For back disorder, males aged 15-44 accounted for 40.4% of total costs compared to 30% in females.

3.6 Defence Compensation Schemes

The Australian Defence Force (ADF) is self insured for Workers Compensation purposes, and therefore funds its outlays directly from its appropriation. All other Commonwealth Departments and civilian members of the Department of Defence are covered by COMCARE, to whom they pay a premium based upon their claims experience. This premium is linked to the departmental claims record and was \$11 million for Defence civilians in 1994/95.

ADF compensation outlays have been considered "below the line" costs. While the ADF has routinely bid for funds to settle compensation issues it has consistently under-estimated the true cost. Compensation costs were funded by the Department of Finance on a "no win-no loss" basis. This meant that compensation funding was guaranteed by the department of Finance. If the ADF had overbid for compensation costs then excess funds would have been returned. In the case of an underbid, the ADF provided details of any outstanding liability and the Department of Finance reimbursed the total cost at no loss.

Members of the ADF are covered by the Safety, Rehabilitation and Compensation Act 1988 (SCRA) and the Veteran's Entitlement Act (VEA), both as amended by the Military Compensation Act 1994. (A new Military Rehabilitation and Compensation act was enacted on 1 July 2004). Dual coverage was available for many members of the ADF with coverage provided internally by the Military Compensation Scheme (MCS) and externally by the Department of Veterans Affairs (DVA). The dual entitlements are complex, but those who enlisted after 7 April 1994, and who have not had peacekeeping or operational service have no external coverage under the VEA.

3.7 Defence Compensation Processes

The Department of Defence administered the SRCA on behalf of the single Service Offices. When injured, members completed a "Claim for Compensation and Rehabilitation Form AB 168" and this was submitted to the Defence Compensation section. A report of injury should also have been made through administrative channels. Claims were assessed to determine if the condition arose as a result of ADF service or was materially contributed to by ADF service. Once liability had been accepted a number of benefits were potentially available. Where an employee suffered an injury resulting in incapacity of 28 days or more or a permanent impairment, the Department of Defence was required to provide and manage a rehabilitation programme to achieve the greatest achievable recovery and earliest possible return to work. The responsibility for rehabilitation rests with the respective Service.

3.8 Military Compensation Costs

Figure 3.4 shows the number of compensation claims made by each Service during the period 1992/93 to 1995/96. It clearly shows that Army members made a significantly greater number of claims compared to their Navy and Air Force counterparts, even after allowing that the Army is twice the size of the other two organisations. Figure 3.5 shows that ADF compensation costs rose sharply in the mid 1990's, doubling in the 4 years between 1992/93 and 1995/96.

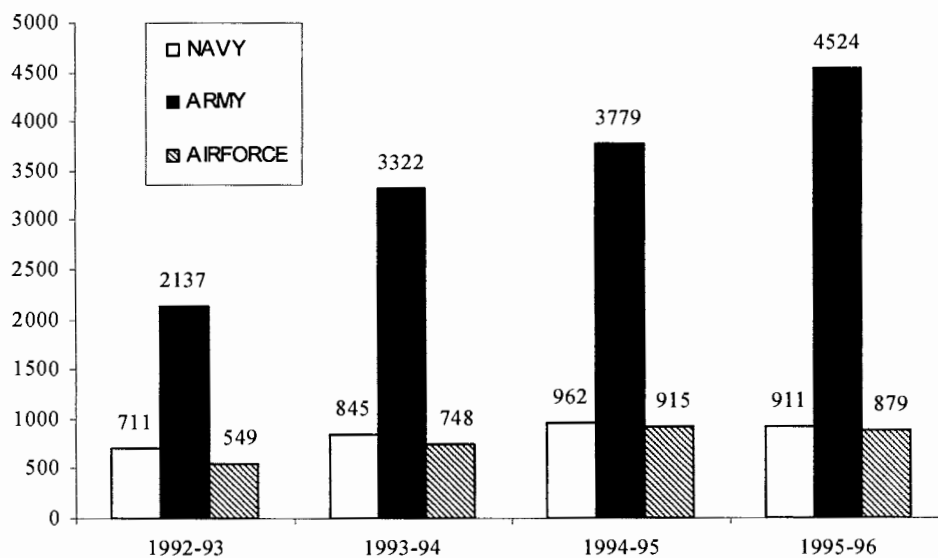


Figure 3.4 The number of claims made by the three Services, 1992/93 to 1995/96.

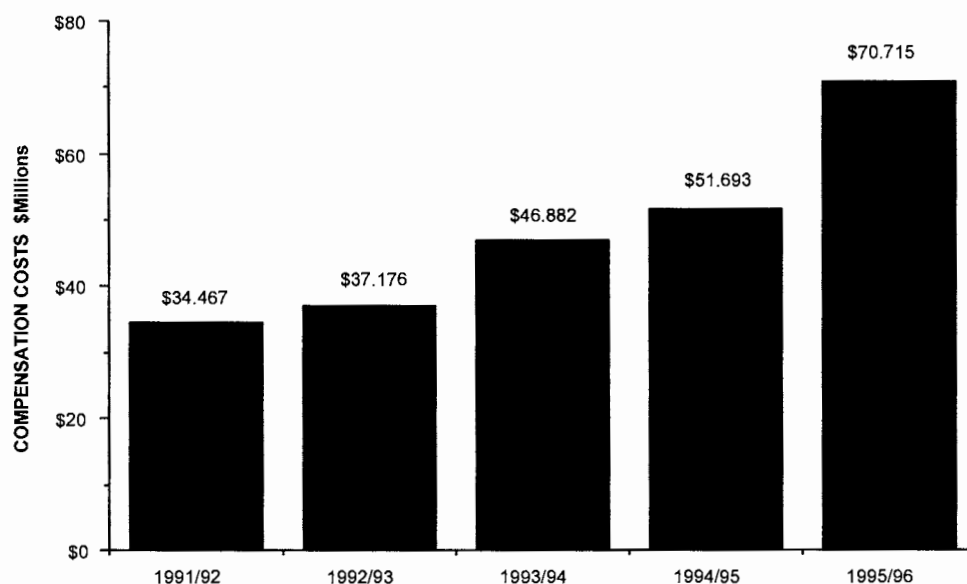


Figure 3.5 Total compensation costs for the Australian Defence Force, 1991/92 to 1995/96.

Figures 3.6 and 3.7 show that Army was responsible for the majority of the ADF compensation costs, increasing steadily from 66% of total compensation costs in 1991/92 to 73.5% in 1995/6. These compensation costs were primarily borne by government as the ADF was reimbursed its compensation costs by Treasury.

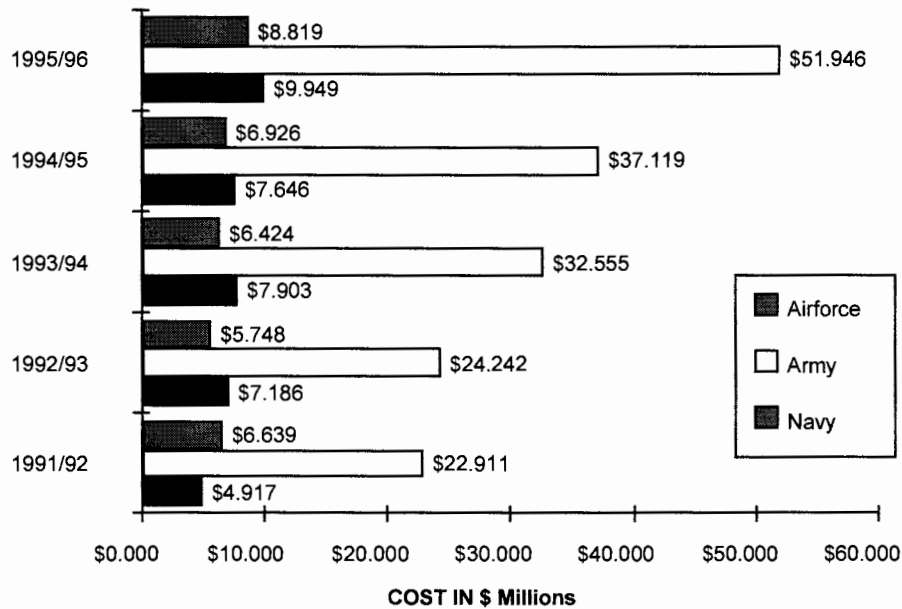


Figure 3.6. The relative compensation outlays for the three Services, 1991/2 to 1995/6

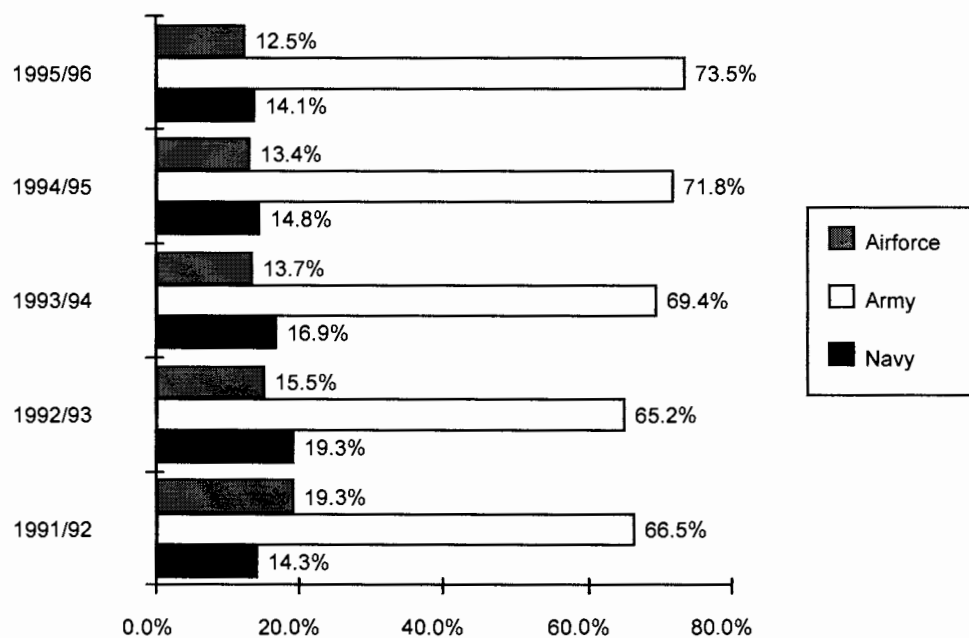


Figure 3.7. The relative compensation cost contribution of each of the three Services.

Figure 3.8 shows that Army was responsible for a disproportionate percentage of compensation costs being only 45% of the total strength of the ADF but accounting for 71% of total compensation costs. The relative strength figures for the three services shown in Figure 3.8 were drawn from the Defence Annual Report 1994/95 (Department of Defence 1995). As at 30 Jun 1995, there were 26,199 members of the Army, 17, 466

members of the Air Force and 14,555 members of the Navy. Strength figures fluctuate through any given part of the year and are traditionally reported as at the end of the financial year. Figure 3.9 shows that the average cost of compensation claims did not differ greatly between the three Services, with Army again having the highest average cost per claim.

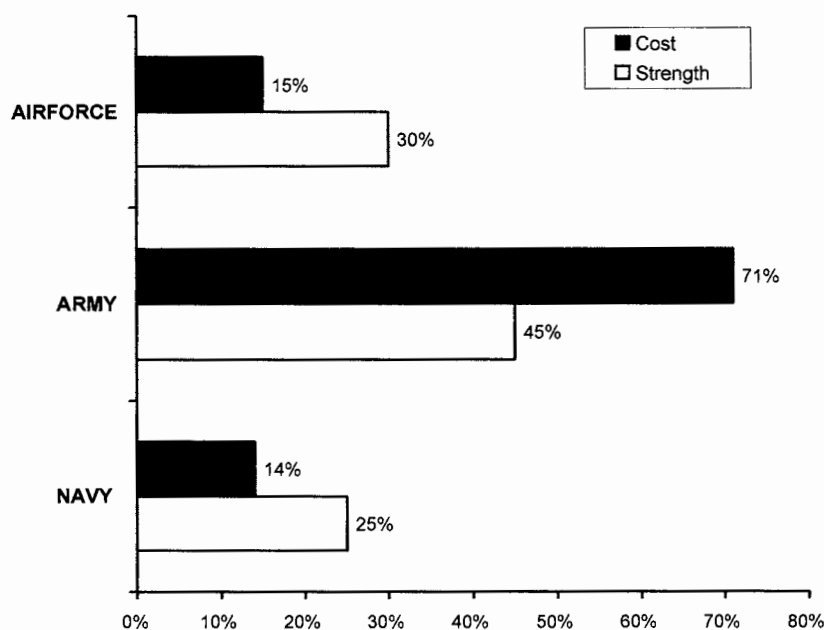


Figure 3.8 The relationship between relative Compensation costs and relative strength for the three Services FY 1994/95.

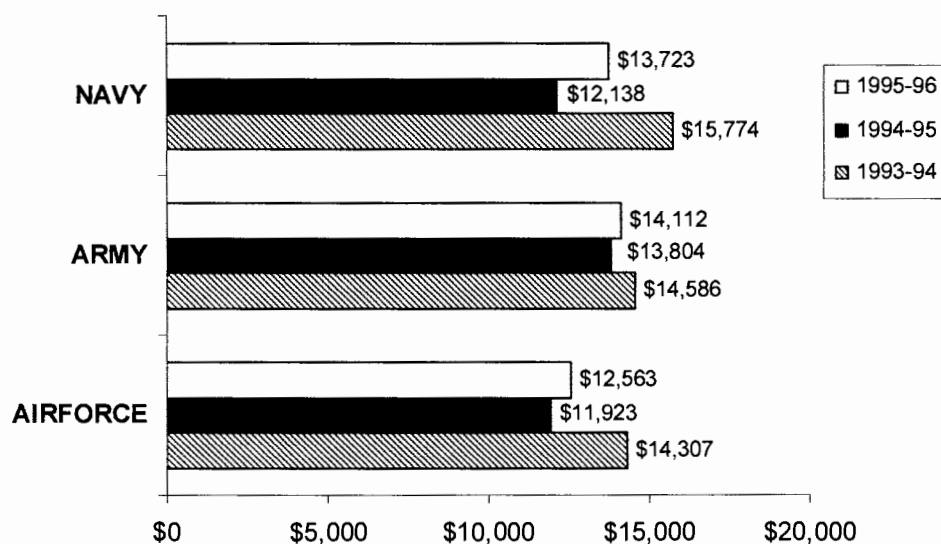


Figure 3.9 Average cost per claim accepted by Service 1993/94 to 1995/96.

The rate of growth in compensation costs was significantly greater than the prevailing inflation rates. Plotting the costs and performing a simple regression analysis produces the equations shown in Table 3.10. The regression equations show a high predictivity for Army and Navy, with the slope of both regression lines differing significantly from zero with R^2 of 0.91 and 0.86 respectively. Air Force on the other hand had a slope that was not significantly different from zero, and therefore was essentially a horizontal line, indicating that Air Force costs were essentially stable. Figure 3.10 shows the slope of these equations

	Regression	95% CI of Slope	
Army	$y = 7.095x - 14113$	(3.05 - 11.14)	$R^2 = 0.91$ $p = 0.011$
Navy	$y = 1.052x - 2090$	(0.26 - 1.85)	$R^2 = 0.86$ $p = 0.025$
Air Force	$y = 0.554x - 1097$	(-0.32 - 1.42)	$R^2 = 0.58$ $p = 0.14$
Total	$y = 8.70x - 17301$	(3.71 - 13.70)	$R^2 = 0.91$ $p = 0.011$

Table 3.10 Simple regression equations for Single Service Compensation costs.

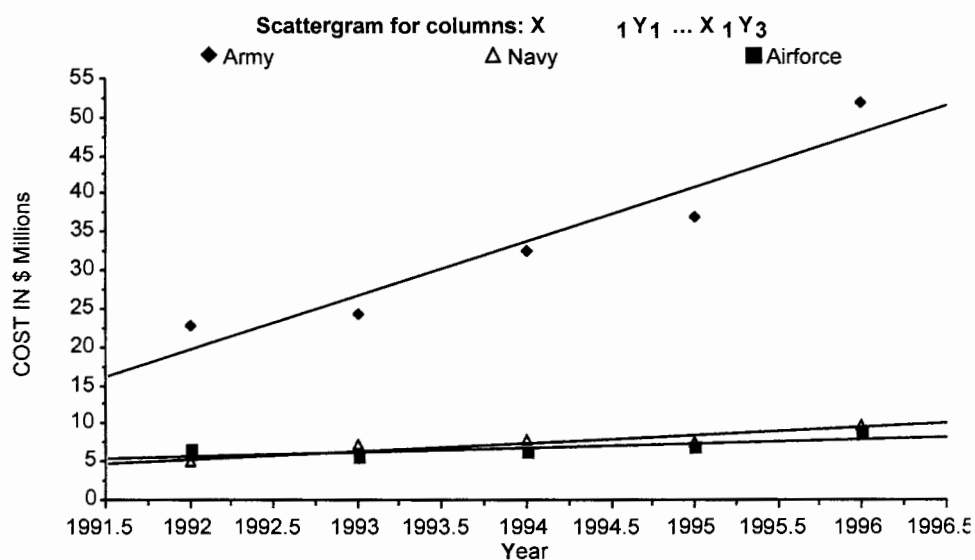


Figure 3.10 Regression lines for Service compensation costs, 1992 to 1996.

The passage of time from commencement to completion of this thesis has allowed the accuracy of these equations to be tested against actual compensation costs. Table 3.11 shows predicted and actual compensation costs from 1997 to 2002.

Table 3.11 shows that the equation for ADF costs was not particularly accurate, with overestimation between 1997 and 1999 and significant underestimation from 2000 to 2002. In the case of Army, the equation was again an overestimate between 1997 and 1999, but highly predictive between 2000 and 2002. This suggests that the Air Force and Navy rates of cost increase changed significantly during this period.

Year	Predicted ADF Costs	Actual Costs	Variation Actual/Predicted	Predicted Army Costs	Actual Costs	Variation Actual/Predicted
1997	\$72.9M	\$61.9M	-15.1%	\$55.7M	\$45.4M	-18.5%
1998	\$81.6M	\$66.1M	-19.0%	\$62.8M	\$46.2M	-26.4%
1999	\$90.3M	\$85.4M	- 5.4%	\$69.9M	\$60.6M	-13.3%
2000	\$99.0M	\$118.M	+19.4%	\$77.0M	\$79.5M	+3.2%
2001	\$107.7M	\$125.M	+16.8%	\$84.1M	\$81.8M	- 2.7%
2002	\$116.4M	\$141.M	+21.8%	\$91.2M	\$90.6M	- 0.7%

Table 3.11 Predicted and actual ADF and Army Compensation costs, 1997-2002.

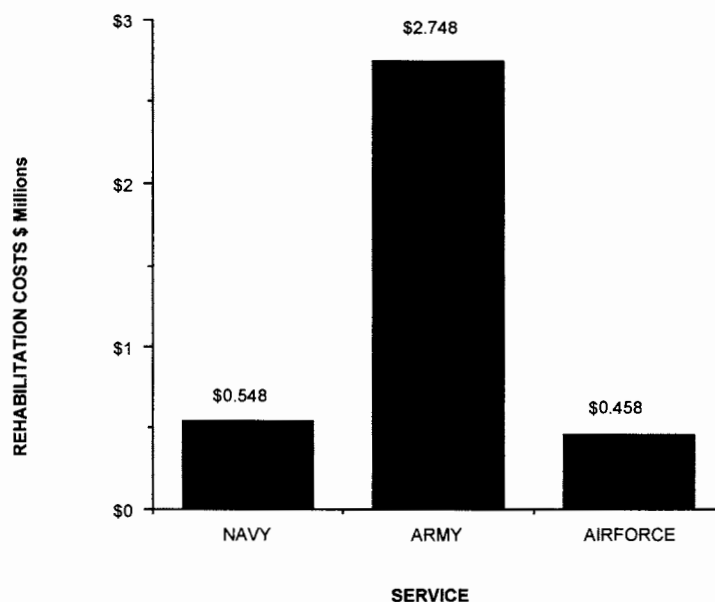


Figure 3.11 Rehabilitation costs for the three Services, 1995/6.

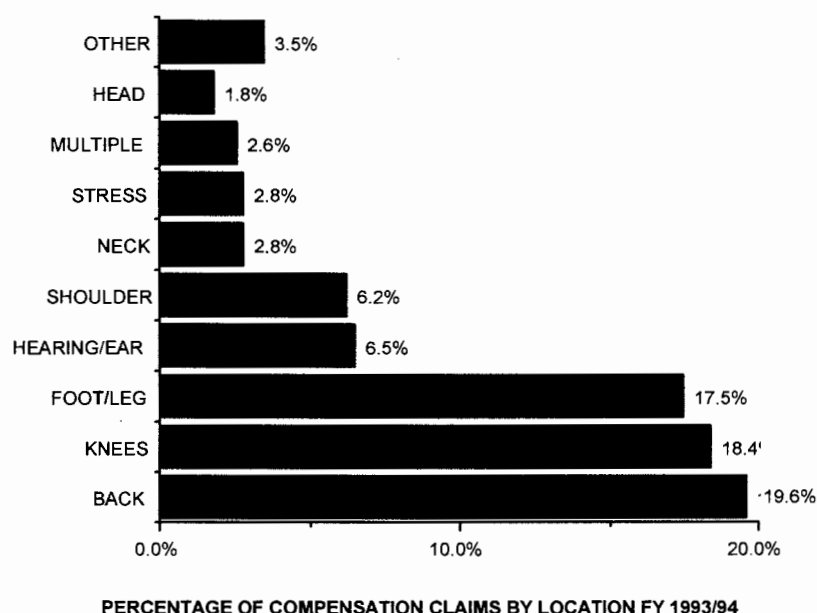


Figure 3.12 The percentage of compensation claims by body site, 1993/94.

Compensation costs doubled in the four years from 1991/92 to 1995/96 from \$34M to \$70M. These costs doubled again in the six years from 1996 to 2002 rising from \$70M to \$141M. During this 8-year period the size of the Defence force decreased by 15%. This rate of cost increase would not be tolerated in the private sector.

The high compensation costs are also reflected in rehabilitation costs. Figure 3.11 shows the relative expenditure for rehabilitation of the three Services in 1995/96. Army expenditures were five times greater than either Navy or Air Force. Figure 3.12 shows the body locations for which compensation was claimed. The back was the most common site responsible for nearly 20% of all claims, followed by the knees with 18% and the leg/foot with 17%.

3.9 Compensation Liability costs

In October 1996, the Australian Government Actuary released a report into the Military Compensation Scheme (MCS) (Thorburn 1996). The terms of reference were to estimate the liability for outstanding claims as at 30 June 1995, and to estimate the

notional premium that would be required to fund claims arising during 1995/96. The rationale for this project was to identify aspects where management intervention might lead to improved outcomes or reduced costs. As the authors noted "Measurement and management of long term liabilities is consistent with the level of accountability expected by the greater community".

The estimation of liabilities was required for the Department of Defence to satisfy its accrual reporting obligations. The report allowed management to determine the financial impact of both past and planned management actions. Data collection within the compensation organization was noted to be poor, with no regular matching of claims data with payments data. There were two methods of making payments. Incapacity and dependent children payments were paid through the Defence Department civilian payments system CIVILPRISM, whilst all other payments were made through the Defence Financial Management Information System (DEFMIS). Both systems are computerised ledger systems, but were not linked to each other.

Estimates of liability were calculated by projecting future claims payments and then making an allowance for claim inflation. The projected payments were then discounted to a present value. The discounting recognised the time value of money, and enabled realistic comparison of long-term financial arrangements. In civilian compensation and insurance schemes, assets are held to support liabilities, so discounting recognises that income will be earned on the assets till the claims are paid.

While the Military Compensation Scheme (MCS) is unfunded, it was considered appropriate to discount the liabilities using an assumed rate of interest, in order to arrive at a meaningful estimate of the present value of the outstanding liability. The assumed interest rate was 8.5%, consistent with the return on Commonwealth securities in 1995, with a term similar to that of the liabilities. This rate was also consistent with the requirements of Australian Accounting Standard 26 (AAS26), which specified that a current rate of interest be assumed when valuing outstanding claims liabilities.

Claim inflation acknowledges the fact that payments will increase over time. This occurs for many reasons, e.g. incapacity payments are linked to earnings, and lump

sums are indexed to inflation. There is also superimposed inflation, where the rate of total growth of the scheme exceeds the rate of inflation.

Medical costs in other schemes have been noted to increase at a greater rate than wage inflation. This is due to a combination of new technology and increased life expectancy, leading to treatment costs occurring over a longer period. Average lump sum payments in other schemes have also been observed to increase at a rate greater than inflation.

The study assigned a benefit growth rate of 4.5%, which was consistent with medium term economic forecasts for wages growth at that time. Incapacity payments and payments to dependant children were assumed to grow at this rate. All other payments were assumed to be subject to superimposed inflation of 3%, giving a total claim inflation of 7.5%. The setting of this 3% rate was judgmental and based on levels experienced in comparable schemes.

The MCS was responsible for 7 main types of payment; Incapacity payments, Lump sum payments for permanent incapacity, Lump sum payments for non-economic loss, Medical expenses, Rehabilitation costs, Death benefits, and Other benefits. The actuarial analysis divided these payments into two groups; incapacity and non-incapacity payments. For the purposes of estimation, incapacity was broken down into 3 categories;

- (a) Short-term - payments made within 12 months of commencing benefit,
- (b) Long term - payments made 12 months after commencement of benefit and,
- (c) Long-term incurred but not reported (IBNR) - refers to claimants who were injured before valuation date, who were not in receipt of benefits at date of valuation, but who will receive incapacity payments in the future.

Incapacity payments consisted of normal weekly earnings (NWE) for 45 weeks, 75% of NWE if incapacity continued past 45 weeks and top-up payments of between 80-100% of NWE in specific circumstances. These incapacity payments were made

under the auspices of the Safety, Rehabilitation and Compensation Act (SRCA) of 1988. Payment for incapacity ceased if there was 'recovery', death or the attainment of age 65.

In 1994/95, there were 2503 incapacity claimants who received \$23.572 million. Of these, 75% were long-term claimants (on benefits for > 12 months). A regularly observed occurrence was that beneficiaries receiving benefits for a long time were less likely to cease than those in receipt for a short time. Cessation rates drop off quickly as the length of time on benefit increases, and then they level off. This phenomenon is typically observed in other compensation schemes.

From 1 July 1993 to 1 July 1995 the number of long-term claimants increased from 820 to 933, a rise of 13.8%. The rate of cessation of payments was 25% for those on benefits for less than 2 years, but only 5% for those on benefits for more than 10 years. The average long-term claimant was aged 47, received \$16,630 per annum and had been in receipt of benefit for 10.5 years. It was assumed in the analysis, based on observed experience that 25% of all claimants would continue to receive benefits for at least 10 years.

Over 50% of the liability attendant to long-term claimants, related to injuries prior to 1980, i.e. injuries that occurred 15 years before the valuation date. If all else was equal, this suggested a substantial liability existed for more recent injuries, where claimants were not in receipt of incapacity payments. It was projected that incapacity payments to existing claimants would continue to be made for at least another 15 years, because the rate of cessation was only slightly higher than the assumed claims inflation rate.

The average delay from time of injury to date of reporting was 4.5 years in long-term claimants. The average delay from date of injury to date of incapacity payments was over 8 years. This was very different to other worker's compensation schemes and was due to the unique interaction of the ADF health services, where free medical and dental care was provided. However this pattern created a substantial IBNR liability.

The estimation of IBNR liability was based on the historical profiles of existing long term claimants. The average long-term claimant commenced benefit at age 36 and

had an average initial benefit of \$16,630 p.a. The liability estimate for this average individual was \$139,330, discounted to 1994/95 dollars.

After the benefit liability estimation it was noted that a substantial liability existed to also make incapacity payments (\$157.4m) and this liability in respect to injuries sustained prior to 30 June 95 was expected to continue to the middle of next century.

Service	Long term	Long Term IBNR	Short term	Total
Army	\$86.8M	\$92.6M	\$39.5M	\$218.9M
Navy	\$25.2M	\$36.2M	\$13.7M	\$75.1M
RAAF	\$24.2M	\$28.6M	\$12.3M	\$65.1M
TOTAL	\$136.2M	\$157.4M	\$65.5M	\$359.1M

Table 3.12 The outstanding claims liability (\$M), as at 30 June 95, by Service. (Inflated and discounted to \$1995).

Table 3.12 shows the estimated outstanding claims liability for the three Services. Army again had the largest liabilities being two thirds of the total ADF liability and three times the Navy and Air Force liabilities. Army was responsible for 61% of the total estimated liability despite representing approximately 50% of the strength of the ADF. This disproportionate liability is a consequence of the physically demanding lifestyle of Army members and is reflected in the preponderance of musculoskeletal injuries observed in soldiers.

3.10 Incapacity liability costs.

Table 3.9 shows the calculated liability for incapacity payments broken down by cause. Incapacity payments for back injury were the single largest cost (\$132 million). Back injuries represented 37% of total liabilities and were over twice the size of the next largest cause of knee injury. These costs reflect the greater degree of permanent disability seen in sufferers of chronic low back pain, compared to those with chronic knee pain.

Injury Group	Long Term	Long Term IBNR	Short Term	TOTAL
Back	\$52.7M	\$61.5M	\$18.2M	\$132.4M (36.9%)
Knee	\$18.2M	\$22.4M	\$12.8M	\$53.4M (14.9%)
Lower limb	\$11.2M	\$12.5M	\$11.5M	\$35.2M (9.8%)
Upper Limb	\$7.0M	\$8.3M	\$7.4M	\$22.7M (6.3%)
Head	\$6.7M	\$7.3M	\$2.0M	\$16.0M (4.5%)
Stress	\$7.6M	\$8.0M	\$1.8M	\$17.4M (4.8%)
Other	\$32.8M	\$37.4M	\$11.8M	\$82.0M (22.8%)

Table 3.13 Outstanding incapacity liability claims \$M, by injury group, as at 30 June 1995. (Inflated and discounted to \$1995).

Back and knee injury together accounted for 52% of total incapacity payments. This rises to 72% if lower limb, upper limb and head injuries are included. Of note was the low level of stress related incapacity, which is in stark contrast to the civilian claims experience. Included in the other category were hearing loss (1.3%), Spinal injury (0.4%), Trunk (4.0%) and Unspecified (17.1%).

As the musculoskeletal causes of liability have been determined to be responsible for 72% of total compensation costs, it is considered reasonable to use this figure as a proportionate estimate for the contribution of injury to overall compensation costs. This is likely to be a reliable lower bound estimate of the true cost.

3.11 Non-Incapacity liability costs

Non-Incapacity payments include the following benefits; Lump sum payments for permanent impairment and non-economic loss, Medical, hospital and pharmaceutical costs associated with the compensable condition, Re-imbursement of household and attendant care benefits, Vocational and medical rehabilitation costs, and Lump sum and payment death benefits to dependants.

Table 3.14 shows a steady increase in total lump sum payments between 1993/94 and 1995/96. Average lump sum payments for permanent impairment increased from \$10,416 in 1993/94 to \$14,033 in 1995/96. The number of lump sum payments also increased from 845 to 963.

Payment type	1993/94	1994/95	1995/96 **
Permanent Impairment	\$8.801M	\$11.203M	\$13.514M
Non-Economic Loss	\$3.292M	\$3.894M	\$9.125M
Medical expenses	\$5.127M	\$5.764M	\$5.440M
Rehabilitation Costs	\$1.951M	\$1.504M	\$1.648M
Death Expenses	\$3.058M	\$2.753M	\$1.587M
Other	\$1.608M	\$2.341M	\$2.570M
TOTAL	\$23.837M	\$27.459M	\$33.884M

Table 3.14 Non-Incapacity payments for the financial years 1993/4 to 1995/6 (\$M)
(** First 10 months only.)

In the estimation of liability for non-incapacity payments the actuaries experienced significant difficulty in matching payments to claims; only 50% of payment records could be matched to claims records. The calculation of the liability was rendered difficult for a number of reasons; a short observation period, payment experience changed dramatically over the period of observation and the long delay between injury and the lodging of a claim. Of the 963 payments in 1995/96, 50% were for injuries that occurred more than 5 years earlier and 20% for injuries that occurred more than 10 years earlier. Thus the trend in payments experience was no guide to the underlying injury experience.

Three factors were thought to influence the delay in claim lodgement;

- (1) ADF health services provided medical care and ADF members received full pay whilst receiving treatment. This removed any incentive to lodge an immediate claim,
- (2) The perception amongst serving personnel that lodgement of a claim may pose a career threat, and
- (3) There was no legislative requirement that claims be lodged within a certain time after injury.

Most accident schemes require that claims be notified within a certain period, usually 6 months. For private sector schemes this is essential in order to manage and underwrite the schemes, allowing insurers to provision against expected liabilities.

The observed experience in the MCS is that the longer the delay in claiming, the smaller the settlement. This probably reflects the fact that severe injuries are probably compensated relatively quickly, whilst less severely injured servicemen do not seek compensation until they discharge from the Service.

The increase in claims was attributed to an increasing awareness of the scheme amongst claimants, and the actuaries noted that there may be increasing claim numbers even if the rate of injury remained stable. Increased awareness can result in the bringing forward of claims which would otherwise have been settled later. This may present the appearance of a deteriorating claims experience.

3.12 Non-economic loss.

Payment for non-economic loss was a feature of the 1988 SRCA, but not the prior legislation. However, a full Federal Court hearing in 1994 held that compensation for non-economic loss was payable in respect of injuries sustained before the commencement of the current act. As a consequence, the actuaries assumed that all future claims for permanent incapacity would attract a payment for non-economic loss.

Payment Type	Army	Navy	RAAF	TOTAL
Permanent impairment	\$48.2 M	\$8.4 M	\$10.5 M	\$67.1 M
Non-Economic loss	\$38.6 M	\$6.7 M	\$8.3 M	\$53.6 M
Medical Expenses	\$41.7 M	\$7.6 M	\$7.9 M	\$57.2 M
Rehabilitation Costs	\$7.5 M	\$0.8 M	\$1.4 M	\$9.7 M
Death Benefits	\$5.6 M	\$1.0 M	\$1.2 M	\$7.8 M
Other	\$15.1 M	\$2.7 M	\$3.4 M	\$21.2 M
TOTAL	\$156.7 M	\$27.2 M	\$32.7 M	\$216.6 M

Table 3.15 Summary of outstanding liability estimates for non-incapacity payments, by Service as at 30 June 95 (Inflated and discounted \$1995).

Table 3.15 again demonstrates the disproportionate liabilities of Army, representing an estimated 75% of the total estimated liability costs for non-economic loss. The interaction of the ADF health service made rehabilitation cost comparisons to other schemes difficult. The majority of rehabilitation costs were for discharged

members, thus a substantial in-service rehabilitation programme absorbed a significant part of the rehabilitation cost that would otherwise fall to the compensation scheme.

Injury Group	Permanent Impairment	Non- Economic Loss	Medical Expenses	Rehabili- tation	Other	Total
Back	\$15.1M	\$12.0M	\$13.7M	\$4.0M	\$5.8M	\$50.6M (24.2%)
Knee	\$18.8M	\$15.0M	\$11.9M	\$1.6M	\$2.8M	\$50.1M (24.0%)
Lower limb	\$10.8M	\$8.6M	\$5.8M	\$1.4M	\$2.0M	\$28.6M (13.7%)
Upper Limb	\$7.9M	\$6.4M	\$3.1M	\$0.6M	\$1.3M	\$19.3M (9.3%)
Head	\$2.5M	\$2.0M	\$4.7M	\$0.3M	\$1.4M	\$10.9M (5.2%)
Stress	\$1.3M	\$1.1M	\$1.9M	\$0.2M	\$0.5M	\$5.0M (2.4%)
Other	\$10.7M	\$8.5M	\$16.1M	\$1.6M	\$7.4M	\$44.3M (21.2%)
Total	\$67.1M	\$53.6M	\$57.2M	\$9.7M	\$21.2M	\$208.8M

Table 3.16. Summary of outstanding liability estimates for non-incapacity payments, by body region. (Inflated and discounted \$1995).

Table 3.16 summarises the total compensation liabilities by body region. As seen previously, back and knee injuries were dominant and musculoskeletal causes accounted for 71.2% for total costs (76.4% including head). One of the primary reasons for this actuarial analysis was to calculate a notional premium on the same basis as used in the workers compensation industry. This premium represents the amount that, with assumed interest income, would be sufficient to meet eventual claims and the associated administration costs arising from injuries that occurred during 1995/96. Table 3.17 shows the total Single Service liability for outstanding claims and the notional premium required to cover these liabilities. Army was responsible for 65% of total liabilities, and its premium was 3.8% of salaries (\$44.3m). This was significantly higher than either Navy or Air Force.

Service	Outstanding Claims Liability	Premium for 1995/96 (% salaries)
ARMY	\$375.6m	\$44.3m (3.8%)
NAVY	\$102.3m	\$11.2m (1.7%)
RAAF	\$97.8m	\$11.1m (1.5%)
TOTAL	\$575.7m	\$66.6m

Table 3.17 Estimated total ADF liabilities and notional premium, 1995-97.

To put this in perspective most private sector employers strive to have their worker's compensation premium at or below 1.5% of salaries. Navy and RAAF have premiums comparable to the private sector, while Army's notional premium is 2.5 times greater than the industry benchmark. This places Army in the worst category of employer from a compensation perspective.

3.13 2002 Actuarial Update

The Australian Government Actuary repeated its analysis of ADF compensation data in 2002. The following section compares the 1995 and 2002 data using the updated data from the 2002 report (Martin 2003).

Service	Year	Incapacity Payments \$M	Non-Incapacity Payments \$M	TOTAL \$M
ARMY	1995	\$218.90M	\$156.70M	\$375.60M
	2002	\$531.70M	\$391.00M	\$922.70M
	Increase	(142.9%)	(149.5%)	(145.7%)
NAVY	1995	\$75.10M	\$27.20M	\$102.30M
	2002	\$127.80M	\$111.10M	\$239.00M
	Increase	(70.2%)	(308.5%)	(133.6%)
RAAF	1995	\$65.10M	\$32.70M	\$97.80M
	2002	\$92.10M	\$88.60M	\$180.80M
	Increase	(41.5%)	(170.9%)	(84.9%)
Total	1995	\$359.10M	\$216.60M	\$575.70M
	2002	\$713.60M	\$590.80M	\$1,342.40M
		(98.7%)	(172.7%)	(133.1%)

Table 3.18 The absolute and relative increase in liabilities for the ADF between 1995 and 2002 (inflated and discounted to \$A1995 and \$A2002).

Table 3.18 shows that liabilities for Army, Navy and Air Force increased by 145%, 133% and 85% respectively. The overall increase in ADF liabilities was 133%. There was a dramatic increase in Navy and Air Force non-incapacity payments, most likely related to legislative changes in 1994. The increase of Army incapacity payment liabilities was twice that of Navy and three and a half times that for Air Force.

Table 3.19 shows the increase in liabilities by selected body regions. Liability for back injury increased by 124%, for knee injury by 151%, for lower limb injury

by 190% and for upper limb injury by 245%. The overall total increase in liabilities was 179%. This dramatic increase in liabilities was likely to be the result of major changes in personnel policy that occurred in 1999. Prior to then, the ADF had an accommodating approach to injured members. From that time onwards there was a requirement for members to be employable and deployable that is, fully fit for overseas deployment. This was linked to a significant restructure, which outsourced and civilianised many military jobs that were suitable for rehabilitating or injured members.

Injury group	Year	Permanent Impairment	Non-economic loss	Medical expenses	Rehab	Other	Total
Back	1995	\$15.1M	\$12.0M	\$13.7M	\$4.0M	\$5.8M	\$50.6M
	2002	\$32.9M	\$19.1M	\$31.6M	\$9.5M	\$20.3M	\$113.4M
Knee	1995	\$18.8M	\$15.0M	\$11.9M	\$1.6M	\$2.8M	\$50.1M
	2002	\$47.0M	\$32.5M	\$25.9M	\$5.6M	\$15.2M	\$126.2M
Lower Limb	1995	\$10.8M	\$8.6M	\$5.8M	\$1.4M	\$2.0M	\$28.6M
	2002	\$30.5M	\$19.4M	\$15.0M	\$4.1M	\$13.8M	\$82.8M
Upper Limb	1995	\$7.9M	\$6.4M	\$3.1M	\$0.6M	\$1.3M	\$19.3M
	2002	\$28.0M	\$18.2M	\$9.8M	\$2.7M	\$7.9M	\$66.6M
Total	1995	\$67.1M	\$53.6M	\$57.2M	\$9.7M	\$21.2M	\$208.8M
	2002	\$185.7M	\$114.0M	\$144.5M	\$29.8M	\$109.0M	\$582.9M
	Increase	(176%)	(112%)	(152%)	(207%)	(414%)	(179%)

Table 3.19 Liability estimates by selected Body region (Inflated and discounted).

Consequently, if an injured member could not return to fully deployable fitness then they would be discharged as below medical standards or not deployable. This led to an increase in medical discharges with the attendant increase in liabilities.

In determining the relative contribution of injury to overall compensation costs in 1995/96, a figure of 72% was chosen. This is based on the data on estimated liabilities produced by the Australian Government Actuary. There is no published data showing actual costs incurred by body part. It is assumed that the actuary had access to

actual expenditure in calculating the estimated liabilities. This 72% figure is a rounding up of the 71.2% liability contribution figure from 1995, and acknowledges that many of the cases within the head category would be classed as injuries, but are not included in this figure. Thus a 72% figure likely represents a reliable lower bound estimate.

3.14 Conclusion

The costs attributable to injury are not visible within the ADF health system or to senior management. Because the accounting system records only broad categories of payment it is impossible to accurately assess the organisational cost of injury. The lack of adequate health surveillance coupled with no linkage to cost data makes accurate determination of direct injury costs not possible at present. Health surveillance and cost data in the ADF was and remains rudimentary and not linked in any meaningful way. In this thesis, a unique database was established to link episodes of care with subsequent costs through the use of a referral number. Unfortunately, no serious attempt to adopt this database across the Defence Health environment was subsequently made.

The data used to estimate direct costs in this chapter are the most accurate available, albeit in a population not representative of the Army as a whole. It is the only data available for which there is an accurate link between an episode of injury and the subsequent costs incurred. The Defence Health Service continues to use a cash payment system that is focussed on managing to a global budget, rather than a system which links episodes of illness and injury with their ultimate costs.

An understanding of where, when and how injuries occur is critical for the development of interventions to prevent and control injuries. The Defence Injury prevention Program has shown the value of injury surveillance and prevention activities at a local level. As Bonnie (Bonnie 2002) noted “one of the highest priorities in injury prevention and treatment is to improve capabilities for injury surveillance, interpreting injury data and translating data into policy-relevant terms, and predicting and measuring the effects of interventions.”

In order for information to be used for decision making purposes it must be available in the first place. The major finding from the proceeding section was the

paucity and poor quality of both health surveillance and cost data within the Australian Army at an organisational level. The failure of the Defence Health Services to implement a reliable and effective electronic health record has stymied the collection of injury surveillance data. Steps are underway to procure a commercial-off-the-shelf software package for use in Defence medical facilities, but its procurement is not anticipated before 2010.

Surveillance systems can be described as information loops, with data coming in and information being returned to those who need it. The loop is complete when the information is applied (Buehler, 1998). The use of surveillance information should be an ongoing part of the Defence management cycle; requiring adequate funding and a business environment that encourages and supports the collection, analysis and use of data. (Holder 2001). This will require support from military leaders to prioritise injury prevention and utilise the information derived from surveillance to take preventative action. In limited locations, the Defence Injury Prevention Program has achieved this, but data collection difficulties and a lack of resources has prevented wider application, and led to subsequent disuse of the system.

McKinnon (McKinnon 2008) identified a number of failings in the existing Defence injury surveillance efforts and reinforced the view that effective Injury surveillance systems provide the foundation for priority setting, but noted that there are currently few formal tools for establishing injury priority in the general community or the ADF.

McKinnon argues that a two stage approach to injury data collection is likely to capture the required information for the vast majority of injuries of interest to the ADF. By prioritising injury concerns based on a minimal data set, users of surveillance data will avoid the risk of being overwhelmed by information. Subsequent efforts can then be directed at obtaining more data where the need is determined. The introduction of a comprehensive and reliable injury surveillance system is critical for the adequate prevention and control of injuries. Linking injury data to cost data enables a rational allocation of priority of effort based on those injuries which have the greatest cost impact.

Data from the US and British armies supports the view that the contribution of injury to health costs in the broader Army is greater than the 27% figure obtained from the Canberra sample in this chapter. While the 27% figure is a likely to represent an accurate lower bound, the Allied data supports the use of a 40% figure as an upper bound.

Use of a 40% estimate of injury contribution, results in an absolute increase in Army direct injury costs of between \$1.0 and \$1.6 Million between 1992/93 and 1994/95. In relative terms, the upper bound produced a nearly 50% increase in the direct injury cost estimate. While injury and musculoskeletal morbidity in the general Australian population is concentrated in the older age groups, the Australian Army invalidity data shows a preponderance in the 25-34 age group, reflecting the impact of the intensely physical nature of Army service on younger members.

Actuarial review of the ADF's compensation liabilities by the Australian Government Actuary noted that data collection within the compensation organization was poor, with no regular matching of claims data with payments data, mirroring the findings within the Defence Health Service. The actuaries noted that in 1995/96, 50% of claims were for injuries that occurred more than 5 years earlier and 20% for injuries that occurred more than 10 years earlier. The trend in payments experience was therefore no guide to the underlying injury experience.

The average delay from time of injury to date of reporting was 4.5 years in long-term claimants, with the average delay from date of injury to date of incapacity payments being over 8 years. This differs from other worker's compensation schemes and was due to the ability to access free ADF health services, whereas civilian workers must lodge a compensation claim in order to be eligible for payment of medical expenses. This failure to report injuries in a timely manner makes it extremely difficult to provision for future costs and suggests a significant sting in the compensation liability tail.

Army was responsible for 61% of the total estimated compensation liabilities in 1995, despite representing nearly 50% of the strength of the ADF. Musculoskeletal conditions were responsible for 78.2% of total outstanding compensation liabilities in 2002, compared to 71.2% of total liabilities in 1995. This would suggest that the

relative importance of musculoskeletal injury increased during the intervening period, and is most likely linked to the less forgiving retention policy for injured soldiers implemented in 1998.

Based on the calculated liabilities by body region produced by the actuaries, an estimate of 72% was made for the contribution of injury in 1995 to total compensation costs. This is considered to be a reliable lower bound estimate of the true contribution to compensation cost, as head injuries were not included.

A notional worker's compensation premium was calculated based on the estimated compensation liabilities for each Service, with Army's premium being 3.8% of wages compared to Navy (1.7%) and Air Force (1.5%). To put this in perspective most private sector employers strive to have their worker's compensation premium at or preferably below 1.5% of salaries. Navy and RAAF have notional premiums comparable to the private sector, while Army's notional premium is 2.5 times greater than the industry benchmark. This places Army in the worst category of employer from a compensation perspective.

The true extent of compensation and future liability costs have been hidden from Defence policy makers. Free from the constraints of a worker's compensation premium, the ADF has not focussed on injury reduction as a high priority, unlike their counterparts in civil industry. The Department of Veterans Affairs now has responsibility for compensation payments, and future liabilities will be borne by them and not the Department of Defence.

Estimated Direct Cost of Injury to Army \$A1996	
AG39 Medical Costs	\$3.63M -\$4.96M
Compensation Costs	\$37.40M
Total	\$41.03M
Outstanding Compensation Liabilities	\$270.0M

Table 3.20 Estimated total direct costs and outstanding liabilities for Army, 1996.

The estimated direct cost of injury for the Army in 1996 is shown in table 3.20. The lower bound of AG39 cost attributed to Army injury was estimated to be 27% of Army's external medical expenditure, while the upper bound cost was estimated to be 40%. Army's total compensation cost in 1995/96 was \$51.95M, and using a figure of 72% of compensation costs being attributable to injury, gives an estimate of \$37.40M. The total direct cost of injury to Army in 1996 was estimated to be \$41.03M, while the outstanding liability for injury was estimated to be 72% of total claims or \$270.0M.

To obtain accurate and reliable data a comprehensive injury surveillance system must be introduced into the ADF, and be linked to accounts data. For any meaningful change in policy approach or allocation of resources, the true extent and nature of costs must be visible. Current attempts to improve injury surveillance in the ADF by incorporating injury surveillance data into the Defence Occupational Health and Safety (OHS) reporting system offers some hope that this can be achieved.

Chapter 4. Indirect costs of Injury for the Australian Army

4.1 Introduction

Traditional approaches to indirect costing have focussed on production losses and the quantum of foregone wages. Invalid pensions are not usually considered to be a cost, but a transfer payment which helps to alleviate the total loss to an individual. They are not considered part of direct medical costs, so this chapter will include both defence invalid pensions and veteran's affairs pensions as part of the scope of indirect cost analysis. This approach is taken because these pension costs are a real and significant burden on the public purse, and provide an opportunity to place a value on a cost not normally considered.

Indirect costs resulting from injury to soldiers comprise a number of different components. These include:

- (a) loss of military operational readiness,
- (b) veterans affairs pensions, funded by the taxpayer,
- (c) invalid pension costs, partially funded by defence member contributions,
- (d) working days lost and restricted duties, borne by the employer, and
- (e) potential lost earnings due to invalidity, borne by the individual and society.

In a military context, the loss of potential future earnings is partially offset by transfer payments from invalid or veteran's pensions.

4.2 Military Operational Readiness

The Army does not produce goods in a traditional economic sense. Its output is operational capability. This is the capability to mount both defensive and offensive operations in support of the defence of Australia. In many ways, this could be viewed as a form of insurance, for which the Nation pays a premium in the form of the Defence Budget.

It is difficult to measure capability, as this is a categorical rather than continuous variable. There is an associated term called operational "readiness" which better lends itself to measurement. This term describes the readiness of both individual soldiers and units to deploy on operations. The distinction is important as while an under strength unit may not be ready at the organisational level, it can be reinforced with personnel and the operational capability retained.

A unit is established at a given strength of 100%. At any given time there will be people absent for a number of reasons such as courses, holidays, resignation and injury. In addition to absences there are a number of individuals who are medically restricted in some way, and depending on their specific trade or job can be termed as "non-effective" or not ready. A soldier who is ready for a deployment to anywhere in the world was classed as "Fit Everywhere" or FE.

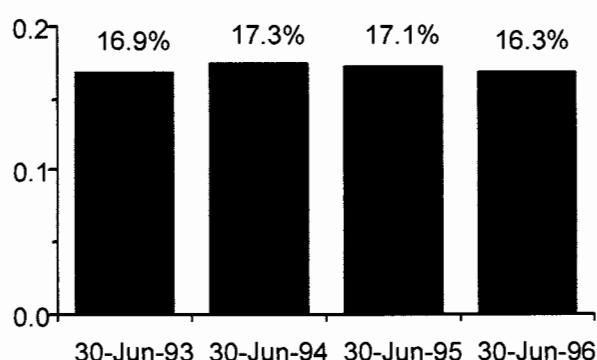


Figure 4.1 The percentage of Army Personnel not FE 1993 to 1996.

Figure 4.1 shows during the 4-year period 1993-1996 approximately 17% of the Army was not fully medically fit or FE. The actual impact of this will have varied depending on the level of medical disability, but reflects the high prevalence of morbidity within the Army population.

Medical fitness was determined by what was termed the Physical Employment Standard (PES) (see section 7.4) The PES is a categorical grading system that determined physical capability and employability. The categories in use in 1996 were Fit Everywhere (FE), Communications Zone Everywhere (CZE- mild limitations), Base

Everywhere (BE – moderate limitations), Home Only (HO – severe limitations), Below Medical Standards (BMS) and Medically Unfit (MU). The latter two classifications usually resulted in medical discharge from the Army.

The PES was determined by the result of what was termed a PULHEEMS profile. PULHEEMS is an acronym that stands for Physical, Upper limb, Lower limb, Hearing, Eyes (L/R), Mental capacity and Stability. PULHEEMS gradings are divided into four categories with the following implications:

- a. grade 2 - normal and FE (Fit Everywhere);
- b. grade 3 - impaired (not FE), but able to perform most tasks;
- c. grade 7 - severely impaired, significant restrictions and not suitable for field deployment; and
- d. grade 8 - medically unfit for continued military service.

The L or lower limb grading was recorded at the time of a member's periodic medical examination and the profile stored on a database at the Army Soldier Career Management Agency (SCMA). This database was terminated in the mid 1990's as a Defence- wide personnel management database was adopted. As the PULHEEMS profile was only used by Army, data fields for it were not included in the new database. Consequently for many years, there was no simple way of determining the causes of medical downgrading. To ascertain the cause of a medical downgrading required the manual review of the individual's paper health record.

The only data available on the cause of medical downgrading comes from the old Army database (Rudzki 1994). Using the L grading as a marker for lower limb injuries (including the spine), Table 4.1 shows the number of members who were not L2 or Fit Everywhere during the years 1987-92

YEAR	L3/L7/L8	NON-FE	ARMY STRENGTH	% L ARMY STRENGTH	% OF ARMY NON-FE	L GRADE AS
						% OF NON-FE
1987	3 010	4 131	31 027	9.7%	13.3%	72.9%
1988	3 278	4 292	32 025	10.2%	13.4%	76.4%
1989	3 368	4 356	31 282	10.7%	13.9%	77.3%
1990	3 800	4 683	30 624	12.4%	15.3%	81.1%
1991	4 077	4 985	31 002	13.1%	16.1%	81.8%
1992	4 215	5 120	29 945	14.1%	17.1%	82.3%

(These figures include soldiers who were discharged during the year noted. Army strength as at 30 June of each year)

Table 4.1 The number and relative contribution of lower limb downgrading to Non-FE medical classifications, 1987-92 (from Rudzki 1994).

Consistent with previous chapters, the overwhelming majority of morbidity was associated with lower limb and back injuries. The number downgraded due to lower limb causes increased from 73 per cent in 1987, to 83 per cent in 1992, thus demonstrating the importance of lower limb and back injuries in the loss of combat strength.

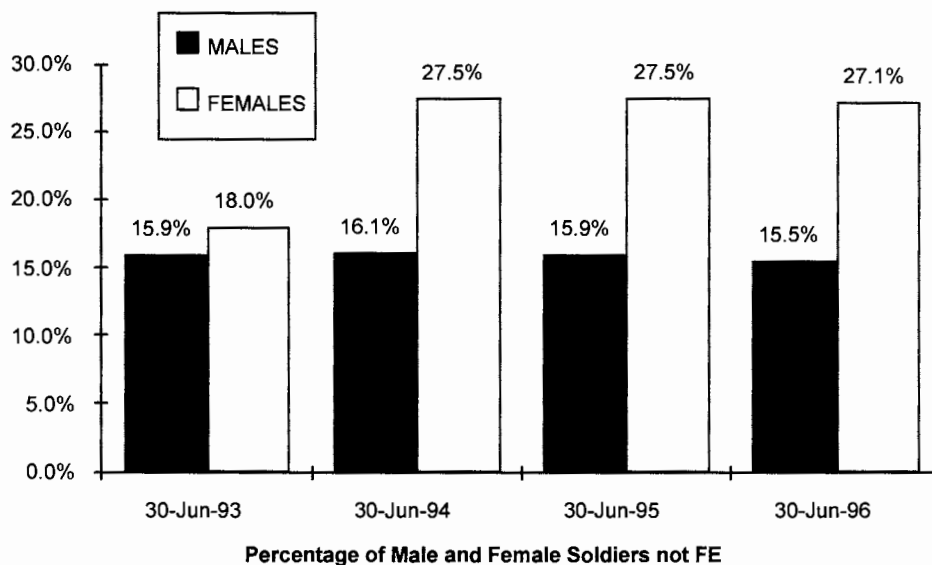


Figure 4.2 Percentage of male and female soldiers not fully medically fit 1993-1996.

Figure 4.2 shows that the morbidity in females was substantially higher than for males. This is consistent with higher injury rates reported in female soldiers. (Rudzki 1994)

There was and still is no agreement or policy as to what constitutes an appropriate level of unit readiness. Ideally it would be 100%, but due to necessary absences this is unrealistic. A figure of 90% of establishment strength has been used in some areas as a reporting trigger. For Army Reserve units, the minimum level of troop strength for a unit to remain effective is considered to be 60% (The Auditor General 1990). Once a unit drops below this level it has lost a substantial amount of its experienced personnel and cohesion. In combat, these units are withdrawn and rebuilt with new reinforcements.

If peacetime units fall below 60% effective manpower, then it can be argued that there is a significant reduction in operational capability of that unit. Given that the Army is a form of insurance, any inability to provide troops ready and able to deploy when required is of concern.

Military units are manned on the basis of three criteria, Operational level of Capability (OLOC), Minimal level of capability (MLOC) and Present level of capability (PLOC). The ratio of PLOC to OLOC is a measure of the personnel strength at a given point in time. The percentage deficiency represents a cost to readiness, as the capability remains, provided supplementation with additional personnel allows the maximal use of existing military materiel.

Medical restriction and medical downgrading increase the impact of existing staffing shortfalls. If a soldier is permanently or temporarily restricted, he cannot perform the arduous tasks of a combat soldier. He is not ready for deployment and therefore his restriction should be included in any calculation of operational readiness. Currently this is not the case. The cost of acquiring and training soldiers is wasted if they are not fit and able to deploy, and the country pays a price in terms of its security. The Army is funded on the basis that it is able to fight, albeit with medium to long-term notice. However it must maintain minimum standards of short-term readiness to ensure that taxpayer's funds are justified.

4.3 Invalid Pension Costs

4.3.1 The Civilian Experience

Invalidity as a result of workplace injury increased dramatically in NSW during the 1990's. Between 1991/2 and 1996/7 there was a 130% increase in workers designated as permanently impaired (2989 vs. 6880) (Workcover Authority 1998). In absolute terms, 16% of male and 15% of female workers compensation claimants were designated as permanently impaired.

During this 5-year period the average size of awards (pain and suffering, and weekly benefits) increased by over 25% in real terms (New South Wales Attorney-General's Department 1997). This increase in permanent impairment adversely affected the financial status of the Workcover authority, changing it from a surplus of \$1.2 billion in 1994 to an increasing deficit of \$454 million at 30 June 1996. No information was available as to whether optimal health outcomes were achieved.

4.3.2 The ADF System

Each Service has distinct criteria for determining the medical fitness of its members and therefore if a member is to be discharged on invalidity grounds, but all members retired as Medically Unfit (MU) were entitled to an invalidity benefit. Invalidity benefits were not granted to members with less than two years of service who had a pre-existing complaint not materially aggravated by military service.

There are two ADF specific pension schemes in existence; the Defence Force Retirement & Death Benefit scheme (DFRDB) and the Military Superannuation Benefits Scheme (MSBS). DFRDB was introduced in 1973, replacing an older scheme, while MSBS was introduced in 1991. The DFRDB scheme was closed to new members in 1992. Invalidity entitlements under these pension schemes are granted if the member is medically discharged from the Service and is unable to obtain civilian employment in the field for which he or she was qualified.

For MSBS, the MSBS Board determines the level of invalidity after reviewing information about the member's skills, qualifications, experience and the relevant Service medical documents. On occasions an independent medical opinion may be sought. Benefits fall into 3 categories;

- (a) Class A - deemed as > 60% incapacity as determined by independent specialist medical review,
- (b) Class B - between 30-59% incapacity, and
- (c) Class C - < 30% incapacity for the purposes of obtaining employment.

Determining a pension class will vary according to occupation. For example, a clerk can be reasonably expected to obtain similar employment, while an infantryman would require extensive retraining to be suitable for civilian employment. Therefore with a similar incapacity the clerk may be given a class B pension while the infantryman would receive a class A pension.

The payment of benefits varies under the two schemes. Under DFRDB, a Class A pension recipient receives 76.5% of his final salary, and a Class B recipient receives half that (38.25%). A Class C recipient is entitled to a refund of his contributions and a lump sum benefit equal to one half of his refund.

Under MSBS, the Class A entitlement is the member benefit of contributions plus interest and the employer benefit calculated on the service a member could have achieved from entry to age 55 (or statutory retiring age if greater than age 55). The member component is paid as a lump sum. The employer component is paid as an indexed pension. The pension entitlement is calculated using a complex formula. A soldier aged 30 who had 10 years service prior to 1996 and was invalided Class A, would receive a lump sum of \$253,000 (\$A1996) and a pension of \$21,125 indexed annually.

Invalided members receive these benefits for life if they are unable to find work, and on death there are reversionary benefits for surviving spouses. For Class C recipients the benefit is the refund of the member's contribution plus interest and the

preservation of the employer benefit until age 55. Invalid pensions are not adjusted because of other income, but Commonwealth payments (Social security, compensation and Repatriation) may be adjusted to take into account the amount of the pension. Classifications are regularly reviewed, with movements up or down depending on changed circumstances.

4.3.3 The Department of Veteran's Affairs System

Any soldier with more than 3 years continuous service before 1992, who sustained a service-related injury or illness that resulted in impairment, possesses an entitlement for a Department of Veteran's Affairs (DVA) pension. There are a number of different types of pension and they vary according to the level of impairment. DVA pensions are payable to ADF members who are still serving. ADF members, depending on their circumstances, are entitled to receive pensions from both their Defence scheme and the Department of Veterans Affairs. Recent legislative changes now allow for crosschecking and adjustment of pension levels depending on circumstance.

4.4 Veteran's Affairs Pensions Costs

Figure 4.3 shows the percentage of veteran's affairs pension recipients in 1994 by category of entitlement. The most common beneficiaries were the World War 11 veterans, but Defence Force/ Peacekeeping troops comprised the second largest category of recipients. This group has nearly twice as many pensioners as former Vietnam veterans.

Figure 4.4 shows the relative proportion of pension outlay cost by category. Defence /Peacekeeping comprised 8.08% of total DVA invalid pension outlays, which was third only to Vietnam War veterans at 8.68%. As the number of World War II veterans decline, the relative importance of Defence Force pensions will increase.

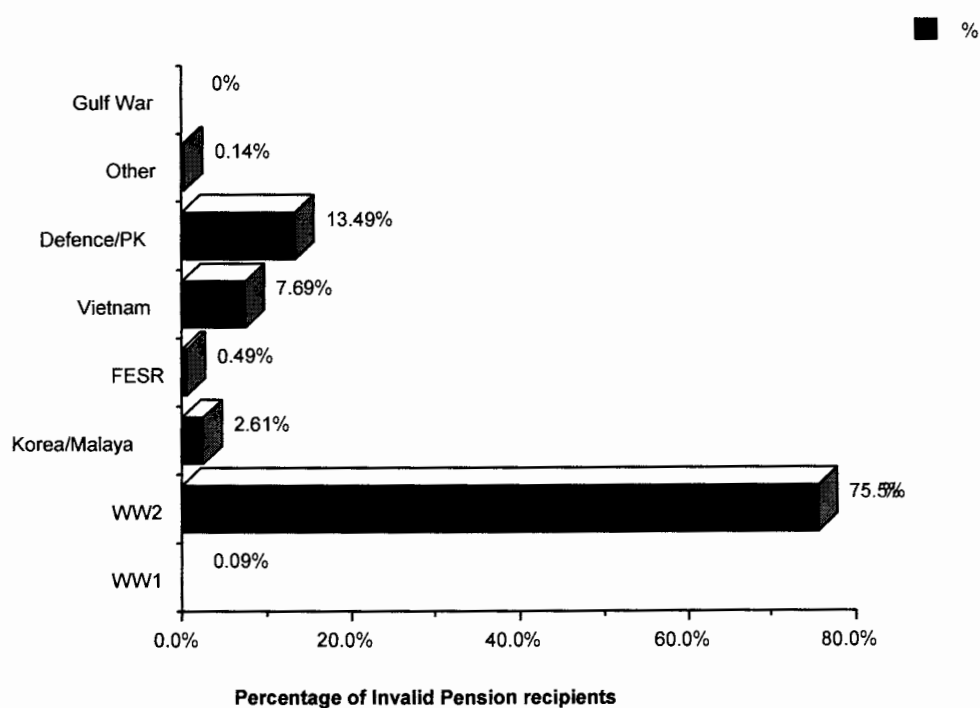


Figure 4.3 The relative proportion of DVA pensioners, by entitlement category, 1994.

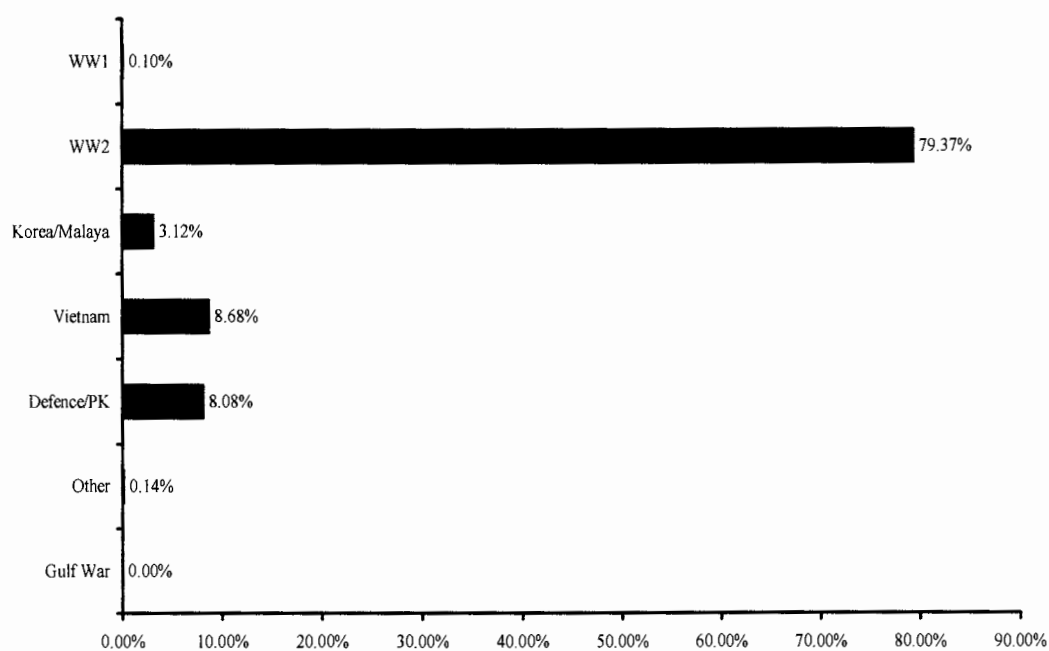


Figure 4.4 The percentage of invalid pension outlay, by entitlement category, 1994.

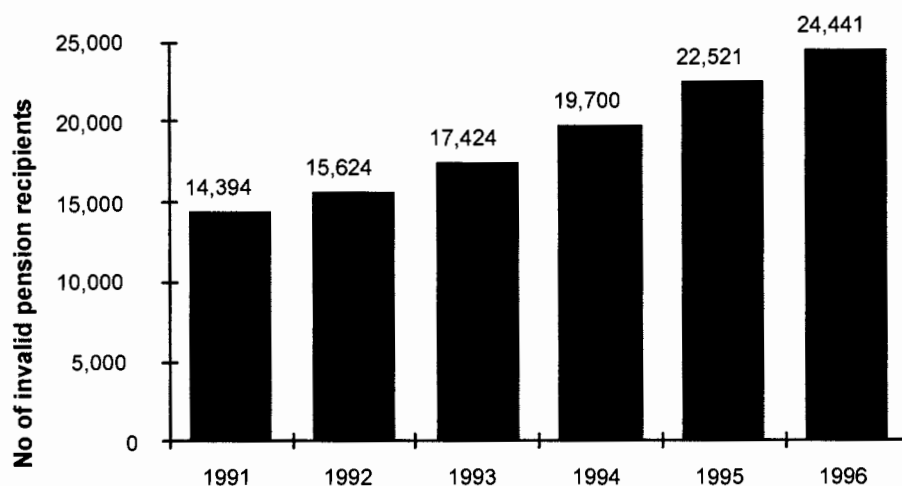


Figure 4.5 The number of Defence Force /Peacekeepers receiving an invalid pension as at 1 July of that year.

Looking at total costs however provides little information about trends. Figure 4.5 shows a steady increase in the number of disability pensions provided to Defence Force members or peacekeepers during the period 1992/3 to 1995/96. There was an absolute increase of 10,047 pensioners, representing a 70% increase in recipients during the 5 years between 1991 and 1996.

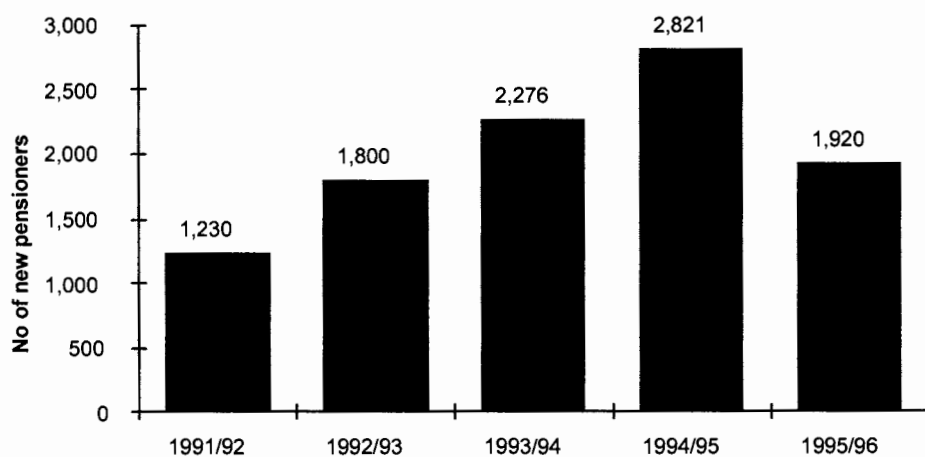


Fig 4.6 The number of new ADF/Peacekeeper pensioners, 1991/92 to 1995/96.

Figure 4.6 shows the annual increase in new invalid pensioner numbers over this period, with the numbers rising steadily between 1991 and 1995. The number of

new pension recipients dropped off sharply in 1996, and there is no obvious explanation for this.

Figure 4.7 represents these increases in percentage terms showing a rate of increase in pensioners rising from 8.5% in 1991/92 to 14.3% in 1994/95.

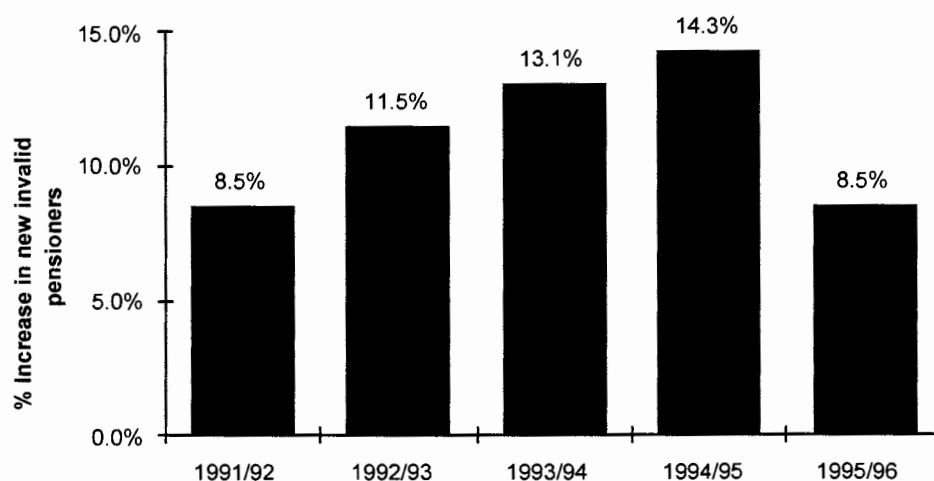


Figure 4.7 The percentage increase in the number of new invalid pension recipients, 1991/92 to 1995/96.

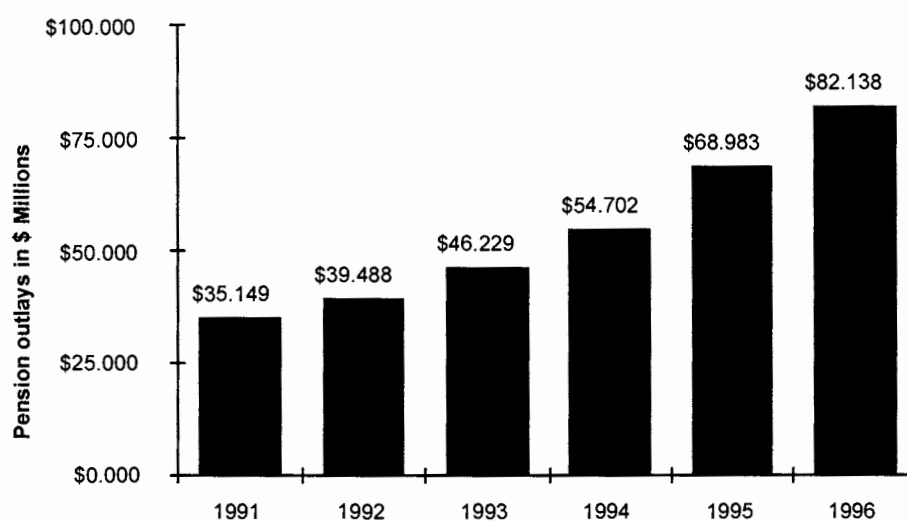


Figure 4.8 Total DVA pension outlays 1991-1996 for Defence Force members.

Figure 4.8 shows the actual cost of these pensions for that period. Total pension outlays rose from \$35M to \$82M in the 6 years from 1991 to 1996, representing a 134% increase in pension costs over that period.

Figure 4.9 shows the annual increase in pension costs over this same period and these ranged from 12.3% between 1991 and 1992 to 26% between 1994 and 1995. Interestingly, despite an 8.5% increase in the number of new pensioners in 1996, pension costs rose by 19.1%. There was no data available from the Department of Veterans Affairs on the type of conditions leading to the awarding of invalidity pensions. There is data available from the MSBS scheme on the causes of medical invalidity from the Army, and it is reasonable to assume a close relationship between invalidity reasons for discharge and the consequent awarding of invalid pensions by DVA.

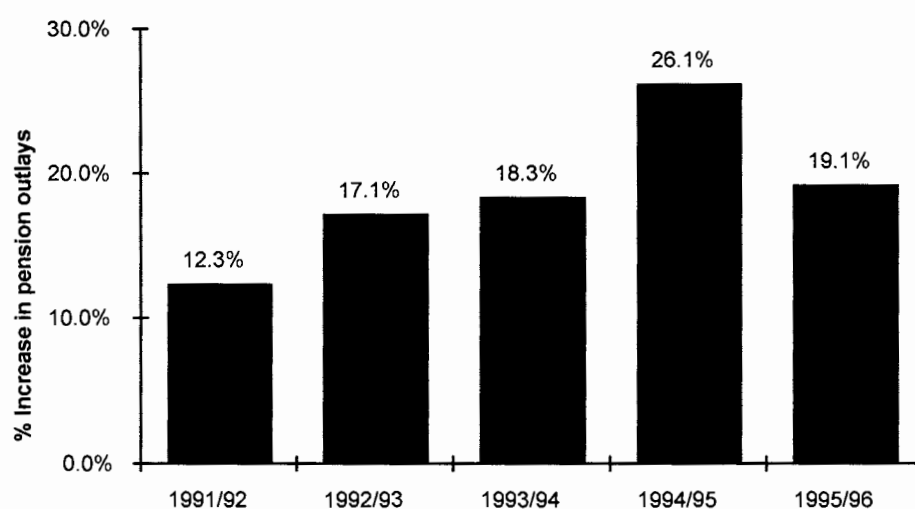


Figure 4.9 The annual percentage increase in invalid pension costs for Defence force members.

Table 4.2 shows the causes of invalidity for which member were entitled to a disability pension under the Military Superannuation and Benefits Scheme (MSBS). Musculoskeletal causes were again dominant, being responsible for between 72% and 78% of all invalidity, with a mean value of 75.6%.

Cause of Invalidity	1996/97	1997/98	1998/99
Malignancy	4 (4.2%)	4 (3.2%)	7 (3.7%)
Digestive system	0 (0.0%)	2 (1.6%)	3 (1.6%)
Mental Health	11 (11.6%)	21 (16.8%)	29 (15.2%)
Other	6 (6.3%)	8 (6.4%)	5 (2.6%)
Musculoskeletal	74 (77.9%)	90 (72%)	147 (77%)

Table 4.2 Causes of Army invalidity recorded by the MSBS scheme, for which members were entitled to an invalidity pension 1996-97 to 1998-99.

4.5 Estimation of Army injury-related DVA invalid pension costs

To estimate the amount of DVA pension costs attributable to Army injury the following assumptions were made.

- (a) Army's costs are disproportionate to its numbers, therefore while representing approximately 50 % of ADF strength it is estimated that Army would account for 72% of pension costs, i.e. in similar proportion to it's outstanding compensation liabilities(as detailed in Chapter 3) and,
- (b) Of the Army related invalid pension costs, it is estimated that 75.6% of these costs will be the result of an injury, similar to the proportion of invalidity due to musculoskeletal causes.

	Estimated Pension Cost
1995-96 Pension increase	\$13.16M
72% Army	\$9.48M
75.6% Injury	\$7.16M
Estimated Ongoing Annual Liability	
1996 Pension Cost	\$82.14M
72% Army	\$59.14M
75.6% Injury	\$44.71M

Table 4.3 Estimated DVA pension cost and ongoing annual pension liability attributable to Army injury, 1996.

Between 1995 and 1996 veterans' pensions increased by \$13.16M dollars and the proportion attributed to Army injury was estimated to be \$7.16M. The total ADF annual invalid pension cost in 1996 was \$82.14M, with the Army component of continuing pension liability estimated to be \$59.14M, with the proportion attributable to injury estimated to be \$41.40M. The ongoing pension liability will compound as new invalid pensioners are added. Table 4.3 illustrates this estimate.

4.6 The Cost of ADF (MSBS/DFRDB) Invalidity Pensions

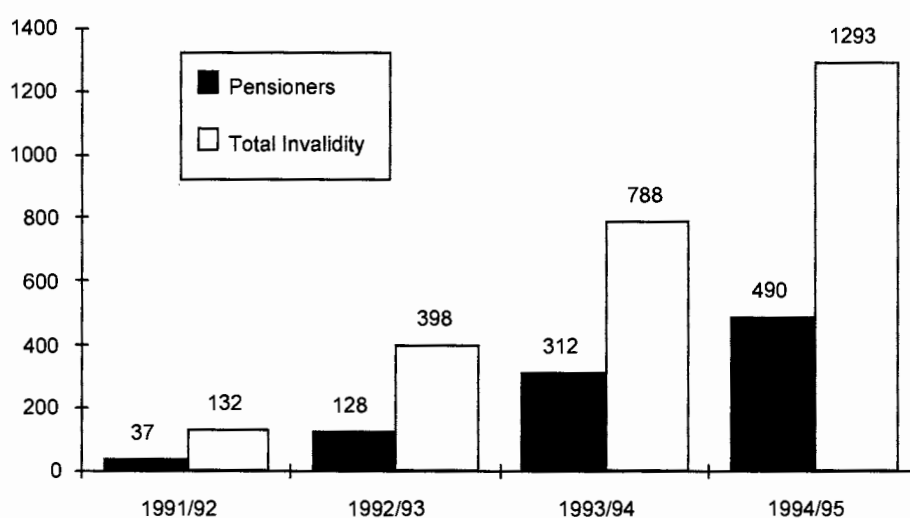


Figure 4.10 The cumulative number of invalidity discharges and invalid pension recipients, MSBS, 1991/92 to 1994/95.

Figure 4.10 shows the accumulating number of invalid pensioners in the MSBS pension scheme from its inception in 1991-92. Those receiving invalidity pensions rose from 37 in 1991-92 to 490 in 1994-95. This dramatic increase is explained by the transitional nature of the new pension scheme. The old DFRDB scheme was closed in 1992, but members were still eligible for invalidity benefits from that scheme.

Figure 4.11 shows that invalidity is primarily a male phenomenon, but this is hardly surprising given that 88% of the ADF is male. Females comprised 15% of new invalid pensioners in 1994-95 which was broadly proportional to their numbers in the ADF population.

Figure 4.12 shows the cumulative cost of invalid pensions paid out by the MSBS scheme over the first four years of its operation. It can be seen that Army was responsible for the overwhelming share of pension costs, rising from 59% of all invalid pension costs in 1991/92, to 69% of pension costs in 1993/94.

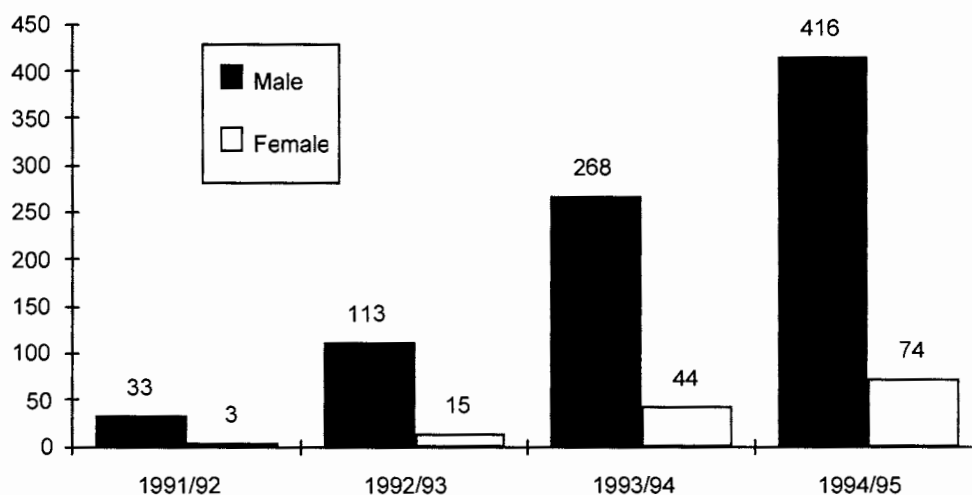


Figure 4.11 The cumulative number of male and female invalid pensioners, MSBS, 1991/92 to 1994/95.

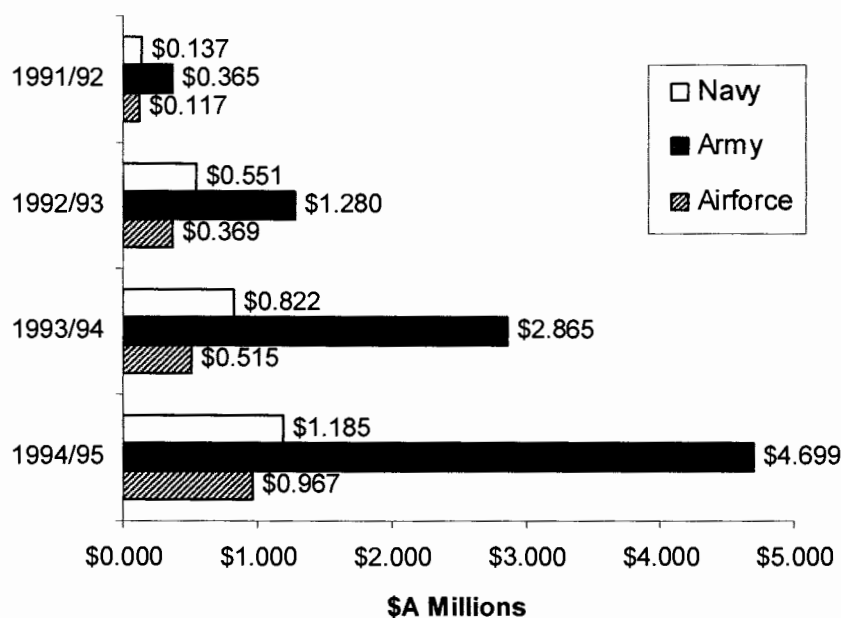


Figure 4.12 Annual MSBS pension liabilities, by Service, 1991/2 to 1994/95

In absolute terms, MSBS invalid pension costs rose at an alarming level over that 4-year period, from a total of \$0.619M in the first year to \$6.851M in 1993/94. This represents a 10-fold increase in new costs over 4 years.

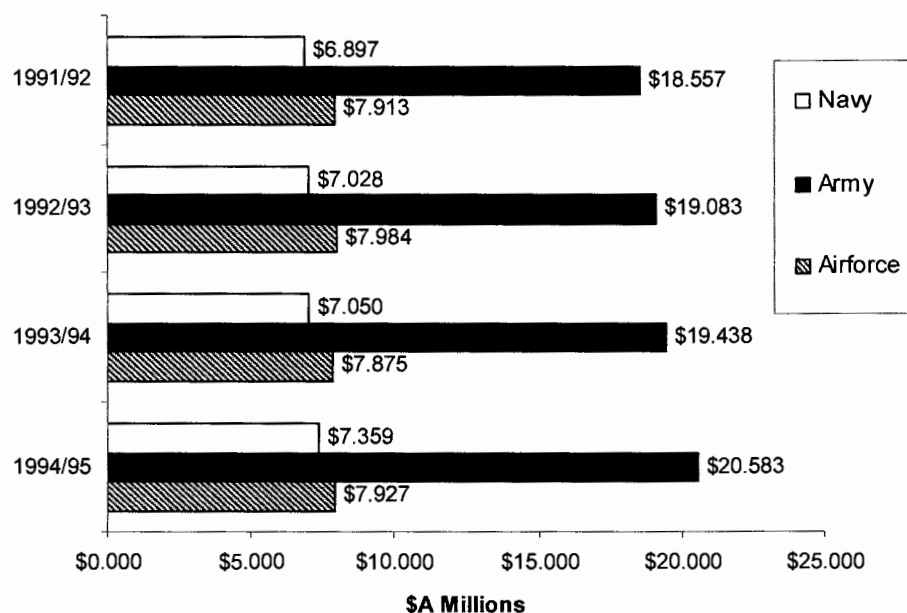


Figure 4.13 Annual DFRDB pension liabilities, by Service, 1991/2 to 1994/5.

Figure 4.13 shows the increase in DFRDB pensions over the corresponding period. In absolute terms, the costs of invalid pensions rose by only half that of the MSBS scheme. This is paradoxical in that the DFRDB scheme contained much older contributors who were theoretically more likely to be invalided, whilst the MSBS scheme held primarily younger and more recent entrants into the ADF. This anomaly can be explained by the high rate of attrition in recent ADF entrants and a “healthy survivor” effect in the DFRDB population

Table 4.4 shows the absolute and relative increases in invalid pension costs over the 4-year period 1991/92 to 1994/95. It can be seen that in the MSBS scheme there were dramatic increases in absolute pension costs which were reflected in the high percentage increases ranging from a 355% increase in the second year to a 163% increase in the fourth year.

The DFRDB scheme has been running for over 20 years and many of its invalid pensioners are aged and frail. A number die each year and are replaced by new pensioners. This “turnover” effect masks the real increase in new pension costs. For MSBS, being a new scheme, the rate of increase in both pensioner numbers and pension costs accurately represents cost increases and demonstrates a substantial ongoing liability for future pension costs.

	91/92-92/93	92/93-93/94	93/94-94/95
<u>MSBS</u>			
Annual ADF increase	\$1.581M	\$2.002M	\$2.649M
% increase	355.4%	191.0%	163.0%
Army	\$0.915M	\$1.585M	\$1.834M
% increase	250.7%	123.8%	64.0%
% of total increase	57.9%	79.2%	69.2%
<u>DFRDB</u>			
Annual ADF increase	\$0.726M	\$0.315M	\$1.461M
% increase	2.2%	0.9%	4.2%
Army	\$0.526M	\$0.400M	\$1.100M
% increase	2.8%	2.1%	5.6%
% Total increase	72.5%	127.0%	75.3%

Table 4.4 The absolute and relative increases in ADF and Army invalid pension costs, 1991/92 to 1994/95, MSBS and DFRDB.

Of particular note is that the cost of Army invalid pensions after 4 years of the MSBS scheme was \$4.7M. This represents 23% of the invalid pension costs of the DFRDB scheme that has been running for over 20 years. For Navy and Air Force the corresponding figures were 16% and 12% respectively.

Army was responsible for over 70% of increased invalid pension costs in both the MSBS and DFRDB schemes. The anomaly in the DFRDB figures was due to a reduction in Air Force invalid pensions paid in 1993/94. This inflated the contribution of the Army increase to a relative figure in excess of 100%.

	96/97 Spine	Total Invalidity	%	97/98 Spine	Total Invalidity	%	98/99 Spine	Total Invalidity	%
Navy	7	35	20.0%	12	44	27.3%	4	47	8.5%
Army	45	95	47.4%	50	125	40.0%	71	191	37.2%
Air	19	51	37.3%	16	47	34.0%	6	33	18.2%

Table 4.5 The relative contribution of spine disorders to Class A and B invalidity, 1996/97 to 1998/99 (MSBS data).

Disorders of the spine were the single most significant cause of invalidity for the period 1997-1999. Table 4.5 shows the number of spine discharges as a percentage of total invalidity.

Army Pension costs 1995 MSBS	\$1.834M
Army Pension costs 1995 DFRDB	\$1.100M
Total	\$2.934M
75.6 % Injury	\$2.218M
MSBS Annual Pension Liability 1995	\$4.699M
DFRDB Annual Pension Liability 1995	\$20.583M
Total	\$25.282M
75.6% Injury	\$19.113M

Table 4.6 Estimated Army invalid pension costs and annual pension liability 1996.

From Table 4.5 it can be seen that disorders of the spine accounted for between 37% and 47% of total invalidity in Army. This was consistently higher than for the other two Services, despite fluctuations. The cost of spinal disorders will be examined in more detail in Chapters 6 and 7. The contribution of musculoskeletal conditions to invalidity was shown in Table 4.2, and therefore an estimate of 75.6% (representing the three year average) was used to calculate the proportion of DFRDB and MSBS pension costs attributable to injury. Table 4.6 shows the estimated Army injury contribution to invalid pension and ongoing pension liability costs for 1995.

4.7 Working days lost and restricted duty costs

Working days lost are a traditional measure of productivity loss and the loss is usually equated to the daily salary. Restricted duties are not normally costed, but in a military context, restrictions represent a significant loss of production or a loss of “capability”.

Days of lost or restricted duty are reported through the Defence Occupational Health and Safety system, utilising a form AC 563 – Report of Injury or Incident. The data used in this section was drawn from the Defence Occupational Health and Safety database. This data represents productivity loss from short-term acute injuries. The days lost is recorded as at the time of the report form being submitted, usually within 30 days of the injury. The OHS database did not record data on long term invalidity.

	No. Injuries Reported	Days Lost	Days/Injury	Total No Troops	Rate of Injury /1000 Troops
<u>Army</u>					
Males	6058	8774	1.45	23377	259.1
Females	904	2391	2.64	2632	343.5
<u>Air Force</u>					
Males	953	1128	1.18	14746	64.6
Females	200	143	0.72	2754	72.6
<u>Navy</u>					
Males	2561	568	0.22	12563	203.9
Females	430	208	0.48	2116	203.2
<u>Total</u>					
Males	9572	10470	1.09	50686	188.8
Females	1534	2742	1.79	7502	204.4

Table 4.7 Reported injuries, rates and days lost by Service and gender, 1995/96.

Table 4.7 shows that there were 11,106 reported injuries in the ADF during 1995/96, with an associated loss of 13,212 days of work. For Army there were 6,962 reported injuries and 11,165 days lost (84.5% of total).

For the purposes of this calculation the value of a lost day will be set at that of a private soldiers daily wage in 1996. The annual salary was \$31,627 and military salaries

are calculated on a 365-day basis, giving a daily salary of \$86 per day in 1996. The cost of one day of restriction is estimated to be half that or \$43 per day.

In Table 4.8, the dollar cost for lost workdays was calculated at \$86 per day. This is a very low estimate of production loss as many of these days lost would have been incurred by members of higher rank and pay. Also, civilian workers are remunerated on the basis of a 38-hour work week, so the 365 day method used in this calculation will provide a low estimate.

	No of injuries	Days Lost	Cost	Total Troops	Cost/ Injury	Cost per capita
<u>Army</u>						
Males	6058	8774	\$763,338	23377	\$126.00	\$32.65
Females	904	2391	\$208,017	2632	\$230.11	\$79.03
<u>Air Force</u>						
Males	953	1128	\$98,136	14746	\$102.98	\$6.66
Females	200	143	\$12,441	2754	\$62.21	\$4.52
<u>Navy</u>						
Males	2561	568	\$49,416	12563	\$19.30	\$3.93
Females	430	208	\$18,096	2116	\$42.08	\$8.55
<u>Total</u>						
Males	9572	10470	\$910,890	50686	\$95.16	\$17.97
Females	1534	2742	\$238,554	7502	\$155.51	\$31.80

Table 4.8 Estimated cost (\$1996) of lost production, by Service and gender, 1995/96.

Army suffered an estimated \$977,355 in lost production due to workplace absence. This is nine times more than production losses in Air Force and over fourteen times greater than Navy. Increased Army female rates of injury were also reflected in increased costs for workplace absence. Cost per injury and cost per capita were twice that of males. A similar ratio was seen in Navy, but the absolute values were one-tenth the costs of Army.

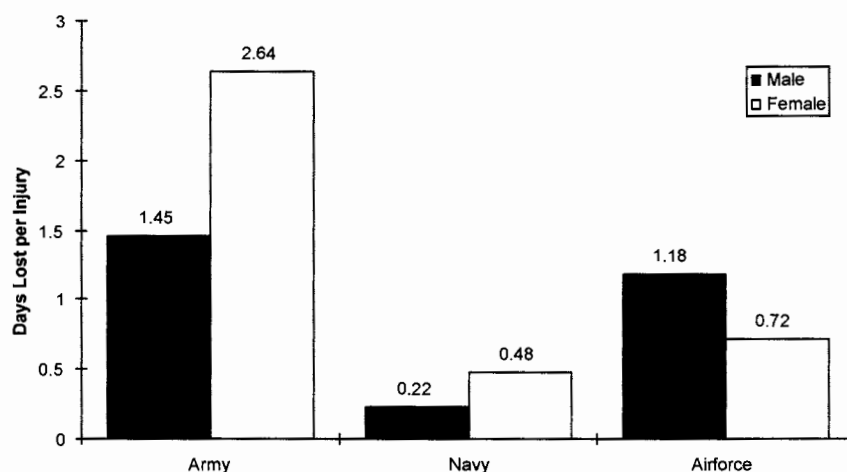


Figure 4.14 Days lost per reported injury by Service and Gender, 1995/96.

Figure 4.14 illustrates the increased female morbidity and shows that Army had five times more days lost per injury than Navy (2.64 vs. 0.48) and nearly four times that of Air Force (2.64 vs. 0.72).

Drummond (Drummond 1986) argues that salary under represents the value of lost production, because it excludes employment on-costs which are traditionally 40% of salary. In the case of military salary, this would increase the value of the daily production loss to \$122 per day.

	Incidents	Lost Days	Salary Cost (\$A1996)	On-Costs (40%) added	% Costs
Army	6,962	11,165	\$971,355	\$1,359,897	84.5%
Navy	2,991	776	\$67,512	\$94,516	5.8%
Air Force	1,153	1,271	\$110,577	\$154,807	9.6%
Total	11,106	13,212	\$1,149,444	\$1,609,221	

Table 4.9 Estimated ADF lost production with employment on-costs added.

Table 4.9 shows that Army production losses increase to \$1.36M when on-costs are included. Even taking into account the low daily wage cost figure, these figures are likely to be a significant underestimate, because Occupational Health and Safety reporting mechanisms have poor compliance. Where the more robust injury reporting system of the Defence Injury Prevention Program was in place, reporting of injury was increased 10-12 fold over earlier OHS reporting.

4.8. The cost of injury to the soldier: foregone wages due to invalidity

4.8.1 Calculation of the value of foregone wages

Traditional burden of disease studies seek to value lost production using lost wages and then use discounting to estimate the present value of those foregone wages. It is important to avoid double counting of production loss and state benefits (transfer payments) as including both will inflate the cost burden (Drummond 1986). Including transfer payments examines the impact on the public purse, as well as looking at the costs to the individual or community as a whole.

Prior to 1978 it was common for analysts to argue that the potential to avert production losses was the major justification for investment in health services. This view no longer prevails (Drummond 1986) and the current argument is whether they should be included at all, as part of the benefit of health service investments or as part of the cost of giving treatment. The main argument for inclusion is that production losses or gains are important to the community, and all other things being equal, society prefers treatments that remove the patient from the workforce for the shortest possible time.

The opposite view holds that earnings loss is a poor measurement of production loss. It is not clear whether production is actually lost, especially with high unemployment, and society's willingness to pay for preventing production loss may have already been incorporated into other estimates of health benefits. Including production losses leads to priority settings based on the type of job a sufferer has. Policy makers may not wish to set priorities in this way.

In cases of short-term illness it is doubtful that production is lost, because staffing levels in large organizations are often based on the assumption of a degree of absence across the total pool of employees. In this case, a reduction in sickness levels may release workers for other tasks, but this would not necessarily result in a proportionate increase in the firm's production. In most studies, the range of costs considered is quite limited, and usually restricted to easily quantified costs. Few studies

attempt to measure the intangible aspects of morbidity and mortality (Drummond 1986).

4.8.2 Lost earnings of Australian Soldiers

Foregone wages due to premature invalidity were calculated using the ADF salary scale in effect at 1 March 1996. It was assumed that members would have normal career progression over a 20-year military career and then retire. It was also assumed that the military pension coupled with any new salary would maintain income at the retirement level until age 55. The 1996 salary was inflated annually using a figure of 3%, which was deemed to be an approximate average of CPI increases over the period 1996-2004, which ranged from 2 to 6 % (Table 4.10).

	2000-01	2001-02	2002-03	2003-04
Sydney	6.2	3.0	2.8	2.1
Melbourne	6.0	2.8	3.3	2.2
Brisbane	5.9	2.9	3.2	2.9
Adelaide	5.7	2.8	4.0	3.0
Perth	5.5	2.7	2.8	2.0
Hobart	5.8	2.0	3.3	2.5
Darwin	5.4	2.1	2.3	1.4
Canberra	6.2	2.5	3.3	2.6
All Cities	6.0	2.9	3.1	2.4

Table 4.10 Percentage change in CPI values 2001-2004 (from ABS Website)

Table 4.11 shows the estimated lost wages discounted back to \$A1996 and the accompanying offset of pension transfer payments. It was assumed that members would continue working until age 55 and then retire. Salary loss at age 55 was then discounted using a discount rate of 5% to the net present value (NPV). NPV losses were then adjusted for invalid pension transfer payments.

Transfer payments were calculated using the DFRDB formula of 76.5% of final salary for Class A pension and 38.25% of final salary for Class B pensions. These pension payments were also inflated at a rate of 3.0%, and then discounted using a

rank of Warrant Officer Class 2. It was also assumed that members who took retirement after 20 years would maintain at least parity with their last military salary, given a second job supplemented by their military pension. In many cases they would exceed their last military salary.

Age	NPV of Lost Wages	Class A Pension adjusted loss	Class B Pension adjusted loss
18	\$822,560	\$476,320	\$683,501
19	\$821,655	\$205,753	\$574,293
20	\$806,289	\$201,918	\$563,559
21	\$790,626	\$198,009	\$552,616
22	\$799,044	\$218,410	\$565,847
23	\$820,380	\$233,307	\$584,597
24	\$804,009	\$201,407	\$561,989
25	\$785,674	\$196,831	\$549,180
26	\$766,983	\$192,166	\$536,122
27	\$747,928	\$187,411	\$522,810
28	\$797,400	\$251,459	\$578,136
29	\$779,035	\$195,249	\$544,572
30	\$756,846	\$189,711	\$529,070
31	\$734,226	\$184,065	\$513,268
32	\$711,166	\$178,310	\$497,158
33	\$687,659	\$172,444	\$480,736
34	\$753,406	\$256,174	\$553,705
35	\$743,106	\$264,205	\$523,204
36	\$720,755	\$260,543	\$505,678
37	\$691,339	\$250,178	\$483,364
38	\$660,962	\$239,221	\$462,142

Table 4.11 Net present value (NPV) of lost wages by age of invalidity and after adjustment for invalid pension transfer payments.

Age	Class A Residual loss	Class B residual loss
	% NPV	% NPV
18	57%	83%
25	29%	70%
30	25%	69%
35	35%	70%
40	27%	70%
45	31%	71%
50	36%	71%

Table 4.12 The effect of pension transfer payments on the loss of lifetime earnings.

It was also assumed that all invalid pensioners would, under normal circumstances have worked until age 55 before taking retirement. Therefore, the work life expectancy of an 18-year-old recruit was taken to be 37 years and that of a 38-year-old Warrant Officer to be 17 years. Because the majority of the Army consists of Other Ranks and there is no way to differentiate between Officers and Other Ranks, it was decided to use the Other Rank pay scale and not the Officer pay scale. This will result in an underestimate of the true cost but will improve confidence in the calculation as a minimal estimate.

Table 4.12 shows the significant effect of transfer payments on final loss of wages. For Class A pension beneficiaries, the net residual loss is between 25-30% of the estimated NPV of lost wages. The very low initial salaries of recruits skew the figures for 18-year-old members. For Class B pensioners there is a consistent 30% residual reduction in the NPV of lost wages across most age groups.

It is also important to test the sensitivity of the results by applying a variety of discount rates. It can often be shown that the choice of a discount rate between the range 2-10% does not affect the study result (Drummond 1986).

Table 4.13 shows the effect of different discount rates on the NPV of lost wages. The effect is most marked in those members who are invalided early in their careers, but the discount rate becomes much less significant once the member is over the age of 45 years.

Years of Service	Age	Foregone Salary	NPV 5% rate	NPV 2% rate	NPV 10% rate
0	18	\$2,110,351	\$822,560	\$1,392,388	\$429,608
1	19	\$2,032,855	\$821,655	\$1,362,501	\$441,081
2	20	\$1,943,861	\$806,289	\$1,318,874	\$438,202
3	21	\$1,857,459	\$790,626	\$1,275,671	\$435,127
4	22	\$1,830,745	\$799,044	\$1,272,312	\$444,979
5	23	\$1,832,460	\$820,380	\$1,288,769	\$462,653
6	24	\$1,748,372	\$804,009	\$1,244,907	\$460,209
7	25	\$1,665,165	\$785,674	\$1,199,872	\$455,874
8	26	\$1,584,382	\$766,983	\$1,155,274	\$451,244
9	27	\$1,505,952	\$747,928	\$1,111,109	\$446,300
10	28	\$1,568,300	\$797,400	\$1,169,898	\$481,385
11	29	\$1,490,438	\$779,035	\$1,125,690	\$478,588
12	30	\$1,411,540	\$756,846	\$1,078,543	\$471,968
13	31	\$1,334,940	\$734,226	\$1,031,853	\$464,899
14	32	\$1,260,572	\$711,166	\$985,616	\$457,348
15	33	\$1,188,369	\$687,659	\$939,829	\$449,285
16	34	\$1,273,122	\$753,406	\$1,017,269	\$498,424
17	35	\$1,221,294	\$743,106	\$987,836	\$501,314
18	36	\$1,154,792	\$720,755	\$944,659	\$494,554
19	37	\$1,079,875	\$691,339	\$893,353	\$482,625
20	38	\$1,006,768	\$660,962	\$842,167	\$469,476
21	39	\$751,927	\$523,596	\$644,787	\$390,281
22	40	\$707,696	\$503,334	\$612,567	\$380,656
23	41	\$663,465	\$482,058	\$579,702	\$370,067
24	42	\$619,234	\$459,718	\$546,181	\$358,420
25	43	\$575,003	\$436,261	\$511,989	\$345,607
26	44	\$530,772	\$411,632	\$477,113	\$331,514
27	45	\$486,541	\$385,771	\$441,540	\$316,011
28	46	\$442,310	\$358,617	\$405,255	\$298,958
29	47	\$398,079	\$330,105	\$368,244	\$280,200
30	48	\$353,848	\$300,168	\$330,494	\$259,566
31	49	\$309,617	\$268,734	\$291,988	\$236,869
32	50	\$265,386	\$235,728	\$252,712	\$211,901
33	51	\$221,155	\$201,072	\$212,651	\$184,437
34	52	\$176,924	\$164,683	\$171,788	\$154,227

Table 4.13 Sensitivity analysis of the effect of different discount rates on the NPV, based on age and years of service.

4.8.3 Estimated Salary loss in invalided soldiers

In the following analysis transfer payments have been included in order to estimate the net loss of income to an invalidity recipient. The net loss will be considered as a productivity loss, borne by the individual rather than society. The transfer payment is a cost borne by government (society).

For the financial year 1996/97 there were 197 disability discharges from the ADF comprising 63 Class A and 134 Class B pensions. For Army there were 40 Class A and 68 Class B Pensions, representing 63% of all ADF Class A pensions and 51% of all Class B pensions. The MSBS figures provide an age breakdown for the type of diagnosis but not for class of pension. Based on the 1996/97 proportion of Class A and Class B we will assume that 38% of invalidity will result in a Class A and 62% will result in Class B.

Table 4.14 shows the age distribution of invalidity pensions for Army in FY1996/97. The figure of 95 differs from the total figure of 108. This discrepancy is due to delays in finalising the diagnosis of particular individuals. The age breakdown was only available for diagnosis categories and not pension categories.

Officer and Other rank salaries differ, but in 1996/97 Officers comprised 5 Class A (12.5%) and 3 Class B (4.4%) of the total invalid pensions granted. For the purposes of this calculation, Other Rank salary losses were used and the mid salary point of the age range was taken for the purposes of the calculation.

1996/97	<20	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60+	Total
Army D/C	6	18	27	14	16	9	3	2	0	0	95
Class A	2	7	10	5	6	3	1	1	0	0	36
Class B	4	11	17	9	10	6	2	1	0	0	59

Table 4.14 Estimation of the number of Class A and Class B pensioners in each age group.

Age	Injury D/C	Class A	NPV Loss Single	Wage Loss Total	Class B	NPV Loss Single	Wage Loss Total
<20	3	1	\$492,791	\$492,791	2	\$683,501	\$1,367,002
20-24	14	5	\$226,209	\$1,131,045	9	\$552,616	\$4,973,544
25-29	25	10	\$219,514	\$2,195,140	15	\$536,122	\$8,041,830
30-34	8	3	\$210,234	\$630,702	5	\$513,268	\$2,566,340
35-39	9	3	\$282,423	\$847,269	6	\$505,678	\$3,034,068
40-44	4	2	\$138,032	\$276,064	2	\$341,002	\$682,004
45-49	2	1	\$118,416	\$118,416	1	\$253,681	\$253,681
50-54	1	0	\$75,176	\$0	1	\$142,236	\$142,236
Total	66	25		\$5,691,427	41		\$21,060,705

Table 4.15 Estimated lost wages resulting from invalidity and adjusted by pension transfer payments. All values are in A\$1996 (inflated and discounted)

Table 4.15 shows that the 66 Army members invalided as a result of injury lost a total of \$26.7M in wages, even after allowing for the transfer payments of the invalid pension. The Class A pension resulted in significantly reduced net loss to the individual.

4.9 Conclusion

Indirect costs resulting from injury to soldiers comprise a number of different components, and this thesis has included invalid pensions. While strictly a direct cost, they are not medical costs and therefore have been included in the calculation of estimated indirect costs of injury. As transfer payments, they are a tangible outcome of the lost production resulting from injury. Other cost components include the productivity losses from sick leave borne by the employer and potential lost earnings due to invalidity, borne by the individual and society.

Injuries can also result in soldiers being medically reclassified or downgraded into categories that restrict their employment and result in an intangible productivity or capability loss. The leading causes of medical downgrade were the usual suspects of lower limb and back injuries, with the proportion of soldiers downgraded due to lower limb causes increasing from 73 per cent in 1987, to 83 per cent in 1992 (Rudzki 1994).

The lack of a comprehensive and effective health surveillance system hampered the correlation between the cause of impairment and the effect of downgrading. The refusal of Defence to record Pulheems data makes any current causal attribution for medical downgrading impossible.

The upward trend in medical downgrading due to injury was reflected in the invalid pension cost data with a 70% increase in DVA invalid pension recipients during the 5 years between 1991 and 1996. The annual increase in pension costs over this same period ranged from 12.3% in 1992 to 26% in 1995. While no DVA data was available on the reasons for invalidity, data from the Military Superannuation Benefits Scheme (MSBS) showed that musculoskeletal causes were responsible for between 72% and 78% of all invalidity, with a three year average of 75.6%. This figure was chosen to estimate the proportion of invalid pensions attributable to injury, while the Army proportion of DVA pension costs was estimated using the proportionate figure of 72% derived from Army's compensation liabilities, as discussed in Chapter 3.

Invalidity in the ADF is primarily a male phenomenon, but this is consistent with the predominance of males in the organisation. After only 4 years of operation, Army invalid pensions within the MSBS superannuation scheme had reached \$4.7M, or 23% of the total invalid pension costs of the DFRDB scheme that had been running for over 20 years. The corresponding Navy and Air Force figures were 16% and 12% respectively. Army costs rose more quickly than the other two Services, being responsible for over 70% of the increase in invalid pension costs in both the MSBS and DFRDB schemes over the period 1992-1996.

In 1995/96 the Army had 6,962 reported work related injuries and 11,165 days of sick leave, representing 84.5% of the ADF total in that year. Using a conservative value of \$86 per lost day, Army suffered an estimated \$977,355 in lost production due to workplace absence. These losses increased to \$1.36M when on-costs were included, and were nine times the loss in Air Force and over fourteen times the loss in Navy. Army had five times more days lost per injury than Navy (2.64 vs. 0.48) and nearly four times that of Air Force (2.64 vs. 0.72), indicating that, in addition to a higher incidence of injury, there was also an increased severity.

Transfer payments in the form of MSBS and DFRDB invalid pensions had a significant impact on the net residual loss of potential earnings. For Class A pensioners, the net residual loss was only 25-30% of the estimated net present value (NPV) of lost wages, highlighting the significant moderating effect of the pension payments. For Class B pensioners, however there was a consistent 70% net residual loss in the NPV of lost wages across most age groups. Varying the discount rate from 2% to 10% had the most marked effect on soldiers who were invalided early in their careers, but the discount rate became much less significant once the member reached the age of 45 years. The residual NPV of lost wages for the 66 soldiers with injury invalidity in 1996/97 was estimated to be \$26.7M.

	Estimated Cost \$A 1996
Veterans Affairs Pensions	\$7.16M
DFRDB/MSBS Pensions 1995	\$2.22M
Total Pensions cost	\$9.38M
Army Lost Production (11,165days) including on-costs	\$1.36M
Total Indirect Costs	<u>\$10.74M</u>
DVA Liability	\$44.71M
DFRDB/MSBS Pension Liability	\$19.11M
Total Pension Liabilities per annum	<u>\$63.82M</u>
Estimated NPV of lost wages of those soldiers in receipt of invalidity pensions for injury	<u>\$26.75M</u>

Table 4.16 Estimated pension costs, annual pension liabilities, lost production and NPV of lost wages due to Army injury.

Table 4.16 summarises the total estimated indirect costs consequent to injury in Army in 1996, as well as the ongoing pension liabilities. Total indirect costs attributed to government were \$10.74M, while individuals who were invalided as a result of injury suffered a residual NPV of lost earnings of \$26.75M. Invalid pension costs were

nearly seven times the estimated production losses, reflecting the long term morbidity associated with chronic injury and subsequent incapacity.

A disturbing feature of the Army experience was the relative youth of those soldiers who were invalidated as a result of injury. Fifty-four percent of Army invalid pensioners were aged 29 years or younger, and in this group foregone wages were much higher than in the older soldiers. In a civilian environment not sympathetic to those with physical disability, the future employment prospects of these individuals are likely to be problematic. Reducing the incidence and severity of injury in young soldiers is the only practical way to significantly reduce future costs.

Chapter 5. Capital Investment losses due to premature separation from the Army due to Injury

5.1 Separation Rates

As discussed in Chapter 4, traditional concepts of production do not apply to the Army. The notion of capability is closely linked to the availability of skilled manpower able to be deployed. A key factor in manning deficiencies is separation from the Army. These fall into two categories, voluntary and involuntary. Involuntary separations are due to medical, psychological or disciplinary reasons.

Any hierarchical organization requires an ongoing staff turnover. However, the most efficient means for this to occur is after people have served defined periods of time, e.g. 10-15 years. If they leave after shorter periods of time, the employer is unlikely to recoup a sufficient return on the funds invested in their education and training.

5.2 Premature separation due to injury

Figure 5.1 shows high medical separation rates in young members of the Australian Army, with 43% of those who left in their first year of service doing so for medical reasons. Medical separation reduces in the middle years, but as personnel become more senior and presumably accumulate wear and tear conditions, the percentage of those discharging with a medical problem increases.

There are artificial spikes at the 19 and 20-year marks. Under the old DFRDB scheme, ADF members became entitled to a pension at 20 years and would conceal injuries until just prior to retirement, in order to achieve pensionable age and have medical conditions noted for compensation and veteran's affairs pension purposes.

Figure 5.2 shows that between 1986 and 1996, 11,998 soldiers were discharged with a medical disability as reflected in their final Physical Employment Standard

(PES) profile. Of these 4606 (38.4%) had less than 4 years of service, reflecting the high morbidity associated with military service for young members.

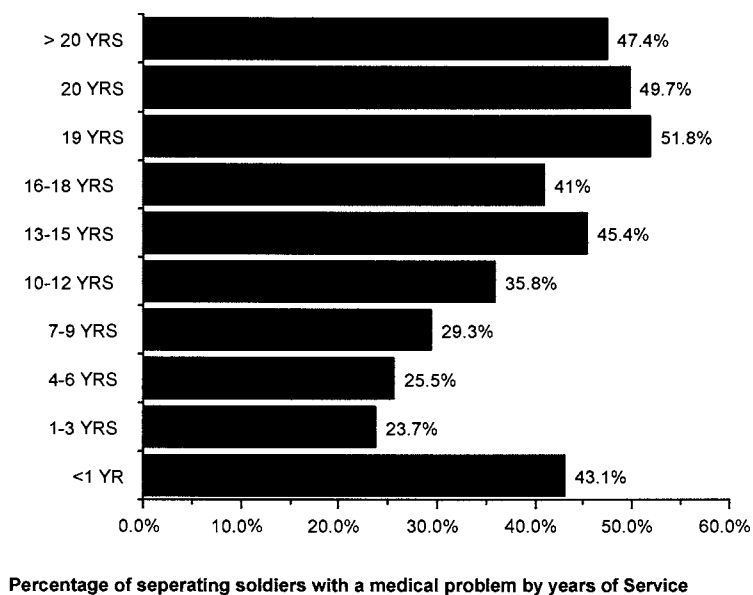


Figure 5.1 The average percentage of medical disability separations from Army, by years of service, 1986-96.

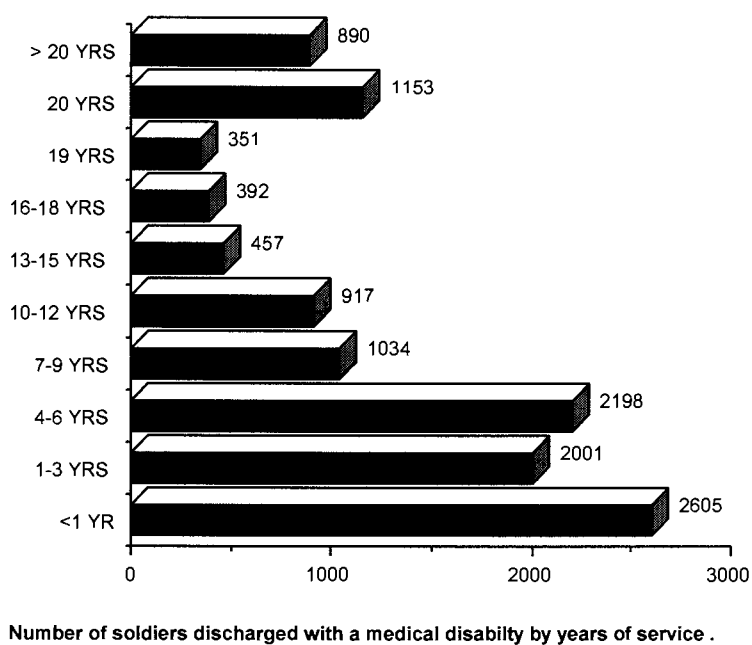


Figure 5.2 The number of soldiers discharged from the Army with a medical disability, by years of service, 1986-96.

5.3 Human Capital Theory

Traditional methodologies do not account for the training cost invested in an individual. In most civilian enterprises, workers usually arrive with the majority of their formal training completed e.g. university or trade. The cost of this training has been borne by the individual and society (via government funding) in varying proportions. Most skills acquired in Tertiary institutions are transferable across a number of industries, although there will always be some specific to job, or "on the job" training involved.

Human capital theory likens education to a capital investment that an individual makes in him or her self. There are two elements to this investment:

- (1) the cost of the training (e.g. Bachelor / Master's degree), and
- (2) the wages foregone whilst studying.

An individual trades off these costs in the belief that after receiving a qualification he or she will command a higher salary that will ultimately compensate for the cost of the education. If the potential benefit in terms of increased salary is unlikely to recoup the cost, then an individual should consider whether the education is a sound investment.

5.4 Organizational Capital Investment in Training

Unlike most civilian employers, the Australian Army invests substantial sums of money into training its members in a number of specific organizational skills. For example, while there is a market for professional skills such as lawyers, doctors, engineers and dentists, there is no market for Artillery, Infantry or Tank Officers. The fighting Corps of the Army (Infantry, Artillery, Armour) require skills that have little or no civilian application. Consequently the Army provides extensive training to equip its members with the skills required to perform their assigned tasks competently.

This training is almost unique in that the total cost is borne by Army, and members do not forego any wages or salary. For Corps such as Ordnance, Electrical and Mechanical Engineers, Aviation, Transport and Signals: many of the skills taught

have civilian application and are highly sought after in the jobs marketplace. The only cost to the employee or Trainee is time. For all of its training courses Army requires a Return of Service Obligation (ROSO), which is akin to a contract, but not formally structured in that way until very recently.

These ROSOs are determined on a time rather than cost basis. The general rule of thumb is that for every year of training the return of service is one for one plus one year. Army has number of methods of entry and these and their ROSOs are summarised in Table 5.1.

Method of Entry	Years of Training	ROSO	Minimum Service (Yrs)
ADFA [§]	3	4	7
ADFA+ RMC	4	5	9
RMC *	1.5	2.5	4
1RTB/IET **	0.5	-	4
Adult Tradesman	2-3	4	6
Direct Entry Officer (DEO)*	0	-	2-4
DEO (Pilot)	2	4	6

Table 5.1 Methods of entry, years of training and return of service obligations, 1996.

§ Australian Defence Force Academy

**1st Recruit Training Battalion/ Initial Employment Training

¥ Direct Entry Officer - professionals e.g. doctors, lawyers.

*Royal Military College (Duntroon)

From Table 5.1 it can be seen that there are number of entry points into Army service with varying degrees of contracted service obligation. These periods represent the minimal contracted time, with members electing to stay on if they choose; a situation termed "open ended engagement", which allows for separation at any time following the completion of the ROSO.

In the case of soldiers, they only have 6 months of training but are contracted for a minimum 4-year period, while for adult tradesmen the contracted period is 6 years, irrespective of the training time. With most trades the learning period is 1.5 to 2

years, and therefore the ROSO is 4 to 4.5 years. In the case of aircraft fitters and mechanics, the training is three years and the ROSO only 3 years.

An officer graduating from the Royal Military College (RMC) can leave the Army after 4 years of service or 2.5 years after graduating. An Australian Defence Force Academy (ADFA) graduate must serve for 5 years after graduation. Table 5.2 summarises the total cost of training various members of Army. These costs were obtained from the Directorate of Costs – Army database as at 1 July 1996.

Course	Duration	Total Cost	ROSO
ADFA	3 years	\$330,000	4 years
RMC	1.5 years	\$138,000	2.5 years
Direct Entry Officer (DEO) Pilot	2 Years	\$501,000	4 years
RMC Pilot	3 years	\$639,000	4 years
ADFA Pilot	5.5 years	\$969,000	4 years
Vehicle Mechanic	2 years	\$154,000	4 years
Aircraft Fitter	3 years	\$243,000	3 years
Electronic Technician	2 years	\$253,000	4 years

Table 5.2 Sample of training costs for various Army employments, \$1996.

5.5 Previous attempts to cost personnel wastage

Wythes (Wythes 1991) attempted to calculate the costs of increased personnel wastage in the Royal Australian Air Force (RAAF). He noted that in 1991 there was no universally accepted methodology for calculating costs, despite the fact that two previous reports had recommended a study of the cost of personnel turnover be undertaken.

He noted that while there appeared to be a consensus on the importance of experience in the ADF, there was no method of quantifying experience in measurable and meaningful terms. One, albeit imperfect, gauge that was readily quantifiable was to measure the replacement cost and overheads incurred when a member separated from the Service.

Wythes argued that a replacement cost approach reinforces the view of labour as a factor of production, and therefore it is a 'cost' that affects the 'profit' on capital and therefore something to be curbed. Taking a leaf from human capital theory, Wythes argued that training expenditure is an investment in capital, not an overhead cost, and capital produces profits. In short, he felt there was a need to change attitudes to view manpower as capital instead of labour; an investment to be protected, not a cost to be curtailed.

Wythes estimated the costs of replacing staff at given turnover rates on a training replacement basis. He argued that the cost of any particular pattern of personnel turnover was the aggregate of:

- (1) the cost of replacement of fully trained personnel,
- (2) the cost of replacing the specific skills and training of personnel who separate, and
- (3) the cost of postings (relocations based on changing job locations)

The first two were classed as training replacement costs, while the last was classed as a cascade cost. Cascade is a reflection on the reality that movement in one area leads to a number of related movements to fill the resulting vacancies. Vacancies created in a particular rank level are filled by peers or the promotion of subordinates. This creates the need to move people between different locations.

Wastage of trained and experienced personnel creates a disproportionate degree of movement. A consultant study into this issue indicated that a single vacancy would lead to an average of 5 vacancies. (Peat Marwick Mitchell Services 1987)

Wythes produced figures stating that for a Warrant Officer vacancy there were 13 postings, for a Sergeant 5.7 and for a Leading Aircraftsman (LAC) only 1. The more senior the loss, the greater the disruption and movement. The average cost of a posting in FY 1989-90 was \$6,410.

In any decision in whether to vary an activity, it is always the marginal cost that is the relevant factor. (Baumol 1979). Given that most training institutions already exist and have fixed costs, marginal analysis applies to the rate of replacement training

generated by the variation in the rate of personnel wastage. Given the scale of training schools, the cost of training n students could be the same as training $n+20$ students.

The primary manpower costs to the Department of Defence are salary and allowances, non-effective benefits (NEBs), general service costs and some base support costs. The Defence Directorate of Costs, aggregated these NEBs and calculated them as a percentage "on cost" of military salaries. General service costs were calculated by averaging the aggregate cost of a basket of 18 expenditure classes. This cost was calculated to be \$25.08 per day in \$1989.

There are four stages in the training replacement process:

- (1) recruitment,
- (2) recruit training,
- (3) basic trade training and
- (4) field and unit training.

The cost of replacing a fully qualified RAAF member was the sum of the costs for the four stages. Recruiting does not lend itself to marginal analysis, because it is continuous process and unless there is a wide variation, it is relatively insensitive to variations in personnel turnover. Wythes estimated that the marginal cost of training a replacement radar technician (highly skilled) was \$166,164. The cost of replacing a supply officer was estimated to be \$26,938. This variation in costs was a function of the duration and quality of training required for each employment.

For the two occupational groups of radar technician, and supply officer the total replacement and cascade costs were estimated to be \$10.5M, for a 5.3% separation rate. If this was extrapolated to the total airman wastage for that year, then the total cost was estimated to be approximately \$195.5M. This represents the marginal cost of additional training courses plus the averaged real costs associated with postings. This could be accepted as the unavoidable cost of doing business, but it is an expensive way of doing business. In 1989, the total airman wastage was 11.48% and Wythes calculated that a 2% reduction in wastage would lead to a saving of \$34.11M.

5.6 The Capital Investment Model.

Human resources are considered valuable by many organizations, but it is often difficult to put a value on these resources. The market does so by paying salaries to people with various skills who are in high demand. The greater the demand, the greater the likely salary. In public sector organizations, salaries are fixed and equal across various skill groups. There is essentially no market, and if the salary is uncompetitive the position will remain unfilled, or be taken by an individual under a contracted obligation.

If one applies the same principles of capital equipment investment to human resources, a picture of the relative worth (or cost) of individual members to the Army can be developed. Capital investment in this case, is the cost of the training that Army expends in achieving a desired level of competence and manning levels. This capital cost is amortised over the various contracted periods of service or ROSOs. If a ROSO is 4 years, this results in an annual depreciation rate of 25%. If a soldier or officer separates prematurely due to injury (before the contracted ROSO period), the initial capital investment is not fully amortised, and there is a resultant book loss equivalent to the remaining net present value (NPV) of the depreciated capital investment.

Trade/Skill	Pilot (DEO)	Aircraft Fitter	Electronic Technician
Cost to Train	\$501,000	\$243,451	\$253,578
Yrs of Training	2	3	2
ROSO	4	3	4
Rate of Depreciation	25% pa	33% pa	25% pa
NPV at end			
Year 1	\$375,764	\$160,678	\$190,184
Year 2	\$250,510	\$80,339	\$126,789
Year 3	\$125,255	\$0	\$63,395
Year 4	\$0		\$0

Table 5.3 Depreciation schedule for capital investment in three selected employments.

This methodology involves calculating the cost of conducting the training courses for each of the skill groups. These costs were obtained from the Directorate of

Costs - Army. The components considered in calculating the cost of the courses included staff wages, support services (medical, dental, psychology, computing), stores and equipment, consumable goods (food and ammunition) and facility operating expenses (fuel, power, water).

Using the values from Table 5.3, a pilot who separates in the second year of his ROSO represents a book loss of \$375,764. An electronic technician who separates in the third year of his ROSO represents a loss of \$63,395.

5.7 Capital Cost of Premature Separation

The costs of individual Army training courses were obtained from the Directorate of Costs- Army database and then allocated against skill groups and their training progression. All training courses required before a member was considered suitable for initial employment were included and this training cost was then depreciated over the ROSO period applicable to the specific skill group. For example, to be an effective infantryman a soldier must have completed recruit training and initial employment training before being considered fully trained (usually 6-8 months). An airframe fitter however, would have needed to have completed his full three year apprenticeship to be fully trained.

A premature separation was defined as separation from Army prior to the completion of a ROSO period. If a member failed to complete the ROSO period, a book loss of the remaining undepreciated value was deemed to have been incurred. This varied for different occupations and skill groups, e.g. six years for Direct Entry Officer (DEO) pilots and Tradesmen and four years for RMC graduates and general enlistment soldiers. Officers do not have trades, but soldiers are allocated an Employment Code Number (ECN), which reflects specific trade skills.

Table 5.4 summarises the estimated cost of premature separations for officers for the three financial years 1992/93 to 1994/95. Between \$11-13 million was lost annually as a result of premature separation of officers. The two occupational groups with the highest losses were pilots and officer cadets.

For soldiers, Table 5.5 shows similar calculations performed by skill group or Employment Code Number (ECN), for all separations defined as premature for the period 1992/93 to 1994/95. The greatest losses were sustained in trainees; with recruits, initial training and apprentices having the greatest cost impact.

Corps	1992/93		1993/94		1994/95	
	No	Cost	No	Cost	No	Cost
RAINF	10	\$414,976	5	\$281,232	9	\$414,976
RAA	0	\$0	2	\$449,598	6	\$899,196
RASIGS	2	\$165,703	5	\$278,555	3	\$218,555
RAAC	3	\$473,371	2	\$453,371	2	\$171,124
RAAOC	2	\$95,550	1	\$75,550	7	\$624,400
RACT	2	\$303,038	0	\$0	3	\$115,760
RAE	2	\$330,443	1	\$20,000	1	\$20,000
RAEME	2	\$172,506	10	\$918,783	0	\$0
AAAVN	8	\$3,105,605	27	\$5,727,133	23	\$4,352,897
ADFA	22	\$3,795,000	22	\$3,795,000	50	\$500,000
RMC	5	\$513,000	5	\$513,000	22	\$3,795,000
Non Corps	41	\$820,000	45	\$450,000	5	\$513,000
SSO	56	\$952,000	35	\$574,000	31	\$511,000
O/GSO	9	\$457,750	3	\$246,650	4	\$322,200
TOTAL	164	\$11,598,942	163	\$13,782,872	166	\$12,458,108

Table 5.4 Cost of premature separation - Officers 1992/93 to 1994/95. (\$1996)

RAINF = Royal Australian Infantry, RAA = Royal Australian Artillery, RASIGS = Royal Australian Signals,
 RAAC = Royal Australian Armoured Corps, RACT = Royal Australian Corps of Transport,
 RAE = Royal Australian Engineers, RAEME = Royal Australian Electrical and Mechanical Engineers,
 AAAvn = Australian Army Aviation, ADFA = Australian Defence Force Academy,
 RMC = Royal Military College, SSO = Special Service Officers, O/GSO = Other General Service Officers

For trained troops the greatest losses were in riflemen, aircraft fitters and motor mechanics. Riflemen costs were the result of large numbers of soldiers being discharged, while motor mechanics and airframe fitters had high training costs and only required small numbers to be discharged in order to generate a large loss.

The significant losses associated with recruits and initial employment training reflects the burden of injury in this population. During the period 1992-95, the recruit

training course was 12 weeks long and initial employment training a further 12 weeks. Consequently all of these separations occurred during the first year of Army Service, and none of these members completed their ROSO. The total cost of recruit training was calculated by the Directorate of Costs to be \$18,500 and included acquisition costs (advertising, screening, and transportation) as well wages, room and board, while the cost of initial employment training was \$18,000. Facilities and training staff costs were fixed and apportioned pro-rata against the throughput of trainees. Even though the recruits and initial trainees left at different stages of training, all premature losses were assigned the total training cost, as the majority of costs were already incurred as a result of their fixed nature. While there will have been variations in wage and food costs, it was not possible to account for these variations. Therefore the total training cost estimates are likely to be a small overestimate of the true losses.

Employment	Code Number (ECN)	No	1992/93 Cost	No	1993/94 Cost	No	1994/95 Cost
Rifleman	343	121	\$4,121,344	112	\$3,010,513	57	\$1,481,108
Clerk	74	22	\$565,493	23	\$393,385	10	\$122,293
Driver	109	43	\$1,027,125	39	\$717,750	21	\$420,751
Tank Gunner	88	25	\$1,002,555	16	\$524,060	3	\$68,785
Field Engineer	140	20	\$579,382	21	\$682,846	5	\$124,153
Gun Number	162	21	\$783,291	13	\$424,281	6	\$277,417
Tank Commander	90	6	\$419,686	6	\$464,754	6	\$419,686
Aircraft fitter	143	5	\$717,935	7	\$1,073,311	5	\$1,283,581
Airframe fitter	146	6	\$738,372	6	\$725,484	2	\$241,016
Motor Mechanic	229	11	\$848,331	20	\$1,692,799	17	\$848,331
Electronic Tech	405	2	\$167,130	2	\$111,420	11	\$1,169,910
Electronic Tech	415	2	\$380,367	5	\$316,367	3	\$443,762
Apprentice	App	34	\$2,700,000	46	\$3,840,000	26	\$1,855,000
Recruit	Rec	52	\$962,000	118	\$2,183,000	388	\$7,178,000
Initial Training	IET	30	\$1,095,000	22	\$803,000	35	\$1,277,500
Other	Other	210	\$5,175,499	197	\$3,810,925	77	\$1,262,254
Total		610	\$21,283,510	653	\$20,773,895	670	\$18,473,547

Table 5.5 The calculated cost of premature separation – Soldiers, 1992/93 to 1994/95.

The NPV losses in skilled tradesmen were rounded up to the nearest whole year, again resulting in an overestimation of the losses due to wages and food, but taking into account the apportionment of facilities and staff costs across the student population.

Table 5.6 shows that the estimated loss of capital investment as a result of premature separation was approximately \$30.9 million per annum (in \$1996).

Year	Total no of premature separations	Total Estimated Cost
1992/93	774	\$32,882,452
1993/94	816	\$34,556,767
1994/95	836	\$30,931,655

Table 5.6 The total estimated loss on capital investment due to premature separation from the Army (Officers and Soldiers), 1992/93 to 1994/95.

5.8 Capital Cost of medical separation due to injury

To calculate the cost attributable to injury, data on the medical classification of those who separated prematurely were obtained and analysed using the same methodology. This data was only available for the soldier groups.

The Army medically classified its soldiers using the PULHEEMS system in 1996. PULHEEMS is an acronym for a number of physical attributes; Physical, Upper limb, Lower limb, Hearing, Eye left, Eye right, Mental capacity, and Stability. These physical qualities are graded with numbers; 2 being normal, 3 representing moderate impairment, 7 representing severe impairment and 8 representing total impairment for work. People whose PULHEEMS profiles were all twos were classified as Fit Everywhere (FE), those with a physical quality of 3 or less were graded either Communications Zone Everywhere (CZE), Base Everywhere (BE), Home Only (HO), Below Medical Standards (BMS) or Medically Unfit (MU).

This group of classifications can be simplified into 3 groups, those without physical restriction, those with a physical restriction and those not medically fit for continued employment. Soldiers who were made MU were medically discharged from

the Army and were entitled to an invalid pension. Soldiers who were made BMS were theoretically suitable for retraining, but in practice were discharged medically as no other Corps group would accept soldiers who had restrictions. These soldiers had no entitlement to an invalidity pension, but were entitled to a lump sum compensation payment based on the independently assessed level of impairment.

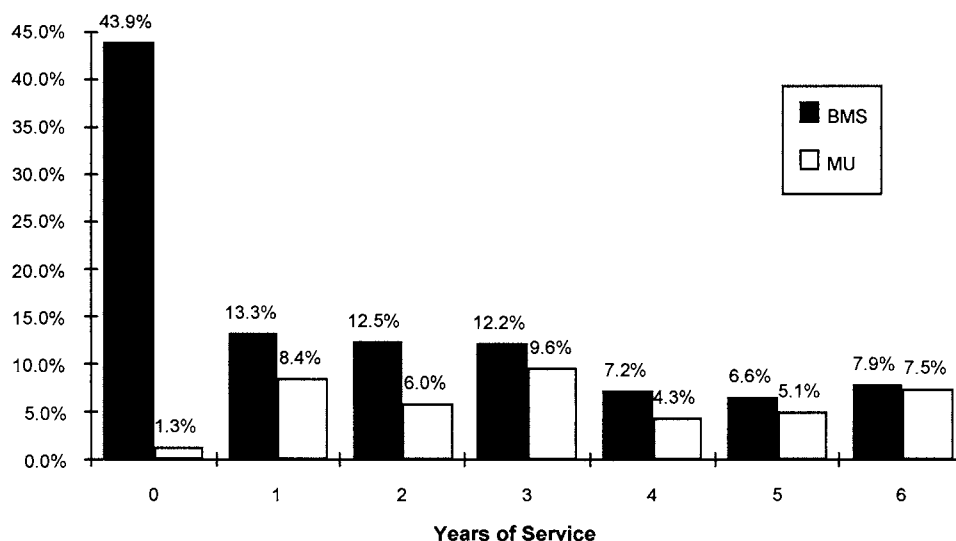


Figure 5.3. The 3-year average percentage of soldiers who were discharged as either BMS or MU, 1992/93 to 1994/95.

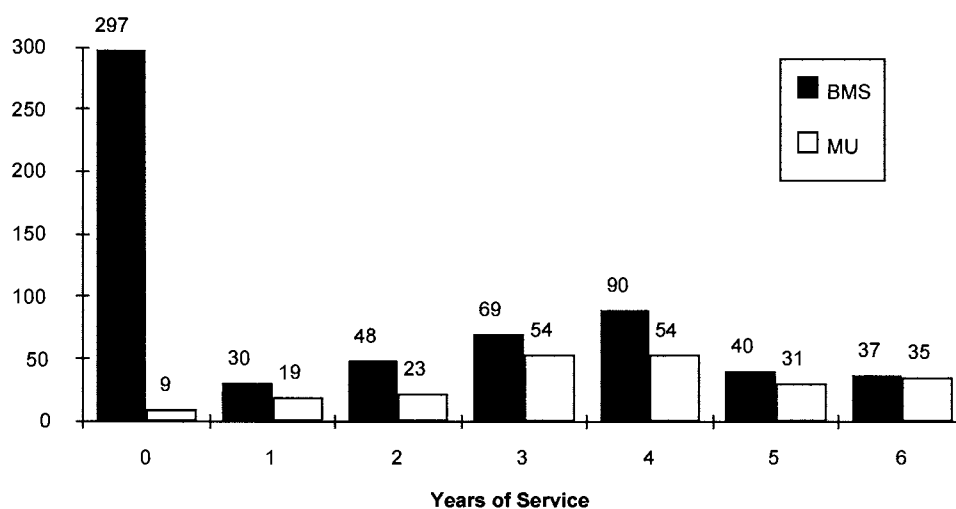


Figure 5.4. The number of BMS and MU soldier discharges, 1992/93 to 1994/95.

Figure 5.3 shows that 45.2% of those who left in the first year of service did so as either Medically Unfit (MU) or Below Medical Standards (BMS), reflecting the morbidity associated with recruit and initial entry training. For those who separated after one to six years of service, MU and BMS discharges comprised between 11.4% and 21.7% of separations.

For the remainder, their medical grading allowed them continued employment, but decreased their career prospects, as promotion courses and advanced training were restricted to FE personnel. So while they were not medically forced from the Service, many elected to leave in order to restart a new career. It could be argued that these separations were as a consequence of injury or illness.

To estimate the cost of injury in soldiers there are two possible methods. The first involves taking the percentage of total capital loss as a consequence of premature separation and then applying the percentage loss attributable to medical discharge (MU/BMS) due to injury. The second method employs the residual value of the training investment at the time of medical discharge. Because data on officer medical separations was not available, a residual loss analysis on this group could not be done.

	Total Loss	MU/BMS	Loss MU/BMS	Injury Cost (80%)
<u>1992/93</u>				
< 1 year	\$2,057,000	22.40%	\$460,768	\$368,614
1-3 Years	\$19,226,510	18.70%	\$3,595,357	\$2,876,285
Total	\$21,283,510		\$4,056,125	\$3,244,900
<u>1993/94</u>				
< 1 Year	\$2,986,000	35.30%	\$1,054,058	\$843,246
1-3 Years	\$17,787,895	19.00%	\$3,379,700	\$2,703,760
Total	\$20,773,895		\$4,443,758	\$3,555,006
<u>1994/95</u>				
< 1 Year	\$8,455,500	53.60%	\$4,532,148	\$3,625,718
1-3 Years	\$10,018,047	29.30%	\$2,935,288	\$2,348,230
Total	\$18,473,547		\$7,467,436	\$5,973,948

Table 5.7 Estimated capital loss from medical separation due to injury, Soldiers.

Musculoskeletal and injury causes accounted for 80% of all medical discharges during this period, so injury was assumed to account for 80% of medical losses. Table 5.7 shows the estimated capital losses attributable to premature medical separation due to injury.

The residual method calculates the remaining residual value of the training investment that was not depreciated to zero at the end of the ROSO period. This value was calculated for individuals based on the percentage value remaining from the initial training investment. The residual value was rounded up to the nearest year, i.e. if a soldier was discharged in his second year of a 4 year ROSO, he would have been deemed to have lost 2 years of service and Army would have sustained a 50% residual training capital investment loss. Table 5.8 summarises the estimated capital loss due to medical causes derived from residual values.

Employment	Code	No	1992/93	No	1993/94	No	1994/95
	No		Residual		Residual		Residual
Rifleman	343	40	\$1,239,623	34	\$821,049	23	\$515,168
Clerk	74	5	\$147,520	6	\$110,640	3	\$36,879
Driver	109	9	\$222,375	11	\$198,000	6	\$123,750
Tank Gunner	88	1	\$45,571	4	\$113,926	0	\$0
Field Engineer	140	4	\$82,768	4	\$124,154	1	\$20,962
Gun Number	162	7	\$261,097	3	\$114,230	2	\$114,231
Tank Commander	90	0	\$0	0	\$0	1	\$140,835
Aircraft fitter	143	2	\$319,082	1	\$241,729	1	\$241,729
Airframe fitter	146	1	\$160,678	2	\$404,129	0	\$0
Motor Mechanic	229	5	\$347,045	6	\$539,847	4	\$308,484
Electronic Tech	405	0	\$0	0	\$0	2	\$278,550
Electronic Tech	415	1	\$126,789	0	\$0	0	\$0
Apprentice	App	4	\$346,000	9	\$730,500	9	\$579,500
Recruit	Rec	18	\$333,000	49	\$906,500	212	\$3,922,000
Initial Training	IET	8	\$292,000	5	\$182,500	16	\$584,000
Other	Other	43	\$1,020,345	50	\$995,758	28	\$482,625
Total		148	\$4,943,893	184	\$5,482,962	308	\$7,348,443

Table 5.8 The cost of medically related discharge from Army, as estimated from residual training investment at time of discharge.

	% Method	Residual Method	Variation
1992/93	\$3,244,900	\$3,955,114	(+21.9%)
1993/94	\$3,555,006	\$4,386,370	(+23.4%)
1994/95	\$5,973,949	\$5,878,754	(-1.6%)

Table 5.9 The variation in estimated loss due to injury, between the direct residual value estimation method and the percentage estimation method.

Table 5.9 compares the values obtained using the two methods and the variation in outcomes. For the years 1992/93 and 1993/94 the residual value method produced consistently higher losses. In 1994/95 there was a substantial jump in recruit discharges, and these had a very low residual training value as most had only received the minimum amount of training prior to discharge. This large number of low value trainees obscured the effect of losses from soldiers engaging in longer and more expensive training courses.

To calculate the cost of premature separation due to injury in the officer group it was necessary to make some assumptions based on the soldier group. Due to the lack of medical discharge data on the officer group, the medical discharge rates observed in the soldier group were applied. But because of the large rise in medical discharges in 1994/95, a three year average discharge rate was applied. It was also assumed that 80% of medical discharges were attributable to injury.

	Total premature separation loss	Rate of medical discharge - Soldiers	Estimated Cost	Injury Cost
1992/93	\$11,598,942	20.6%	\$2,389,382	\$1,911,506
1993/94	\$13,782,872	27.2%	\$3,748,941	\$2,999,153
1994/95	\$12,458,108	41.4%	\$5,157,657	\$4,126,125
		3 Year Average		
1994/95	\$12,458,108	29.7%	\$3,700,058	\$2,960,046

Table 5.10 Estimated capital losses from to premature separation due to injury in Officers.

Table 5.10 shows that the estimated loss in officers was \$4.12M if a medical discharge rate of 41.4% was applied. As this is significantly higher than previous years, a 3-year average rate of 29.7% was also applied yielding a loss of \$2.97M. But as pension and compensation data for this period indicates a significant increase in medical pension liabilities, the 41% medical discharge figure may yet again be a reflection of changed personnel management policy which occurred at that time.

5.9 Conclusion

All hierarchical organizations require an ongoing staff turnover, but if there is high turnover in the early stages of employment, the employer is unlikely to recoup a sufficient return on the funds invested in education and training. The Army had high medical separation rates in junior staff. Between 1986 and 1996, 11,998 soldiers were discharged with a medical disability as reflected in their final Physical Employment Standard profile. Of these 4606 (38.4%) had less than 4 years of service, reflecting premature and the high morbidity associated with military service for young members.

This thesis argues that investment in the training of soldiers represents a capital investment no different to that of a new piece of equipment. The use of a capital depreciation approach to personnel is unusual, but as training of staff is fully funded by the Army, the training investment should be considered an organisational asset, as opposed to an individual training investment as in the human capital model.

These training investments are substantial and time critical. If there are staff losses in specialised areas such as tank drivers, there is no ready supply in the market able to fill the gap. The challenge for defence planners is to ensure that the flow of skilled labour is sufficient to allow for the efficient and effective operation of the capital intensive equipment used by Defence. In these terms, capability could be described as the right equipment operated by the right people with the right training.

Injury interrupts the supply of skilled manpower necessary for Army to staff its organisation and achieve its mission. Where premature separation as a consequence of injury occurs, Army fails to achieve a reasonable return on the capital invested and

reducing the incidence of injury provides an opportunity to improve the supply of skilled labour and reduce training costs.

As Wythes (Wythes 1991) argued, skilled labour should not be considered as an overhead cost that affects the profit on capital, but as an investment in capital that produces profits. The Army does not make profits but it does provide capability options to government. Investing in the training of its soldiers allows Army to produce capability; which effectively is the profit that Army should produce from the capital it has invested.

The estimated annual cost of premature separations for Officers for the three financial years 1992/93 to 1994/95 ranged between \$11-13 million, with pilots and officer cadets incurring the greatest losses. For soldiers, the losses ranged from \$21.3M to \$18.5M with the greatest losses sustained in recruits, initial trainees and apprentices. The total cost of premature separations ranged from \$32.9M in 1992/93 to \$30.9M in 1994/95.

The proportion of those who left the Army for medical reasons varied, with 45.2% of those who left in the first year of service doing so as either Medically Unfit (MU) or Below Medical Standards (BMS), reflecting the morbidity associated with recruit and initial entry training. For those who separated between one and six years of service, MU and BMS discharges comprised between 11.4% and 21.7% of separations.

Two methods were used to estimate the cost of premature separation due to injury. As musculoskeletal and injury causes accounted for 80% of all medical (MU/BMS) discharges, the first method applied this percentage to the total losses due to premature medical separation. The second method used the residual value of the training investment at the time of medical discharge.

The residual value method provided a 20% increase in estimated loss compared to the proportional method, with the exception of 1994/95. The difference in 1994/94 was the result of a substantial jump in recruit medical discharges (212) compared to earlier years (18 and 49 respectively). This large number of recruits had not received much in the way of training prior to discharge and consequently had a very low residual value, obscuring the effect of training losses from more highly trained soldiers.

	Total premature loss	Estimated medical discharge rate	Medical discharge loss	Injury loss
Officers	\$12,458,108	41.4%	\$5,157,657	\$4,126,125
Soldiers	\$18,473,547		\$7,467,436	\$5,973,948
Total	\$30,931,655		\$12,625,093	\$10,100,073

Table 5.11 Estimated total capital loss from premature separation due to injury 1994/95.

Table 5.11 estimates the total capital loss attributable to premature separation due to injury. The total capital loss was estimated to be \$10.1M. As there was no data available for the 1995/96 period, data from 1994/95 has been used to estimate the 1996 cost. Because of the rounding up of years of service and the impossibility of accurately apportioning salary and food costs, the estimated losses in trainees will likely be a slight overestimate.

The loss of trained staff has significant impacts on the ability of Army to staff its organisations and man its equipment. Army provides and fully funds the training of its workers necessary to achieve its capability outputs; a rarity in an employment environment where most skilled workers can be “purchased” in the marketplace.

Training costs have not previously been treated as an investment and therefore quantified and depreciated as such. The capital investment model provides Army with a methodology to accurately account for its training investment and provides a financial incentive to reduce premature separation for all reasons, including injury.

Chapter 6. The cost of surgical procedures used for the treatment of low back disorders in soldiers.

6.1 Introduction.

The previous chapters have examined large databases to estimate the scale of the costs involved with injury, an approach which has been termed a top down approach to determining costs (Ekman 2005). However, the paucity of data and its poor quality prevents a more detailed examination of the injury problem. One area where comprehensive Army data was available was in an earlier study conducted by the author into the area of spinal surgery.

Spinal surgery is usually the consequence of chronic low back pain attributable to injury. The preceding chapters have shown that back pain is the single leading cause of disability in the Army, being responsible for 40% of ADF invalid discharges, making back injuries the single most important subgroup of injury in Army. A systematic review of the cost of back pain found that only a small proportion of back pain sufferers were responsible for the majority of back pain costs (Dagenais 2008). This small proportion almost certainly includes those who undergo spinal surgery, so the characteristics of this group are important to analyse in order to fully understand the quantum of costs and outcomes of back injury.

This chapter will examine the costs attributable to spinal surgery in a small Army cohort. The perspective taken is that of society as both direct medical costs and indirect costs are reviewed, but invalidity pension costs are not assessed. The perspective of government, in terms of health managers, will also be adopted, as all health costs were paid for by government with no private insurance input. A “bottom up” approach will be taken in this chapter (Ekman 2005), where detailed individual patient data is obtained, allowing for the analysis and comparison of subgroups (Soegaard 2007b).

6.2 Disability due to Low Back Pain (LBP)

Lumbar pain has reached epidemic proportions in western industrialized countries. The reported lifetime incidence of low back pain in the literature varies from 48%-69% (Frymoyer 1983) (Beiring-Sorensen 1982), point prevalence rates being variously reported between 12.0% (Beiring-Sorensen 1982) and 30.2% (Valkenburg 1982). In a recent systematic review of 27 studies examining the cost of back pain, Dagenais found the prevalence of back pain to range from 5-65%, with a mean of 18.7% and a standard deviation of 4.6% (Dagenais 2008).

The natural history of low back has been reported to be relatively benign with only 10% of acute episodes failing to resolve by 2 months (Brooks 1998), although a British study (Croft 1998) found that 75% of patients in a general practice setting still experienced back pain 12 months after an acute episode. The authors in this study found that while patients ceased seeking medical care at 3 months, most still had substantial back pain and disability.

In the United Kingdom (UK), 1 in 25 workers changed job annually because of a back condition (Harris 1971) and, on any given day, 0.05% of the workforce was disabled for more than 6 months by a back problem. Wood estimated that one-third of all musculoskeletal complaints in the UK in 1978 were back related (Wood 1987). In the United States, Low Back Pain (LBP) was the most frequent cause of activity limitation in those aged 64 or less (Andersson 1990).

Long, in a study of chronic low back pain sufferers, found that persistent low back pain was most common in people aged in their mid-to-late thirties and early-to-mid forties (Long 1996). These patients were mostly white, affluent and generally well educated. The average patient suffered from intermittent pain for 10 years, with the pain usually well localised, but varying greatly in severity. These patients reported significant functional impairment at work, home and play and most had consulted multiple health care providers and received a variety of treatments and medications, with none being effective. Muscle spasm, tenderness and trigger points were common, but neurological signs were rare despite one in three patients having a diagnosis of disc prolapse. Myofascial syndrome and spinal instability were the next most common

diagnoses. Only 20% were prescribed surgery, with 60% being offered additional conservative therapy and 20% given no further treatment.

The 1989/90 Australian National Health Survey (Australian Bureau of Statistics 1991) found that back pain was reported in 9% of the population, but more commonly in the middle aged (15% of people aged 45-49). The same survey in 1995 (Australian Bureau of Statistics 1995) found that only 2.4% of the total population reported a current back injury or related condition. The highest reported rates of current back injury were in the 35-44 yr group (4.2%) and the 45-54 yr group (4.8%), with over 440,000 Australians reporting a current injury-related back problem in 1995.

However, ten years later and the situation had changed significantly, with the 2004/05 National Health Survey finding that over three million Australians or 15.1% of the Australian population, reported suffering from back pain, with a prevalence in the 15-24 year age group of 9% (Australian Bureau of Statistics 2006a). These figures indicate a significant worsening of the morbidity burden of back pain in the years since this thesis was commenced in 1996.

The incidence of reported compensable back injury in NSW was 5.8/1000 workers in 1992 and 6.1/1000 workers in 1996. In 1984-85, one in four compensated injuries was for back injury [Qld 23%, NSW 24% and SA 28%] (National Occupational Health and Safety Commission 1989).

The disability associated with low back pain has progressively increased in the United States, with disabling episodes rising by 26% between 1974 and 1978, while the total population increased by only 7% in the same period (Andersson 1990). Andersson also noted that there were significant problems with the validity and reliability of low back pain data (Andersson 1991). Most data in national statistics relied on reported cases and these were unlikely to be an accurate reflection of the true incidence. Classification systems also varied greatly, so data retrieval was difficult and correct diagnoses were unlikely to be recorded, with a tendency to over report severe LBP in comparison to milder forms.

6.3 Cost of Low Back Pain (LBP)

The determination of work-related LBP costs is difficult. In the United States, there are many sources of payment for direct costs; worker's compensation, group and private health insurance, and social security benefits. Direct costs typically include medical care, rehabilitation expenses and death benefits. Indirect costs are associated with production losses, training and legal expenses.

In the US, back injuries accounted for an average of 21% of all compensable work injuries (Antonakes 1981), but comprised an average of 33% of compensation and medical costs for occupational injuries. Spengler found that back injuries comprised 41% of total workers compensation costs in a sample of Boeing workers (Spengler 1986). The US National Safety Council estimated the cost of back pain to the US economy to be \$31.4 Billion in 1981 (National Safety Council 1981). Australian health system costs attributable to back problems in 1993/94 were estimated to be \$700 million (Mathers 1999).

Holbrook estimated the annual total cost of back pain to be US\$16 Billion [1984 dollars] (Holbrook 1984). In Holbrook's study, direct costs were dominant, accounting for 81.4% of total costs, while the indirect costs due to lost earnings accounted for only 18.6%. This was a reflection of the extremely expensive US health care system, where inpatient services accounted for 34.9% of total costs.

Total estimated costs of low back pain to society have been reported as being up to 1.7% of the gross national product (GNP) in the Netherlands (Norlund 2000, van Tulder 1995) and 0.5% to 2% of GNP for the United States (Cats-Baril 1991). As much as 75% of the costs could be attributed to patients who were still on sick leave after 6 months (Andersson 1999).

Snook (Snook 1987) estimated that in 1986, the mean cost per compensable case of back pain was about US\$6,000 with a median value of \$750. The large discrepancy between the mean and the median values reflected the fact that back pain costs were not normally distributed, with a few high cost cases accounting for the majority of costs. Abenhaim found that 10% of cases were responsible for 75% of direct costs (Abenhaim 1987). Hashemi (Hashemi 1998) in an insurance cohort study

reported that 5% of claims accounted for 65% of costs, while Kim in a Korean study found that 6% of claims accounted for 29% of total costs (Kim 2005). Watson, in a workers compensation cohort from Jersey found that 35% of back pain cases returned to work after 1 day and the 3% of those disabled for more than 6 months accounted for 33% of benefit costs (Watson 1998).

Leavitt (Leavitt 1971) on the other hand found that in Californian cases, medical costs only accounted for 33% of costs with compensation for lost wages accounting for the remaining two thirds. Snook (Snook 1987) found the average cost per case of compensable back pain was US\$5,739 in 1987, with a median cost per case of US\$350. The study found significant variation in costs per state, with the average and median cost per case over 2.5 times more costly in Massachusetts than Wisconsin. In Snook's study, 10% of case accounted for 78% of costs.

Luo found the incremental (additional) medical care costs attributable to back pain, compared to a control group without back pain, totalled US\$26 billion and included higher costs for office-based visits (US\$11.1 billion), outpatient services (US\$4.7 billion), inpatient care (US\$4.5 billion), prescription drugs (US\$3.9 billion), and ED visits (US\$1.1 billion). Patients in the highest 10% of costs accounted for 99% of inpatient care costs, 90% of ED visits, 87% of outpatient services, 53% of prescription drugs, and 52% of office-based visits (Luo 2004).

Antonakes (Antonakes 1981) showed that as the duration of back pain increased, costs rose at an accelerated rate due to increasing levels of permanent or partial disability. Leavitt (Leavitt 1971) reported that medical costs accounted for one third of total costs while disability payments accounted for the remaining two thirds of costs (permanent disability 66% and partial disability 33%). Costs increased dramatically with surgery, which was usually associated with payment for permanent partial disability. Laminectomies were found to result in 10-25% permanent total disability. These high cost cases were characterised by greater degrees of hospitalisation, surgery, litigation and psychological impairment (Abenhaim 1987).

In the UK during 1978, nearly 1% (375,000) of the population experienced an episode of back pain, which required certified incapacitation. It was estimated that this incapacity cost the UK community £220M pounds in lost productivity. The social

security system also paid out £40M in sickness and invalidity pensions, and NHS medical costs were estimated to be at least £60M (Working Group on Back Pain 1979). In the UK, the economic burden of back pain to the National Health Service was calculated to be £1632 million in 1998 (Maniadakis 2000).

In NSW, between the years 1991/92 to 1997/98 the incidence of occupational back injuries remained stable at between 5.5 and 6.0/1000 workers, but the cost of these injuries almost doubled in the same 7 year period (Workcover 1999). The gross incurred cost of back injuries in NSW during the period 1995/96 was approximately \$212.5 million, which accounted for 36% of the total workplace injury cost (Workcover Authority 1997). The gross incurred cost is the sum of payments plus an estimate of future liability if the claim was still open at the end of 1995/96. The estimated average cost was \$16,195, but half of all claims cost \$2,091 or less. Weekly payments (31%) were the largest cost component, followed by medical payments (16%) and legal costs (13%). Cases undergoing surgery were not identified in the Workcover report.

With increasing disability comes increased cost. In the NSW Workcover cohort, at six months post injury, 27% had not returned to work, with permanent disability reported in 16%, accounting for 50% of the value of gross incurred temporary disability costs (Workcover Authority 1997). Private Workers Compensation data (Poynter 1996) showed that for the years 1992-1995, low back injuries accounted for 19% of claims, 30.2% of total claims cost and 33.8% of total weeks lost work.

Tables 6.1 to 6.3 summarise the NSW workers compensation experience. Table 6.1 shows that total payments for back-related injury in NSW rose by 47% in the 4 years between 1991/92 and 1994/95. Table 6.2 compares the mean and median costs of back disease and back injuries. It shows that while there were fewer disease conditions they were on average much more costly, with a higher median value. The difference in cost is explained by the high permanent disability rate of 42.6% in the disease group compared to 16.1% in the acute injury group, with the relative risk of permanent disability in the disease group being 2.6.

	Non-compensation Payments \$'000	Compensation Payments \$'000	Total Payments \$'000
1991/92	\$106,287	\$259,971	\$366,258
1992/93	\$130,167	\$302,392	\$432,559
1993/94	\$141,287	\$332,556	\$473,843
1994/95	\$144,615	\$393,967	\$538,582

Table 6.1 Workcover NSW payments for workplace back injuries 1991/92 to 1995/96.

Type	Number	Mean Cost \$	Median Cost \$	Total
Injury	13,121	\$16,195	\$2,091	\$212.5M
Disease	312	\$36,687	\$13,284	\$11.45M

Table 6.2 The comparison between occupational injury and disease as recorded by the Worksafe NSW database, FY 1995/96.

Most conditions in the disease category were disorders of the intervertebral disc. The distinction between disease and injury of the lumbar spine should be considered a misclassification. Workcover defined injury as the result of a single precipitating acute event, meaning that repetitive or overuse injuries were classed as diseases. For practitioners of musculoskeletal medicine the distinction between chronic overuse injury (repetitive strain) and industrial “disease” of the low back is a moot point.

	Disability	Permanent Disability (PD)	Incidence of PD	Relative Risk
Injury	13,121	2,114	16.1%	1.00
Disease	312	133	42.6%	2.64

Table 6.3 The number and incidence of permanent disability in those workers sustaining reportable workplace back injury and disease.

Dagenais, in a review of published studies examining the cost of low back pain found 8 studies that provided estimates of both direct and indirect costs (Dagenais

2008). Mean direct costs accounted for only 22% of total costs, indicating that indirect costs were a much larger contributor to the cost of low back pain. Hutubessy (Hutubessy 1999) estimated productivity losses due to low back pain in the Netherlands at \$4.6 billion based on daily absences and disability costs for the actual duration of work absences. Maniadakis (Maniadakis 2000) estimated work productivity losses in the UK of £9.1 billion based on 116 million lost work days, while Walker (Walker 2004) estimated work productivity losses in Australia at AUD\$8.1 billion based on 62,441,052 lost work days.

6.4 Spinal Surgery

Spinal surgery is a relatively common event with more than 200,000 patients undergoing a lumbar procedure in the United States every year (Wilkinson 1983). In Australia, there were 2518 discectomy or fusion procedures (Item numbers 40301, 40321, 48636, 48648- 75) to the lumbar spine for which Medicare benefits were paid in 1997, and in 2008 this figure had risen to 10,742, a 400% increase (Medicare Australia 2009).

Rates of spinal surgery are known to vary significantly from nation to nation. In Sweden, during 2000, approximately 3 to 4 per 100,000 adults had a lumbar fusion because of low back pain of unknown origin (Stromqvist 2001). Rates of lumbar fusion in US Medicare recipients were 30/100,000 in 1992, doubled to 60/100,000 in 1998 and reached 110/100,000 in 2003 (Weinstein 2006c). These figures however, are not representative of the situation in the younger working population. Weinstein found an 8-fold variation in regional rates of lumbar discectomy and laminectomy, and a nearly a 20-fold range in lumbar fusion rates in 2002 and 2003 (Weinstein 2006c). He noted "This represents the largest coefficient of variation seen with any surgical procedure".

US Medicare expenditure for inpatient back surgery more than doubled over the decade from 1992 to 2003, with costs for lumbar fusion rising by more than 500%, from US\$75 million to US\$482 million. In 1992, lumbar fusion represented 14% of total spending for back surgery, but by 2003 lumbar fusion accounted for 47% of

spending. For lumbar discectomy and laminectomy expenditure was estimated to be US\$306 million in 2003 (Weinstein 2006c).

The most recent Medicare Australia data reported 6,186 lumbar spine fusions in calendar year 2008 (item numbers 40321, 48648-75), representing an annual rate of 29/100,000 (Medicare Australia 2009). These figures publically funded procedures only, with privately funded compensation procedures likely to be much higher. Given that most work-related spinal injuries workers compensation cases, usually in private hospitals, the true rate is likely to be between 1.5 to 2 times greater (33.58/100,000). The rate for the "at risk" population of working adults is likely to be higher again.

	Total Number of procedures Jan 1997-Dec 2008	Percentage Incidence	Medicare Rebate \$Millions	Percentage Medicare Rebate
Lumbar Fusion all types MBS item no 40321, 48648-75	39,011	55.2%	\$19.810	56.25%
Lumbar Discectomy MBS item no 40301, 48636	29,508	41.7%	\$15.298	43.45%
Manipulation under anaesthesia MBS Item no 48600	2,010	2.8%	\$0.101	0.29%
Manipulation under anaesthesia with addition of epidural medication MBS item no 48603	197	0.3%	\$0.002	0.01%
Total Procedures	70,726		\$35.211	

Table 6.4 Number of lumbar spine surgical procedures and Medicare Australia rebate costs for the period Jan 1997 – Dec 2008.

Table 6.4 shows that over the last 11 years there 70,726 surgical procedures on the lumbar spine funded by Medicare. Lumbar fusions comprised 55% of procedures and 56% of costs, while lumbar discectomies comprised 42% of procedures and 43% of costs. Manipulation under anaesthesia comprised 3% of total procedures.

Figure 6.1 shows that the Medicare rates of lumbar discectomy and fusion have steadily increased over the last decade, with the rate of fusion increasing faster than discectomy. These increases parallel those observed in the United States, but are not of the same absolute magnitude. Despite being a relatively common procedure, there is

considerable debate about the efficacy and the efficiency of lumbar fusion for chronic low back pain (Gibson 1999).

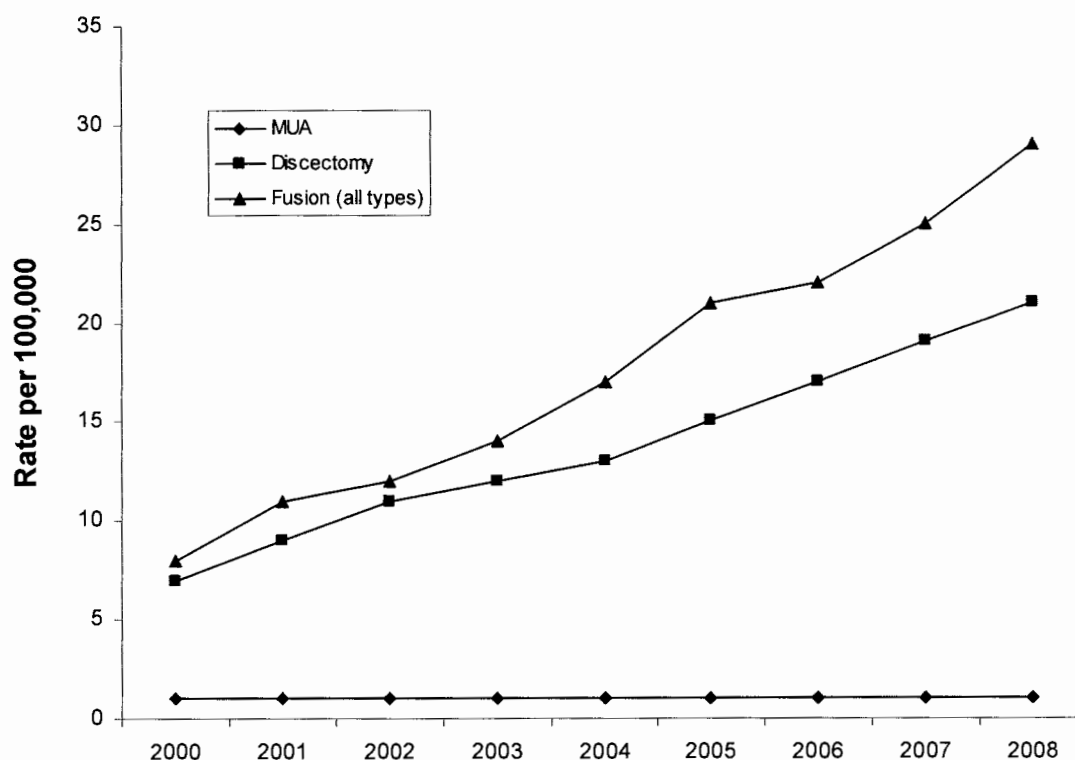


Figure 6.1 Medicare rates of lumbar discectomy, fusion and manipulation under anaesthesia, Australia 2000-2008. (Medicare Australia 2009)

6.5 Cost of spinal surgery in a cohort of soldiers - Methods

The data presented in the next two chapters is from a retrospective observational study utilizing data obtained from patient health records, and a patient questionnaire. A bottom up approach was adopted, as described by Ekman, where more detailed cost and outcome data is obtained from individual surveys and records (Ekman 2005).

The operating theatre record book for the calendar years 1987-89 at the 1st Field Hospital, Ingleburn, Sydney were reviewed. All patients who had undergone a spinal surgical procedure were included in the study. A spinal surgical procedure was defined as any procedure on the lumbar spine performed by a surgeon in the operating

theatre.

Data was initially collected in 1991 and analysis commenced in 1996. Sixty-one patients were identified from this review of the operating theatre records. The medical records for each of these 61 individuals was obtained from Central Army Health Records and reviewed. Approval to review the patient records was given by the Director General of Army Health Services. This study pre-dated the establishment of the Australian Defence Force Ethics Committee.

The surgical procedures were performed by visiting Orthopaedic surgeons at 1st Field Hospital of whom the numbers varied between four and five. No attempt was made to record data on the surgeon involved in any of the cases. The aim was to collect a sample that was representative and generalisable to community orthopaedic practice.

The following data was obtained from the medical records:

- (a) Age of patient at time of first surgery,
- (b) Time in service at time of first surgery,
- (c) Time from initial presentation to first surgery,
- (d) Time from first surgery to discharge,
- (e) Diagnosis,
- (f) Number and type of investigations performed,
- (g) Number and type of Procedure/s performed,
- (h) Number of hospital bed days,
- (i) Number of days sick leave and
- (j) Number of days restricted duty

Cost calculations were based on 100% of the 1989 Medicare schedule fee for the procedures identified in the medical record. Investigation charges were also calculated at 100% of the Medicare schedule fee for that investigation. Anaesthetic fees were calculated using a cost of \$11 per anaesthetic unit and applied to the number of units listed alongside each procedure in the Medicare schedule.

Hospital bed day costs were calculated using an all inclusive cost of \$276 per day, this being the figure used by the Commonwealth at that time for the purposes of cost recovery in civil litigation. Indirect costs were calculated using the 1989 daily salary of a private soldier of \$60 per day. For a day in hospital or on sick leave a cost of \$60 was allocated. For a day of restricted (light) duties, a 50% loss of productivity was assumed, giving a figure of \$30 per day. This was an under-estimate as many of the patients were of more senior rank and their daily salaries were significantly higher. Where members were permanently medically restricted, a maximum of 365 days of restricted duty was calculated.

Where individuals had multiple procedures and investigations these were combined and a cost per patient rather than cost per episode of care was obtained. All direct and indirect costs were pooled for all the procedures and absences of the patient. This analysis did not attempt to estimate the net present value of wages lost due to permanent incapacity or any transfer payments such as compensation or invalid pension payments, nor did it cover ongoing medical costs.

Additionally in March of 1991 a questionnaire was sent to the last known address of the 61 patients. This questionnaire requested participation in a follow-up study and asked questions about current levels of pain, disability, function and patient satisfaction. A check of the central Defence personnel database was made in 1996 to ascertain the number of subjects still in employment within the military. These results will be described in Chapter 7.

6.6 Cost of spinal surgery in a cohort of soldiers - Results

Number of Procedures (n=106)	No of patients (n=61)
One	31
Two	20
Three	6
Four	3
Five	1

Table 6.5 The number of procedures performed on the sample group.

Table 6.5 shows that the 61 patients underwent a total of 106 procedures, with 30 (48%) undergoing two or more procedures. The average age of the patient sample was 29.7 years with a mean time in service of 8 years.

Table 6.6 details these 106 procedures, which were divided into 36 non-operative and 70 operative procedures. There were four types of non-operative procedures and over 20 different individual operative procedures involving different lumbar levels. In an attempt to simplify the great variety of surgical procedures they were grouped into four broad categories: non-operative, decompression procedures, stabilization procedures, and combined decompression and stabilization procedures.

Procedure	Number
Non-Operative	
Epidural Steroid	14
Facet injection of Steroid	2
MUA + Epidural Steroid	11
Manipulation under Anaesthesia (MUA)	9
Sub-total	36
Operative	
Discectomy 1 level	31
Discectomy 2 levels	2
Discectomy + metal fusion (various)	6
Laminectomy 1 level	5
Laminectomy 2 levels	5
Bony fusion - 1 level	5
Bony fusion 2 levels	2
Discectomy + Bony fusion	2
Hartshill (metal) fusion 1 level	3
Hartshill (metal) fusion 2 levels	3
Metal Fusion (various)	6
Metal + bony fusion (various)	2
L4-S1 Removal Hartshill fusion	1
Re-explore Hartshill fusion	1
Subtotal	70
Total	106

Table 6.6 The type and number of surgical procedures performed.

Table 6.7 details the diagnoses recorded in the medical records. There were 17 different diagnoses recorded and in one case, no formal specialist diagnosis was recorded. There was a lack of common diagnostic terminology and terms such as prolapse, protrusion and rupture were used interchangeably. The most common

diagnosis was single level disc prolapse with 21 cases (34%) with disc degeneration being the second most common diagnosis in 11 (18%) cases.

Diagnosis Recorded	Number
Chronic LBP	3
Annulitis	1
Disc degeneration	11
Disc prolapse 1 level	21
Disc prolapse 2 levels	4
Disc protrusion	1
Disc rupture	1
Disc disease	2
Disc prolapse + spondylolysis	4
Facet joint strain	1
Spondylolisthesis	5
L5 spondylolysis	1
Spondylolisthesis + disc degeneration	1
L5/S1 transitional vertebra	1
Neuralgia paresthetica	1
Schwannoma	1
Spina Bifida S1 + scoliosis	1
No diagnosis recorded	1
Total	61

Table 6.7 The recorded pre-operative diagnoses found in the medical records.

Type of Cost	No	Cost (\$A1989)
<u>Direct</u>		
Hospital Bed Days	2,897	\$799,572
Anaesthetics	1204 units	\$13,244
Operations	106	\$63,951
Materiel rental/use	18	\$11,096
Investigations	320	\$47,048
Total Direct Costs		<u>\$934,911</u>
Mean Cost/patient (n=61)		<u>\$15,326</u>
<u>Indirect</u>		
Lost Work Days*	10,288	\$617,280
Restricted Duty days**	17,751	\$532,530
Total Indirect Costs		<u>\$1,149,810</u>
Mean Cost/patient (n=61)		<u>\$18,849</u>
Total Estimated Cost		\$2,084,720
Total Mean Cost/patient		\$34,175

Table 6.8 Estimated total direct and indirect costs of all spinal surgical procedures in this cohort (A\$1989). (* Lost workdays are the sum of hospital bed days and sick leave calculated at \$60/day) (**Permanently restricted patients were allocated 365 days, calculated at \$30/day)

Table 6.8 details the estimated total direct and indirect costs for this patient cohort. The total direct cost was estimated to be \$934,911 with a mean cost of \$15,326 per patient while total indirect costs were estimated to be \$1,149,810 with a mean cost of \$18,849. The total estimated cost was \$2,084,720 with a mean cost per patient of \$34,175 (\$A1989). There were 2,897 hospital bed days, or an average of 47.5 days per patient. This large number of bed days reflects the routine use of inpatient rehabilitation in the post-operative period. The Army had a policy that single soldiers who lived in a barracks environment must either convalesce with their next of kin or remain in hospital. They were not allowed to rehabilitate or have sick leave in the barrack lines. This policy therefore resulted in a very large number of inpatient days compared to modern civilian practice, where every effort is made to keep inpatient stay to a minimum.

Thirty-one patients (51%) had a single procedure and thirty underwent two or more procedures. Table 6.9 shows the breakdown of direct and indirect costs between those who had a single procedure and those who underwent multiple procedures. The mean patient cost for multiple procedures was 57% more than those undergoing a single procedure.

		Total Cost (A\$1989)	Mean (SD)		Median
<u>Single Procedures</u>					
(n=31)	Direct	\$346,793	\$11,187	(\$8660)	\$8,819
	Indirect	\$480,450	\$15,498	(\$7790)	\$13,740
	Total	\$827,243	\$26,685	(\$13,764)	\$28,908
<u>Multiple Procedures</u>					
(n=30)	Direct	\$588,117	\$19,604	(\$13,543)	\$17,182
	Indirect	\$669,360	\$22,312	(\$9,252)	\$18,870
	Total	\$1,257,477	\$41,916	(\$19,618)	\$37,077

Table 6.9 The total, mean (SD) and median costs of spinal surgery in those with single and multiple procedures.

Table 6.10 shows the cost breakdown between the four subgroups of surgical procedure in the single procedure group.

Type	Direct Cost	Indirect Cost	Cost Ratio	Total Cost	Mean Cost per patient (SD)
Non-Operative (n=12)	\$96,307	\$168,840	1:1.75	\$265,147	\$22,095 (14,675)
Decompression (n=14)	\$153,463	\$220,290	1:1.43	\$373,753	\$26,696 (13,354)
Stabilization (n=2)	\$42,475	\$37,470	1:0.88	\$79,945	\$39,972 (2,979)
Stabilization + Decompression (n=3)	\$54,548	\$53,850	1:0.98	\$108,398	\$36,133 (7,539)

Table 6.10 Single procedure total and mean costs (A\$1989), by type of procedure.

The non-operative group had the lowest mean cost, but surprisingly this was not greatly different from the group undergoing a decompression procedure. The majority of cost in the non-operative group was due to morbidity i.e. sick leave, bed days and restricted duty. The ratio of direct costs to indirect costs differed by the type of procedure; with the more simple procedures having indirect costs dominant, while the more complex procedures had direct costs equalling indirect costs.

Those who had a stabilization procedure (bony and/or metal fusion) had the highest mean cost. Stabilization & decompression procedures were on average 35% more costly than decompression procedures, while stabilization procedures were 50% more expensive.

Type	Direct Cost	Indirect Cost	Cost Ratio	Total Cost	Mean Cost (SD)
Non-Operative (n=3)	\$10,179	\$39,900	1: 3.91	\$50,079	\$20,483 (11,757)
Decompression (n=8)	\$91,621	\$163,320	1: 1.78	\$254,941	\$31,867 (10,075)
Stabilization (n=4)	\$88,772	\$78,570	1: 0.88	\$167,342	\$41,835 (17,799)
Stabilization + Decompression (n=15)	\$353,110	\$376,200	1: 1.06	\$729,310	\$48,620 (20,095)

Table 6.11 Multiple procedure costs (A\$1989), by type of procedure.

Table 6.11 shows the mean cost associated with those subjects who underwent multiple procedures. Patients who underwent both non-operative and operative procedures were grouped under the operative procedure. Those undergoing multiple non-operative procedures had significantly lower costs than those who also underwent

operative procedures. Decompression procedures were 56% more expensive, while stabilization and decompression procedures were 137% more expensive than non-operative procedures. Both stabilization groups were more costly than the decompression group, with stabilization and decompression being 53% more expensive, and stabilization being 31% more expensive. Again in procedures involving stabilisation, direct medical costs were greater than or equal to indirect costs.

6.7 Cost of investigations

Table 6.12 details the number of X-ray and Computed Tomography (CT) scans performed on the group. There were 189 lumbosacral spine examinations for an average of 3.1 series per patient. Twenty-one (34%) patients underwent four or more lumbar spine x-ray examinations with one patient having nine lumbar spine series. A lumbar series includes an AP, lateral and sacral view. In some cases oblique films were also included, particularly in cases of suspected spondylolisthesis or spondylolysis. There were 76 CT scans performed on 50 patients with an average of 1.5 CT scans per patient. Five patients had 3 or more CT scans. The ready availability of magnetic resonance imaging (MRI) in current times has reduced the role of the CT scan in the diagnostic work up of lumbar spine disorders, but has not eliminated it. Because general practitioners in Australia are not allowed to order MRI scans under Medicare, many are forced to order a CT of the lumbar spine if they wish to investigate a diagnosis of disc prolapse, as there is no restriction on the right of general practitioners to order CT scans.

X-Ray series	Patients (n=61)	CT Scans	Patients (n=61)
0	0	0	11
1	18	1	30
2	11	2	15
3	11	3	4
4	6	4	1
5	6		
6	4	Total	76
7	3		
8	1		
9	1		
Total	189		

Table 6.12 The number of lumbar spine series and CT scans performed.

Additional Investigation	No of Patients
None	24
Discogram	15
Myelogram	7
Bone scan	1
MRI	5
Discogram + Myelogram	2
MRI + Discogram	2
MRI + Bone Scan x2	1
Discogram x2	1
MRI + Myelogram x2	1
Total	59

Table 6.13 Other investigations ordered on the patient group.

Table 6.13 shows additional investigations performed on the cohort. In the late 1980s MRI scanning had just become available through private clinics, which explains the small number of MRI investigations. Thirty-seven patients had an additional 40 investigations, with a discogram being the most common single investigation. In this cohort there were 7.6 lumbar spine CT scans performed for every MRI scan.

Investigation	No	Cost (\$A1989)
X-Ray	189	\$15,120
CT	76	\$17,860
MRI	10	\$3,300
Other Ix	52	\$10,768
Total	320	\$47,048

Table 6.14 Total number and Cost of investigations (\$A1989).

Table 6.14 outlines the number and cost of investigations. These costs were calculated using 100% of the Medicare schedule fee applicable for the specific investigation in 1989. The 27 patients had an additional \$47,048 worth of investigations, with a mean cost of \$1742 per patient.

6.8. Limitations and comparison with other studies

This study was a retrospective observational study, and therefore suffers from the usual concerns regarding confounding, selection and recall bias. Retrospective cohort designs are common in the injury literature, and they commonly produce

descriptive data (Caine 1996). This study was limited by its small sample size, but was restricted to the feasibility of following up patients from the three year window chosen.

The use of a cohort comprising all patients undergoing a spinal surgical procedure within a three year period provides data that was an accurate reflection of clinical orthopaedic practice in the late 1980s in South Western Sydney. It is reasonable to argue that these findings were generalisable to community practice at that time, as all five orthopaedic surgeons were visiting medical officers and held appointments at university teaching hospitals. Surgical practice has changed in the intervening period, but there is evidence that demonstrates an increase in operative procedures at the expense of non-operative procedures over the intervening period (Weinstein 2006c, Medicare Australia 2009).

This study provides the first comparison of cost between non-operative procedures such as manipulation under anaesthesia and epidural injection of corticosteroid with the more common operative procedures of lumbar fusion and discectomy. In a systematic review of published studies of epidural steroid injections Abdi (Abdi 2007) found only one study comparing epidural steroid injections to another surgical procedure (discectomy).

One of the strengths of this study was the quality of the medical data and the compliance with post-operative management with regards to sick leave and rehabilitation. Soldiers are, in effect, a 'captive' population who receive free medical care and once in a treatment regime are highly likely to follow it through. It is unlikely that there were any confounding compensation factors, as all soldiers received income support as a matter of routine and had no medical costs to pay. If medically discharged, they were entitled to an invalidity pension.

A societal perspective requires the calculation of both direct and indirect costs, as the costs of production loss from sick leave and disability can greatly exceed diagnostic, therapeutic and treatment costs (Maniadakis 2000, Maetzel 2002). Indirect productivity losses attributable to the surgical procedure in this study were calculated, using the human capital approach, and applying a societal perspective as advocated by Soegaard (Soegaard 2006). All work absences from the Army required a medical

certificate and these certificates were placed in the medical record and were available for review. Thus the productivity losses captured in this study are considered accurate.

The Spine Patient Outcomes Research Trial [SPORT] (Weinstein 2008) calculated productivity losses using lost work days and missed homemaking days. This study did not calculate lost homemaking days as all the subjects were employed. Other studies calculated drug utilisation and costs, but this study did not because there was no prescription database and copies of prescriptions were not placed into the medical records.

The SPORT study used self reported work days lost from a patient recall diary, while this study calculated lost work days directly from medical sick leave certificates in the medical records (Tosteson 2008). Fritzell (Fritzell 2001) estimated production losses due to sick leave from low back pain using data from the Swedish Social Insurance Board. Tosteson used a human capital approach, in which the extent of production losses was valued by current earnings and calculated for the entire length of impairment.

This study also provided a detailed breakdown of the number, type and distribution of investigations. Only a few recent studies examining the cost of spinal surgery (Tosteson 2008, Soegaard 2007a) provided total and mean investigational costs but no description of the distribution of investigations between individuals. The description of individual utilisation of investigational resources provides useful insights into individual variations in surgical management that could be useful to hospital managers who must manage tight budgets. Payors would also be interested in the clinical rationale for repeated investigations in subjects with known pathology.

In this analysis, the estimated ratio of indirect to direct costs for stabilisation procedures was approximately 1:1. Heinrich (Heinrich 1931) estimated that the ratio of indirect to direct costs for most injury conditions was approximately to 7:1. Seferlis in a study of treatments costs for chronic low back pain found a ratio of indirect to direct costs of 9:1 (Seferlis 2000).

Fritzell (Fritzell 2004) in a cohort of spinal fusion patients reported the ratio of mean indirect costs to direct costs as being 3.62: 1, with a ratio in a non-operative

group of 2.87 :1, consistent with the view that indirect costs are dominant. However, the SPORT study (Weinstein 2008) found the opposite, with the ratio of indirect to direct costs to being 1: 2.85. This relationship was reversed in the non-operative group with the ratio of indirect to direct costs being 1.27:1. This inversion of the cost ratios is most likely a reflection of the high costs of surgical inpatient care in the US, compared to Sweden (Tosteson 2008).

The MRC spine stabilisation study (Wilson MacDonald 2008) found that costs increased with increasing complexity of the fusion procedure. Fritzell found instrumented fusion to be 66% more expensive than simple fusion, and interbody fusion was 103% more expensive (Fritzell 2004). Kuntz (Kuntz 2000) also reported that instrumentation in patients who had a lumbar fusion for degenerative spondylolisthesis increased hospital costs by 50% without producing a significantly better outcome.

This study confirmed the principle of increasing cost with increasing complexity, with decompression and stabilisation procedures demonstrating the highest cost, but as Chapter 7 will show, no significant improvement in clinical outcome compared to more simple procedures. Stabilisation and decompression procedures were nearly 25% of the cases described in this study, but based on the current literature this combined procedure is no longer in vogue. Complex instrumented fusion or simple discectomy are the more commonly applied procedures (Fairbanks 2005).

In the five patients in this study who underwent a single stabilisation procedure in this study, the 1989 dollar total direct medical cost of fusion was A\$97,023, with a mean direct cost of A\$19,404. This figure is inflated because of the large number of inpatient rehabilitation bed days included in the calculation of direct costs. Total costs [direct + indirect] for this single procedure fusion group was A\$188,343 with a mean total cost of A\$37,668. Between 1989 and 2003 the CPI increase in Australia was 37.5% (Rate Inflation 2009), resulting in 2003 dollar figure for direct medical costs of \$26,680.

The MRC Spine Stabilisation Trial (Wilson-MacDonald 2008) found that total medical costs were £ 6927 for a Graf fusion, £6164 for a posterolateral fusion and £9264 for a 360 degree fusion. Using a 2003 mean exchange rate A\$2.51 = £1 (FX

History 2009), the mean direct costs (2003 A\$) of fusion surgery in the MRC study were A\$17,386 for Graf fusion, A\$15,471 for posterolateral fusion and A\$23,252 for 360 degree fusion.

Soegaard calculated the direct medical costs of different fusion types in a Danish population (Soegaard 2007a). Using a 2003 exchange rate of A\$1 = 4.27 Danish Kroner (FX History 2009), the mean cost of a non-instrumented fusion was DKK 88,285 (A\$20,675), an instrumented fusion DKK 94,396 (A\$22,106) and a circumferential fusion DKK 120,759 (A\$28,280). These calculations included diagnostic, inpatient, surgery and follow-up costs. The standardised direct medical costs in both these studies are comparable to the inflated cost estimates in this study.

In an observational cohort study of 695 subjects who underwent a spinal fusion procedure between 1996 and 2002 Soegaard found that the 2 year societal costs (direct and indirect costs) for spinal fusion in a heterogeneous surgical population was 38,937 euro (Soegaard 2007b). Using a 2002 mean exchange rate of 1 euro = A\$1.74 (FX History 2009), the mean societal cost of spinal fusion in Denmark was estimated to be A\$67,750. Inflating the A\$1989 costs by the CPI increase over that period [33.8%] (Rate Inflation 2009), gives a 2002 dollar figure of \$A50,340 for stabilisation procedures, approximately 15% less than the total cost calculated by Soegaard.

In a Swedish study of lumbar fusion costs, Fritzell calculated the mean total cost to be SEK 704,000 (1999 Kroner) in the surgical group compared with SEK 636,000 in the non-operative group (Fritzell 2004). Direct medical costs were 123,000 SEK for the surgical group and 65,200SEK for the non-surgical group. Using a 1999 conversion rate of A\$1 = 5.34SEK (FX History 2009), the total 1999 Australian dollar costs were A\$131,835 for the fusion cohort and A\$119,101 for the non-operative group, while the direct medical costs were A\$23,033 and A\$12,209 respectively. Between 1989 and 1999 the CPI increased by 19.1% (Rate Inflation 2009), giving a total mean cost of stabilisation procedures of A\$44,862 (1999 dollars) with mean direct costs being A\$23,110. The direct medical costs of fusion were almost identical, but the total cost figure was influenced by the method of calculating indirect costs, with Fritzell calculating productivity losses for a 2 year period following surgery, while this study limited productivity losses to a maximum of 365 days for those soldiers on restricted duty.

Tosteson (Tosteson 2008) used Diagnostic Related Group costs (DRG) for lumbar discectomy to estimate direct surgical costs in the SPORT study. Total mean cost for the surgery cohort was US\$27,273 and US\$13,135 for the non-operative group (2004 US Dollars). Using a 2004 conversion rate of US\$1 = A\$1.36 (FX History 2009), the SPORT cost was A\$37,091 (2004 dollars) for the surgery cohort. In the period from 1999 to 2004, the CPI rose 40.7% (Rate Inflation 2009), giving a mean cost A\$37,561 (2004 dollars). The mean cost for those with repeat surgeries in SPORT was A\$38,105, compared to A\$44,836 in the multiple procedure decompression group in this study. Despite the 15 year gap between these studies the mean costs are extremely similar when described in comparable terms.

Soegaard (Soegaard 2007a) reported diagnostic costs, but provided no indication of the number of investigations per patient. Mean cost per patient was approximately 5,000 Danish Kroner (DKK), and using a 2003 currency conversion of A\$1 = 4.27 DKK (FX History 2009), the mean investigational cost for fusion patients was A\$1,170 (2003 dollars). The mean cost for all investigations in this cohort was A\$1742 (1989 dollars). Inflating this figure by the CPI increase between 1989 and 2003 (37.5%, Rate Inflation 2009), provides a value of A\$2395 (2003 dollars).

Neither the SPORT study (Tosteson 2008) or the Swedish Lumbar Spine Study (Fritzell 2004) provided any detail on the total number of investigations performed on individuals. The SPORT study reported a mean diagnostic test cost in 2004 US dollars of US\$859 per surgery patient and US\$882 per non-operative patient. Using a 2004 currency conversion rate of US\$1 = A\$1.36 (FX History 2009), the mean diagnostic cost in the surgery group was A\$1168 (2004 dollars). Inflating the A\$1742 mean cost to 2004 Australian dollars (40.7%, Rate Inflation 2009) provides a mean diagnostic cost of A\$2451.

The cost of investigations is disproportionally higher in this study compared to other reported studies and this may reflect the number of multiple procedures performed, with the concomitant increase in multiple investigations observed.

6.9. Discussion

This study is the first to compare the cost of all spinal procedures performed within a community orthopaedic setting. Because all the visiting orthopaedic surgeons held public teaching hospital appointments, the findings should be generalisable to the orthopaedic community of that time. From an economic standpoint this is important, as existing practice is what therapists, administrators, and politicians responsible for fund allocation most easily relate to (Baltussen 1996).

The one key area of difference in clinical practice was the extensive use of inpatient rehabilitation in the post-operative period, resulting in a significantly increased number of bed day costs attributable to surgery. Previous studies have either confined themselves to single types of procedure, usually discectomy and fusion exclusively or compared conservative management to either fusion or discectomy.

An uncontrolled study using observational data may produce evidence relevant to real practice but will introduce bias for making causal inferences. Drummond noted that this tension between internal and external validity is a theme that recurs in the health economic literature (Drummond 1997). Drummond terms this as a “trade-off between bias and relevance”. Drummond puts forward the proposition that “an economic evaluation is only as good as the data it is based on, but economic analysts must do the best they can with the available data”.

Costs of illness studies serve a different purpose to health economic evaluations (Dagenais 2008). Cost-benefit, cost-utility and cost-effectiveness analyses focus on evaluating the costs of various interventions rather than the overall cost of the problem itself. As the ever increasing efforts to reduce health cost continue, increasing focus will be placed on absolute improvements in outcomes and the quantum of cost necessary to achieve these. With rates of spinal surgery increasing these efforts will increase.

The Fritzell study of 2004 (Fritzell 2004) was the first published full economic evaluation comparing lumbar fusion with nonsurgical treatment for therapy-resistant chronic low back pain. This seems remarkable given that spinal fusion has been a

procedure in common use for over 30 years. It also highlights the paucity of relevant literature available when this thesis commenced in 1996.

The Medicare Australia figures (Table 6.1) reveal that fusion procedures accounted for 55% of total procedures involving surgery of the lumbar spine and 56 % of total Medicare expenditures. Stabilisation and decompression procedures have fallen out of favour and there were no item numbers for this combination of procedures in the Medical Benefits Schedule of Feb 2009, but there were combined procedures for the cervical spine.

This study captured detailed cost data on a range of surgical procedures applied to the lumbar spine. It demonstrated high levels of imaging and other invasive investigations, and a high incidence of multiple procedures. While nothing can be said about causation, useful observations regarding the cost of achieving outcomes can be made in Chapter 7. Of particular concern was the wide variation in both diagnosis and subsequent surgical procedure observed in this study.

Epidemiological research into back pain and its surgical treatment has been hampered by methodological problems in definition, classification and diagnosis. Wood found no consensus on classification and diagnosis, making it difficult to rely on insurance and hospital data (Wood 1987). Comparison of different studies was hindered by the lack of standardized outcome measures, and the difficulties in adjusting for compensation and psychological status. (Fraser 1997)

Schonstein found significant variation in the diagnostic labels used for back pain in general practice, suggesting a lack of precision in diagnosis with a consequent variety of treatment methods (Schonstein 2000). Bogduk (Bogduk 2000) has addressed this problem and noted that the International Association for the Study of Pain (IASP) "recognized that many diagnostic labels were illegitimate, inappropriate, or fanciful". The IASP stipulated strict criteria for the use of particular diagnostic labels, with the aim of ensuring "consistent, disciplined and accountable use of terms". The use of stringent criteria "was to highlight the deficiencies of contemporary practice and to indicate the need for research into the reliability and validity of traditional diagnostic practices..... the exercise established that it was essentially impossible to render any

conventional or traditional diagnosis for low back pain. The means to do so were simply not available, not reliable, or not valid".

Bodguk railed against diagnostic imprecision and argued that "labels, such as 'segmental dysfunction' are simply metaphors, with no established biological correlates..... 'degenerative disc disease' conveys to patients that they are disintegrating, which they are not. Moreover, disc degeneration, spondylosis and spinal osteoarthritis correlate poorly with pain and may be totally asymptomatic. They are age changes and do not constitute diagnoses."

There is a clear need for more definitive diagnostic criteria for spinal surgery and the plethora of surgical procedures is reflective of the lack of such criteria. The wide range of diagnostic labels for what is theoretically the same condition suggests that the lack of diagnostic precision may represent a lack understanding of the underlying pathology. Long found that in a cohort of chronic low back pain sufferers, muscle spasm, tenderness and trigger points were commonly reported, but neurological signs were rare despite one in three patients having a diagnosis of disc prolapse (Long 1996).

Has anything changed in the twenty years since this study was done? The recent comments of Glassman (Glassman 2009) suggest not: "This study clearly emphasises the need for greater specificity in our diagnostic characterization of patients undergoing lumbar fusion surgery. Chronic low back pain is a symptom, not a diagnostic entity for which treatment outcomes can be readily extrapolated. Asking whether fusion is a good treatment for low back pain is like asking whether antibiotics are a good treatment for shortness of breath. Antibiotics would be the obvious choice if the etiology is pneumonia, but not if the cause is congestive heart failure".

The number and range of investigations was of concern, in particular the number of plain lumbar films. Thirty-four percent of the patients in this study had four or more lumbar films. Plain x-ray of the lumbar spine comprises 5% of all radiological investigations in UK NHS hospitals (Royal College of General Practitioners 1995), but the findings rarely alter clinical management (Kaplan 1986, Rockey 1978). In a study by Kendrick (Kendrick 2001), 30% of x-rays taken in a cohort of 420 patients with back pain had no abnormality detected, while 69% had disco-vertebral degeneration

noted. Lumbar disc herniation is often seen on imaging studies in the absence of symptoms (Boden 1990, Jensen 1994) and can regress over time without surgery (Saal 1989).

Kendrick argued that clinical guidelines should be consistent and recommended against radiography, particularly in the absence of serious disease, for cases of low back pain of less than 6 weeks duration in primary care. The role of multiple plain film and CT examinations of the lumbar spine is questionable and there is considerable debate about the risks of low level radiation exposure. The UK National Radiation Protection Board (Cox 1995) has concluded that the available data is broadly consistent with the thesis that, at low doses and low dosage rates, the risk of induced neoplasia increases as a simple function of dose and there is no threshold-like component related to DNA damage or DNA repair.

A typical abdominal CT has a dose of 10 Millisieverts (mSv), compared with 2.3mSv for a cranial examination. This equates to the same radiation risk as 500 chest x-rays and a background equivalent radiation time (BERT) of 4.5 years (Dixon 1998). The better resolution available with Spiral CT has seen an upsurge in its general medical use.

The patients in this study group had a high incidence of CT use, which may not reflect current practice. However Medicare data shows that in 2008 there were 268,353 CT scans of the lumbar spine (12.53/1000) and 329,648 plain x-rays of the lumbar spine (15.4/1000) performed in Australia. By contrast there were only 59,239 lumbar spine MRI conducted under Medicare (0.42/1000), demonstrating that CT was 4.5 times more commonly used in the diagnosis of lumbar spine disorders than MRI (Medicare 2009). This proportion is similar to that observed in this study where there 7.6 CT scans performed for every MRI scan, and at a time when access to MRI was severely restricted.

MRI scanning offers the prospect of no radiation exposure, but the relative ease and reduced cost of obtaining a CT, and the difficulty in accessing public MRI services, means that plain films and CT are often the preferred investigation of the lumbar spine in the general community, and this remains as true in 2009 as it was in 1989.

Deyo (Deyo 1986) has detailed the indications for spinal x-rays in cases of acute back pain. If x-rays have been performed within the past 2 years and there are no clear indications other than exertional pain, then there is little likelihood of a subsequent x-ray changing the diagnosis or influencing treatment. The use of oblique films is not warranted except in cases where spondylolysis is suspected (Scavone 1981). There is a strong case to be made that one set of plain films is all that is required to exclude bony pathology of the lumbar spine, and that repeated plain films offer no additional clinical information and merely serve to increase cost and risk for no clinical benefit.

Imaging is only as valid as it's correlation with clinical signs and symptoms. Numerous studies have demonstrated similar pathological findings in asymptomatic subjects compared to symptomatic subjects (Hitselberger 1968, Weisal 1984, Holt 1968, Boden 1989). These and other findings call into question the sensitivity, specificity and predictive value of imaging studies of the lumbar spine. At present, no carefully controlled studies have determined the specificity or sensitivity of these imaging studies in the diagnosis of other disorders of the lumbar spine such as spinal stenosis or spinal instability. Many findings seen on imaging such as disc bulging, abnormal MRI T2 weighted images diagnosed as "disc degeneration", and facet arthropathy have questionable clinical significance (Frymoyer 1991).

The role of the discogram in diagnosing disc disease has recently been called into question. Carragee (Carragee 2000a) studied 42 patients with chronic back pain and 54 asymptomatic controls. All subjects underwent physical examination, psychometric testing, plain x-rays, MRI and provocative discography. A total of 109 discs were evaluated in the symptomatic group and 143 discs in the asymptomatic group.

Fifty nine percent of the symptomatic group had a high intensity zone in the annulus suggestive of an annular tear, as did 25% of the asymptomatic group. Seventy percent of the high intensity zones tested positive on discography in both groups, with pain intensity being similar in both groups. The authors noted that while disc prolapse has a distinct and recognizable pattern, the annular tear did not. The high prevalence of 25% in asymptomatic individuals was considered too high for reliable clinical use. Carragee (Carragee 2000a) found the best predictor of a positive provocation on discography was psychometric testing and argued that discography may be of little

diagnostic value in patients with abnormal psychological findings or marked illness behaviour.

In a follow-up study, Carragee (Carragee 2000b) found that previously asymptomatic patients had persisting low back pain 1 year after having undergone discography. Again, persistent morbidity was noted in 40% of those who had an abnormal pre-investigation psychometric screen. Those with normal psychometric screening results had no residual pain.

The literature of economic evaluations in chronic low back pain continues to grow, but in a review of published economic evaluations, Soegaard found the quality of most published papers to be poor (Soegaard 2006). The broad methodological differences seen in the literature make it difficult for decision-makers to adopt a consistent approach in seeking value for money.

Soegaard noted that published studies reported very different patient populations: Fritzell (Fritzell 2001) and Hacker (Hacker 1997) defined the patient population by chronic, non-specific low back pain, Klara (Klara 2003) and Ray (Ray 1997) defined their populations by degenerative disc diseases, Katz (Katz 1997) and Kuntz (Kuntz 2000) targeted degenerative stenosis and Schofferman (Schofferman 2001) reported a mixed population of spondylolisthesis, disc degeneration, stenosis and scoliosis. It is therefore very difficult to draw comparisons or conclusion across such diverse populations. Soegaard noted that “There is a great potential for improvement of methodological quality in economic evaluations of lumbar spinal fusion and further research is imperative.”

6.10 Conclusion

This study is the first to compare the cost of all spinal procedures performed within a community setting. Previous studies have confined themselves to either discectomy or fusion procedures exclusively or compared conservative management to either fusion or discectomy.

In this cohort of soldiers, considerable costs were incurred. As a general principle, the more invasive or complex the procedure, the greater the cost. The non-operative group had the lowest mean total cost, but surprisingly this was not greatly different from the group undergoing a decompression procedure. The majority of costs in the non-operative group were due to sick leave, bed days and restricted duty. The ratio of direct costs to indirect costs differed with the type of procedure, with indirect costs dominating in more simple procedures, while more complex procedures had direct costs equalling indirect costs.

Decompression procedures were 56% more expensive, while stabilization and decompression procedures were 137% more expensive than non-operative procedures. Both stabilization groups were more costly than the decompression group, with stabilization and decompression being 53% more expensive, and stabilization being 31% more expensive. These findings were consistent with UK Medical Research Council (MRC) Spine Stabilisation Study (Wilson-MacDonald 2008) and the Danish study by Soegaard (Soegaard 2007).

This patient cohort also underwent a large number of expensive investigations, which, based on the great variety of diagnoses, did not improve diagnostic precision. Twenty-one (34%) patients underwent four or more lumbar spine x-ray examinations with one patient having nine lumbar spine series. Five patients had 3 or more CT scans. The ready availability of magnetic resonance imaging (MRI) in current times should have reduced the role of the CT scan in the diagnostic work up of lumbar spine disease, but has not. In this cohort there were 7.6 lumbar spine CT scans performed for every MRI scan, but recent Medicare data shows that there were 4.5 CT scans of the lumbar spine for every MRI in 2008.

The diagnostic costs in this study were significantly higher in comparable terms than those reported in SPORT (Tosteson 2008) or by Soegaard (Soegaard 2007a). This was surprising and may be the consequence of the significant number of multiple procedure cases observed.

As well as the monetary cost, a number of these soldiers were exposed to relatively high doses of ionising radiation. The risks associated with this exposure should be balanced against the benefit of outcome, but this relationship was not clear.

Legitimate concerns can be raised about the radiation exposure being sustained in the effort for diagnostic accuracy. It would seem appropriate that guidelines on the relative frequency and type of imaging should be developed by the College of Surgeons and the College of Radiologists in order to minimize the radiation exposure of patients.

The direct medical cost figures in this study are comparable to the figures for lumbar fusion reported by Soegaard and MacDonald–Wilson (Soegaard 2007b, MacDonald–Wilson 2008), and comparable to the direct medical costs reported for discectomy in the SPORT study (Tosteson 2008). This is a surprising given the methodological differences regarding inpatient days in the military cohort.

The wide variation in both diagnosis and subsequent surgical procedure in this study was surprising, but consistent with the findings of others (Schonstein 2000, Glassman 2009) suggesting a lack of precision in diagnosis with a consequent variety of treatment methods. There is a clear need for more definitive diagnostic criteria for spinal surgery.

A cost of illness study is by its very nature a descriptive study that seeks to quantify costs and not to identify risk factors or identify causation. This study does not provide a formal economic evaluation in the way that cost-utility and cost-effectiveness evaluations do. By providing data about the quantum and distribution of costs, decision makers can make more informed decisions about the relative value provided by certain procedures.

Chapter 7. Outcomes of Spinal Surgical Procedures in Army Soldiers.

7.1 Introduction

The linkage of cost data to outcomes seems a logical clinical process, but one that is rare. Soegaard noted in 2007 that “To the best of our knowledge, no stochastic analysis has investigated co-variation between costs and effects.” When this thesis was first commenced in 1996, there were no published studies in this area and the delay has provided the opportunity for other authors to examine this relationship. The first randomised evaluation of cost effectiveness in lumbar spine fusion was only published in 2004 (Fritzell 2004).

Patients undergo surgery with the expectation of a positive outcome, but as Zucherman noted, this is not always the case. “The patient and surgeon expect a successful outcome, defined as elimination or significant reduction of pain and disability, and markedly improved function. It is hoped that the patient will return to work, discontinue medications and resume a normal place in family and society. Unfortunately, 20-40% of patients will fail to gain the desired outcome. In fact, 1-10% of patients will be worse after initial surgery.”(Zucherman 1986).

The success rates of spinal fusion reported in the literature vary greatly, ranging from 16-95% (Barr 1987, Thorvaldsen 1989, Turner 1992). This relatively high incidence of poor outcome has given rise to the term ‘Failed Back Surgery Syndrome’ (Zucherman 1986). This refers to a situation where the patient has continued disability due to either surgical complications, failure to remove the symptomatic pathology or occurrence of another pathology subsequent to surgery.

Since the 1930s, lumbar fusion has been a controversial intervention for the treatment of chronic low back pain (Christensen 2004). The level of supporting evidence has increased during the last decade but similarly, so has the rate of surgery, at a pace not seen in other major orthopaedic procedures. Deyo investigated the potential reasons for this increase and found no association with improved indications or efficacy, but did find an association with the approval of new surgical instrumented implants for lumbar fusion (Deyo 2005).

The first two published randomised controlled trials (RCT) examining the effectiveness of lumbar fusion found evidence of improved clinical outcome from surgery compared to non-operative care (Fritzell 2001, Moller 2000a), but three subsequent trials did not find any such benefit (Brox 2003, Ekman 2005, Fairbank 2005). In the RCT with the best reported results, the mean improvement in pain intensity score was only 2 points on a 10-point scale, and the disability improvement using the Oswestry Disability Index was only 10 to 12 points on a 100-point scale (Carragee 2006a). Malter found a post spinal fusion complication rate of 18%, with 20% of those patients going on to reoperation over the subsequent 5 years (Malter 1998).

The use of complex instrumentation in lumbar fusion increases costs, but there is no evidence of enhanced benefit compared to less complex procedures (Fischgrund 1997, Moller 2000b, Fritzell 2002, Hacker 1997, Christensen 2002).

Disc degeneration, annular fissures, small protrusions, and facet arthritis are commonly found in individuals with little or no back pain (Boden 1990, Jensen 1994, Jarvik 2005). Many studies have shown that serious disability in this group is associated with abnormal psychological profiles, multiple chronic pain processes, and compensation issues (Pincus 2002, VonKorff 2005). The severity of chronic pain in this group does correlate well with the presence or extent of degenerative findings, rather with associated psychosocial conditions (Carragee 2006b) It should not therefore be surprising that surgical treatment of poorly defined discogenic pain has been somewhat disappointing (Gibson 2005, Carragee 2006c).

This Chapter will examine the subjective and functional outcomes of the cohort of patients described in Chapter 6 and relate these outcomes to the direct and indirect costs of the procedures involved.

7.2 Procedure differences between Responders and Non-responders

In March of 1991 a questionnaire was sent to the last known address of the 61 patients identified in the cost study. This questionnaire requested participation in the follow-up study and asked questions about current levels of pain, disability, function

and patient satisfaction. Forty-seven patients responded to the questionnaire, giving a response rate of 77%. Subjects were asked to rate their current levels of symptoms on different Likert scales examining frequency of pain post-operatively and lifestyle impact. Levels of perceived success were ascertained by the question "Do you regard your operation as a success? Yes/No".

In 1996, a review was conducted of the study population using the central Army Personnel Database. From the database it was determined that as at 30 June 1996, 46 subjects had been discharged and 15 were still serving.

	Mean (95% CI)	Range (years)
Age (yrs)	29.7 (27.7-31.6)	18-56
Time in Service (yrs)	8.0 (6.2-9.7)	0.2-35.5
Time from presentation to first procedure: discharged (years) (n=46)	2.6 (1.9-3.3)	0.2 -8.7
Time from presentation to first procedure: serving (years) (n=15)	3.3 (2.0-4.6)	0.6-8.3
Time from first operation to Discharge (years) (n=46)	3.2 (2.3-4.1)	0.1-11.0

Table 7.1 Age, time from initial presentation to first procedure and discharge as at 30 June 1996.

Table 7.1 shows some of the characteristics of the study population, with a mean age of 30 years and a mean time in Service of 8 years at the time of their first procedure.

Those who continued to serve had a slightly longer mean time from initial presentation to time of initial surgical procedure of 3.3 years versus 2.6 years, but this difference was not statistically significant. The mean time from initial surgical procedure to discharge was 3.2 years.

Table 7.2 shows the profile of responders and non-responders. There were 6 non- responders in the single procedure group for a total response rate of 80.5% (25/31) and a 73.4% (22/30) response rate in the multiple procedure group. Only in the multiple procedure, decompression and stabilization sub-group was there a response rate less than 67%.

	Non-Op	Decompression	Stabilization	D+S	Total
<u>Non-responders</u>					
Single procedure	4	2	0	0	6
Multiple Procedures	0	3	0	5	9
<u>Responders</u>					
Single Procedure	8	12	2	3	25
Multiple Procedures	3	5	4	10*	22
Total	15	22	6	18	61

Table 7.2 Summary by procedure type of those who did and did not respond to the follow-up questionnaire. (* response rate < 67%)

These findings indicate little difference between responders and non-responders in each of the procedural groups with the exception of those with multiple procedures involving decompression and stabilization. This would suggest that the responder group represents a reasonable sample of the procedural groups.

7.3 Subjective success ratings and cost outcomes.

	Non-Op	Decompression	Stabilization	D+S	Total
<u>Single procedure</u>					
Successful	1(12%)	7(58%)	2(100%)	1(33%)	11 (44%)
Unsuccessful	7(88%)	5(42%)	0	2(67%)	14(56%)
<u>Multiple Procedures</u>					
Successful	0	3(60%)	2(50%)	4(40%)	9(41%)
Unsuccessful	3(100%)	2(40%)	2(50%)	6(60%)	13(59%)
<u>Total</u>					
Successful	1(9%)	10(59%)	4(66%)	5(38%)	20(43%)
Unsuccessful	10(91%)	7(41%)	2(34%)	8(62%)	27(57%)

Table 7.3 Success of procedure type as rated subjectively by the patient.

Table 7.3 shows the various procedural sub-groups and compares them to the subjective rating of success by the responder group. It shows that the non-operative

group had the worst subjective success rate. This group underwent injection of epidural steroid, manipulation under anaesthesia or a combination of both. These results do not lend any support for the routine use of these procedures.

Both decompression and stabilization procedures had subjective success ratings of 59-66%, while the combination of a decompression and stabilization procedure had a subjective success rating of only 38%. The rationale for combining these 2 procedures is not clear and these results also do not lend any support for their routine use.

When considering the cost of spinal procedures, outcome is an important but until recently overlooked variable. One procedure may be more expensive than another, but can be justified on either better subjective outcome or better functional outcome. Table 7.4 compares the mean direct and indirect costs of the different procedural sub-groups by subjective rating of success.

	Direct	Indirect	Total
<u>Single procedure</u>			
Successful (n=11)	\$15,348 (\$9139)	\$15,164 (\$3952)	\$30,511 (\$12326)
Unsuccessful (n=14)	\$9,128 (\$7499)	\$16,663 (\$9625)	\$25,760 (\$14209)
T-test of means	p=0.08	p=0.51	p=0.38
<u>Multiple Procedures</u>			
Successful (n=9)	\$19,176 (\$10809)	\$23,203 (\$5943)	\$42,380 (\$13560)
Unsuccessful (n=13)	\$14,355 (\$12573)	\$20,739 (\$7158)	\$35,094 (\$17804)
T-test of means	p=0.25	p=0.32	p=0.19
<u>Total</u>			
Successful (n=20)	\$17,262 (\$10808)	\$19,183 (\$8851)	\$36,446 (\$15967)
Unsuccessful (n=27)	\$11,741 (\$10400)	\$18,686 (\$8622)	\$30,427 (\$16427)
T-test of means	p=0.077	p=0.94	p=0.22

Table 7.4 Means costs and standard deviations (SD), by subjectively reported success.

There were no statistically significant differences in mean cost between those procedures rated a success or those rated as unsuccessful. There was near statistical significance in the single procedure group, where the more successful procedures had a higher mean cost. This however can be explained by the very poor reported success rates for non-operative procedures, which had significantly lower direct costs. Interestingly, there was little difference in the mean indirect costs, suggesting that the

degree of post-procedural morbidity (hospital stay, sick leave, restricted duty) was similar in the two groups.

	Direct	Indirect	Total
<u>Operative Procedures</u>			
Unsuccessful (n=17)	\$15,993 (\$10630)	\$21,118 (\$8239)	\$37,112 (\$14333)
Successful (n=19)	\$16,634 (\$9917)	\$18,625 (\$6452)	\$35,259 (\$14051)
T –test of means	p=0.85	p=0.31	p=0.71

Table 7.5 Comparison of mean costs and (SD) by subjective outcome for operative patients (both single and multiple procedures).

Table 7.5 addresses this issue by excluding non-operative procedures and shows that there was no significant difference in mean direct cost between those operations rated as successful and those rated as unsuccessful. Therefore cost of the operative procedure had no impact on the subjective rating of success.

7.4 Function and cost outcomes

In 1996, the Army had a categorical grading system to determine physical capability and employability. These categories were Fit Everywhere (FE), Communications Zone Everywhere (CZE- mild limitations), Base Everywhere (BE – moderate limitations), Home Only (HO – severe limitations), Below Medical Standards (BMS) and Medically Unfit (MU). The latter two classifications usually resulted in medical discharge from the Army.

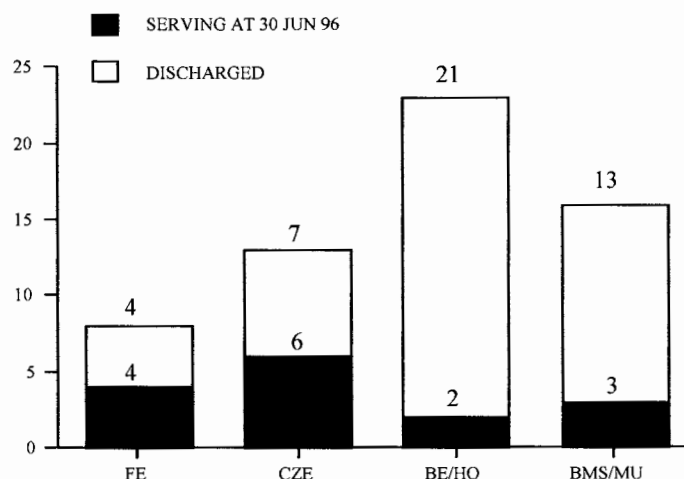


Figure 7.1 The medical employment standard and discharge status of the 61 subjects as at 30 June 1996.

The medical classification status at discharge for each member was ascertained to provide an objective measure of functional employment outcome. Review of the central Army personnel database at 30 Jun 1996 showed that only 15 (25%) of the cohort of 61 patients were still serving between 6 and 8 years following their surgical procedure.

Figure 7.1 shows that 75% of the original cohort had been discharged at a minimum of 7-year follow-up. Thirteen (21%) had been discharged as either below medical standards or medically unfit with a further three likely to be discharged. Only eight (13%) of the original sixty-one subjects had retained a medical category of fit everywhere (FE), and only four of those were still serving in 1996. These could be classed as very successful outcomes or even “cured”.

Table 7.6 shows that there were no statistically significant differences in mean cost between the different objective functional outcomes (CZE vs. BE/HO or BE/HO vs. BMS/MU). Therefore a good functional outcome cost exactly the same as a bad functional outcome.

	FE	CZE	BE/HO	BMS/MU
Total Cost	\$256,153	\$383,028	\$792,171	\$544,291
Mean (SD)	\$32,019 (\$10430)	\$29,464 (\$15650)	\$34,442 (\$14901)	\$32,017 (\$20434)
Median	\$34,887	\$33,590	\$35,664 P=0.35	\$31,180 p=0.69

Table 7.6 Functional outcome by mean (SD) and median cost.

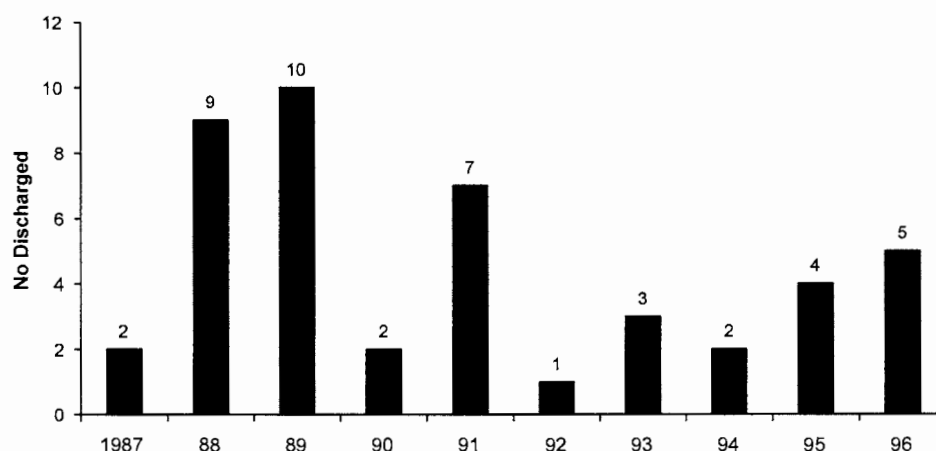


Figure 7.2 Number of cohort discharges from the Army by Year.

Figure 7.2 shows that 21(34%) subjects were discharged from the Army by the end of 1989, the majority of whom had been made MU/BMS and would likely have been discharged within 12 months of their last procedure. Subsequent discharges occurred progressively, with a peak of 7 discharges in 1991.

Table 7.7 shows the functional outcome by the different categories of procedure. Interestingly, while the non-operative procedures had the poorest rating of subjective success they had the best objective work outcomes, with 53% being FE or CZE. Stabilisation procedures had the worst objective outcome with only 17% being either FE or CZE.

	FE	CZE	BE/HO	BMS/MU	TOTAL
NON-OP	2 (13%)	6 (40%)	4 (27%)	3 (20%)	15 (100%)
DECOMPRESSION	2 (9%)	4 (18%)	9 (41%)	7 (32%)	22 (100%)
STABILISATION	1 (17%)	0	4 (66%)	1 (17%)	6 (100%)
D&S	3 (17%)	3 (17%)	6 (33%)	6 (33%)	18 (100%)
Total	8	13	23	17	61

Table 7.7 Functional employment category by surgical procedure group

Both decompression procedures and decompression and stabilisation procedures had the worst objective outcome with 32 and 33% percent respectively of MU/BMS grading. For decompression procedures this poor outcome suggests that the indications for surgery may not have been appropriate.

7.5 Pain and subjective disability outcomes

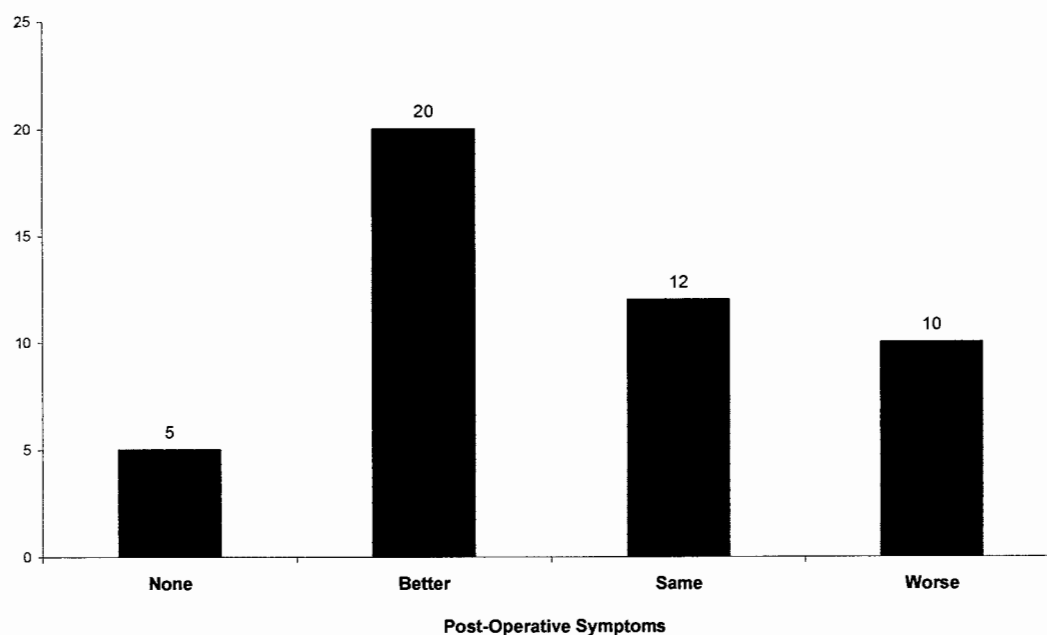


Figure 7.3 The perceived level of symptoms post-operatively.

Pain scores were elicited using the 11 point pain Numerical Rating Scale (NRS). This scale has been shown to be valid, reliable and appropriate for use in clinical practice. It is comparable to the Visual Analogue Scale and the Verbal Rating Scale, has good sensitivity and generates data that can be statistically analysed for audit

purposes (Wilkinson 2005). Multi-level Likert items were used to elicit subjective patient views on their current functional status.

Figure 7.3 shows that only 5 (11%) of the 47 respondents reported themselves as symptom free at follow-up. Twenty (42%) reported their symptoms as better, while 12 (25%) had the same symptoms and 10 (22%) said they were worse.

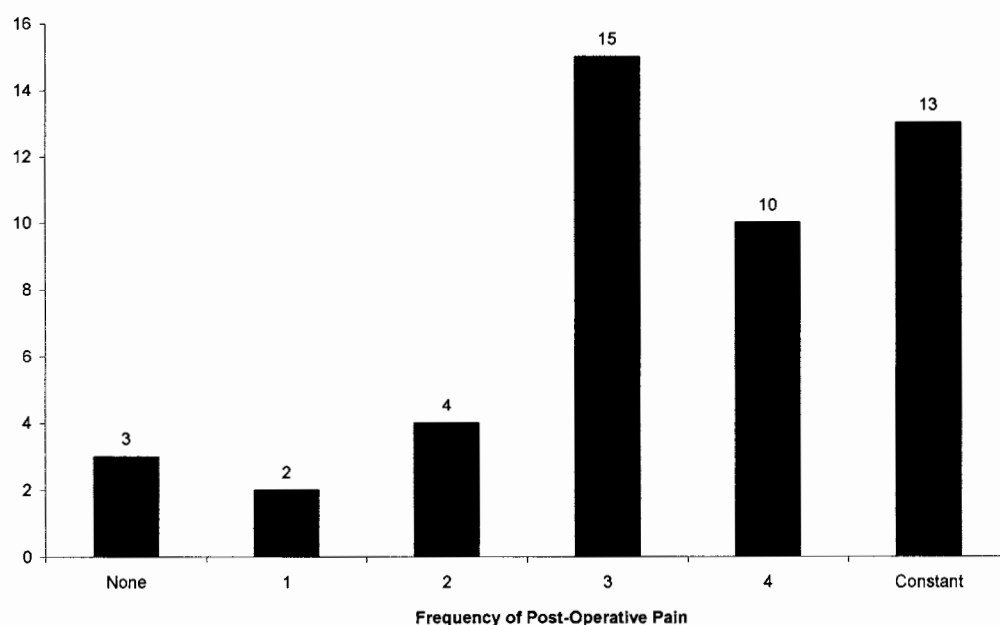


Figure 7.4 The perceived frequency of pain post-operatively.

Figure 7.4 shows that only 3 respondents reported no pain while 2 had infrequent pain. This presumably represents the 5 respondents who reported no symptoms. Interestingly 25 (53%) reported reasonably frequent episodes of pain following their procedure and 13 (28%) reported constant pain.

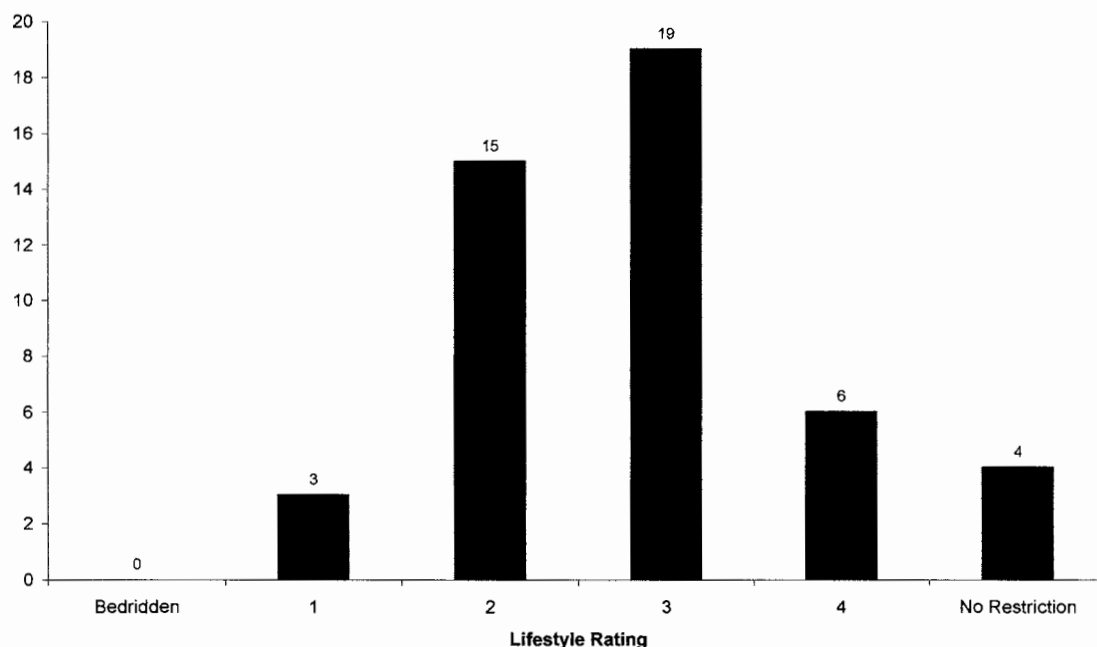


Figure 7.5 Perceived lifestyle restrictions in the post-operative period.

Figure 7.5 shows the self-reported restrictions in lifestyle. Only 4 subjects reported no restrictions, while 25 claimed mild to moderate restriction and 18 reported more severe restriction. Figure 7.6 shows the Numerical Rating Scale (NRS) pain score response for those who rated their procedures successful and unsuccessful. Of the forty-seven respondents, nine did not mark the rating scale in their response, leaving only thirty-eight with NRS pain scores. Of those that did respond, 22 (58%) reported pain scores in the 7-10 range. This indicates that these subjects had high levels of ongoing pain many years after their original procedures. Also of note was the clear relationship between pain score and subjective rating of success. All those subjects with a pain score of 0-3 rated their procedure a success.

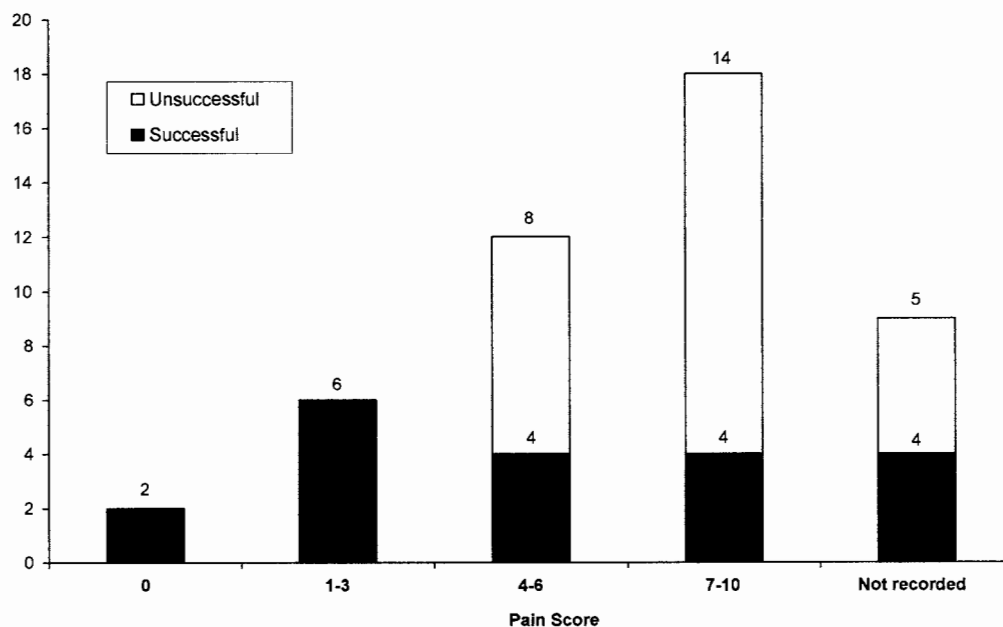


Figure 7.6 The recorded post-operative NRS pain scores at time of follow up.

As the pain score increased the subjective rating of success fell away. Interestingly 4/38 (11%) still rated their procedure a success despite having residual pain scores of between 7 and 10. This finding is surprising, but is reflective of the importance of psycho-social factors in determining outcomes.

	0	1-3	4-6	7-10	Not Recorded	TOTAL
NON-OP	0	0	5 (46%)	4 (36%)	2 (18%)	11 (100%)
DECOMPRESSION	1 (6%)	3 (18%)	3 (18%)	7 (40%)	3 (18%)	17 (100%)
STABILISATION	1 (17%)	1 (17%)	1 (17%)	2 (32%)	1 (17%)	6 (100%)
D&S	0	2 (15%)	3 (23%)	5 (39%)	3 (23%)	13 (100%)
TOTAL	2 (4%)	6 (11%)	12 (26%)	18 (39%)	9 (20%)	47

Table 7.8 Numerical Rating Scale Pain Score (NRS) by procedure type - responders (n=47)

Table 7.8 shows that no patient in the non-operative group reported a pain score of less than 4, and this was consistent with the poor subjective success rating but at odds with the objective functional grading. This would suggest that these members continued to work despite their back pain being reported as moderate. Perhaps more

importantly they were able to continue working, whereas others with similar pain scores could not. All procedure types produced a similar percentage of patients with high residual pain scores greater than 7.

If pain relief is used as an outcome measure, no procedure performed well. If a pain score of 4 or more is considered as significant residual pain, then 82% of the non-operative group, 58% of the decompression group, 49% of the stabilisation group and 62% of the decompression and stabilisation group were left with significant residual pain, 2 or more years after their procedure. Only 4% of respondents reported no pain with none of the operative groups appearing to be better than another.

	0	1-3	4-6	7-10	Not Recorded	Total
Successful	2 (10%)	6 (30%)	4 (20%)	4 (20%)	4 (20%)	21
Not Successful	0	0	8 (30%)	14 (52%)	5 (18%)	27

Table 7.9 NRS pain score compared with subjective rating of outcome.

Table 7.9 confirms the link between residual pain score and rating of subjective success. Those who rated their procedure as unsuccessful had high residual pain scores, with none of this group reporting pain scores of 3 or below. For the successful group however, only two (10%) subjects were pain free and four (19%) reported pain scores of 7 or greater. This disparity is probably the result of different individual pain threshold and tolerance levels. This result is consistent with research findings that indicate psychological variables are highly significant in determining the return to work outcome. It should be no surprise that a procedure that fails to abolish pain will have its functional outcome determined by the residual intensity of pain and the individual's response to that pain.

7.6 Limitations and comparison with other studies

This study was limited by its retrospective observational design. The subjective rating questionnaire did not use validated indices with the exception of the Numerical Rating Scale (NRS). While a weakness, the simple rating scales employed did provide a

clear understanding of specific aspects of the patient's discomfort, whereas the aggregate scores of validated composite instruments are more difficult to relate to specific symptoms or types of disability.

At least 2 years of follow-up is required for surgical studies evaluating low back pain treatment (van Tulder 1997). Because of the retrospective design this study only measured subjective patient outcomes at 2 years follow up with no baseline values against which to measure improvement. If the proposition is that spinal surgery is effective in abolishing chronic low back pain, then this approach provides some useful data, but if the hypothesis is that spinal surgery will reduce pain then baseline data is essential.

Missing data is an important limitation in interpreting study results. Although an analysis of those who did respond to the questionnaire did not appear to indicate that they differed from those who responded, it is possible that the responses were biased. The preponderance of missing data from the decompression and stabilisation group could reflect either greater satisfaction or dissatisfaction and could have biased the results.

The only validated instrument in the study questionnaire was the Numerical Rating Scale for pain. The other Likert items in the questionnaire are not comparable to other outcome measures published in the literature. When measuring subjective outcomes, differences in motivation for recovery, expectation of treatment success, and perception of changes in health status may affect the results. The use of a military cohort in this study is noteworthy as there was unlikely to be any confounding due to compensation status. All soldiers wished to remain employed in the Army and saw surgery as a means to achieve this and were strongly motivated to remain in the Army.

The mean age of this cohort of 29.7 years was younger than that reported in three recent surgical studies; 41.4 years (Weinstein 2006b), 52 years (Soegaard 2007) and 58 years (Glassman 2009). The MRC spine stabilisation study did not report mean age of subjects, but did report that only 12.6% of patients were under the age of 30 (Fairbanks 2005). It is reasonable to say that the subjects in this study were younger than the general population normally undergoing spinal surgery.

There are a number of reasons for this. The demanding nature of Army service leads to a high incidence of back injury as demonstrated in previous chapters. There is considerable pressure to recover quickly and achieve a suitable medical classification in order to maintain employment. Free medical care is a condition of military service, so there is an environment where young soldiers wishing to prolong their military careers could seek the option of spinal surgery as a quick fix for their problems; one free of cost concerns as they were effectively unconstrained by sick leave and rehabilitation concerns.

There are a myriad of rating scales for pain and disability described in the literature. Soegaard noted that determining the magnitude of a clinically relevant improvement in clinical studies was not straightforward, and therefore the reported percentage of patients benefiting from surgery was often arbitrary (Soegaard 2007b).

Despite several studies comparing surgical and non-operative treatment of the lumbar spine, baseline differences between treatment groups, small sample sizes, or the lack of validated outcome measures limit the comparisons or conclusions that can be drawn regarding optimal treatment. (Hoffman 1993, Gibson 1999, Jordan 2003, Weinstein 2008)

A Cochrane review of studies involving the surgical treatment of lumbar spondylosis or degenerative disc disease (Gibson 2005) found that most of the earlier published papers reported technical surgical outcomes with only crude ratings of clinical outcome. More recent trials reported patient-centred outcomes of pain or disability, but Gibson noted there was very little information on occupational outcomes, and in particular a lack of reported long term outcomes beyond two to three years (Gibson 2005).

Many studies of surgical outcome did not report VAS or NRS pain scores as primary outcome measures, but used composite instruments such as the Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36) bodily pain and physical function scales (McHorney 1994) and/or the Oswestry Disability Index (ODI) (Daltroy 1996) as their primary outcome measures.

The SF36 bodily pain scale comprises two indices; Pain-magnitude and Pain-interfere, with the resulting score being a composite of the two indices (Ware 2009). The Bodily Pain scale is scored from 0-100, but inversely to the VAS and the NRS, with a higher score representing less pain and a lower score representing more pain. The Bodily Pain scale is one of four scales that comprise the Physical Health summary measure of the SF 36, with the other scales being Physical Functioning, Role-Physical and General Health. Weinstein (Weinstein 2006a) considered a 10-point difference in the SF-36 bodily pain and physical functioning scales or a similar effect size in the ODI to be clinically significant. Interpretation of the clinical significance of changes seen in quality-of-life scales is difficult, for despite considerable interest in knowing the minimal clinically important difference for various scales, no consensus exists with regards to methods for providing such benchmarks (Beaton 2000, Beaton 2001).

This study found large numbers of subjects (18/47, 38.3%) who completed the follow up questionnaire had residual pain scores in range of 7-10. This level of residual pain was only partially related to self rated perceptions of success, with a significant number of subjects with high residual pain scores rating their surgery a success. Being a retrospective study there was no opportunity to examine the change in pain score from baseline at the follow-up period. None of the studies reviewed provided a distribution of raw pain or disability scores, with only mean pain scores being reported. Thus it was not possible to determine how many patients were rendered pain free from any of the interventions studied. In this study only 4% (2/47) of those who responded to the follow up questionnaire reported themselves as pain free, while a further 12 % (6/47) reported NRS pain scores in the range of 1-3.

Frymoyer (Frymoyer 1983) found that of those who rated their pain as moderate, only 2% proceeded on to surgery, while of those who described their pain as severe, 10% preceded to surgery. Junge (Junge 1996), in a cohort of subjects undergoing discectomy, reported a mean pre-operative NRS pain score was 6.7 and noted that two years post operatively 23.4% still had a pain score greater than 6. Leufven (Leufven 1999) reported a reduction in mean NRS pain score from 8.6 pre-operatively to 4.0 at 1 year and 4.2 at 5 years following circumferential lumbar fusion.

Cornefjord in a study of patients with spinal stenosis found no statistically significant difference in pain score between those who underwent decompression and

fusion and those who had decompression alone (Corneffjord 2000). There was a 50% reduction in the number of patients reporting constant or daily leg or back pain, but at follow up 43% reported constant leg pain and 45% constant back pain. Saal (Saal 2000) in a study of intradiscal electrothermal therapy (IDET), reported mean VAS pain scores falling from 7.64 (SD 1.33) to 4.44 (SD 2.18) at two months post-operatively.

Fritzell (2001) reported a reduction in VAS pain score from 64 to 43 (33%) in a surgical fusion group, compared to a reduction from 63 to 58 (7%) in a control nonsurgical group ($p=0.0002$). Pain scores improved most during the first 6 months and then gradually worsened. Disability as measured by the Oswestry Disability Index (ODI) was reduced by 25% (47 to 36) in the surgical group compared with a 6% reduction (48 to 46) in the nonsurgical group ($p=0.015$). Brox, in a study comparing lumbar fusion to physiotherapy and cognitive behavioural therapy found no significant difference in pain scores between the two groups at 1 year follow-up (Brox 2003).

Fairbank (Fairbank 2005) in a study comparing spinal fusion to rehabilitation reported the SF36 bodily pain index in the fusion group improved from 28.6 (17.3) at baseline to 48.1 (26.4) at 24 month follow-up. For the rehabilitation group bodily pain improved from 30.0 (16.0) to 44.9 (25.1) at follow-up. There was no significant difference in pain improvement between the two groups.

	Assigned to Surgery			Assigned to Nonoperative Treatment		
Baseline	Surgery (n = 140)	No Surgery (n = 92)	P Value	Surgery (n = 107)	No Surgery (n = 133)	P Value
Bodily pain- mean (SE)						
Randomised Cohort - Intention to Treat	24.1 (16.7)	31.7 (20.2)	.002	24.1 (16.8)	28.9 (17.7)	.03
Observational cohort – As treated	21.2 (15.8)				36.2 (20.3)	<.001

Table 7.10 Baseline SF36 Bodily Pain scores for both randomised (Weinstein 2006a) and observational (Weinstein 2006b) cohorts.

The Spine Patients Outcomes Research Trial (SPORT) trial was a major multi-centre trial comparing discectomy to conservative treatment in a randomised and

observational cohort with proven intervertebral disc prolapse. (Weinstein 2006a, Weinstein 2006b). Table 7.10 shows the baseline SF36 bodily pain scores in the randomised cohort. The group that chose non-operative care had significantly higher bodily pain scores (i.e. less pain) at baseline.

The SPORT study recently reported 4 year follow-up data (Weinstein 2008). Table 7.11 shows the mean change in SF36 body pain index at two, three and four year follow up. On an intention to treat basis, there were no significant differences in SF 36 bodily pain score at any of the follow-up periods for the surgical and non-surgical groups. Using an 'as treated' analysis, the mean difference in SF36 bodily pain scores ranged from 11.4 at 2 year follow-up to 15 at 4 year follow-up. Based on a threshold of clinical significance set at a 10 point difference on the 100 point scale, the authors argued that this reduction in pain was clinically significant.

Baseline mean SF36 Bodily Pain	26.9(0.82)	Intention to treat- RCT cohort	Baseline mean SF36 Bodily Pain	26.6 (0.5)	As treated - combined cohorts.	
SF36 Bodily Pain Score (0-100) (SE) at follow-up						
	Surgery	Non-operative	Treatment effect(95%CI)	Surgery	Non-operative	Treatment effect (95%CI)
2 year	n=187	N=191		N=662	N=344	
Mean change(SE)	40.5(1.9)	37.5(1.9)	3.1(-2.2,8.4)	43 (0.87)	31.6 (1.2)	11.4 (8.5,14.2)
3year	N=180	N=170		N=581	N=318	
Mean change(SE)	39.2(2)	36.2(2)	3.4 (-2.1,8.9)	43.8(0.9)	31.8(1.2)	12 (9,15)
4 year	N=149	N=150		N=511	N=283	
Mean change(SE)	41.3(2.1)	36.8(2.1)	4.5(-1.2,10.3)	45.6(0.95)	30.7(1.3)	15 (11.8,18.1)

Table 7.11 Mean changes in SF 36 Body Pain scores at 2, 3 and 4 year follow up in the SPORT study. (Weinstein 2008)

The authors of SPORT attributed the large effects seen in the as-treated analysis to the very high cross-over of randomised subjects observed in the study, with only 60% of those assigned to surgery eventually having surgery, and 43% of those assigned to non-operative care having surgery at 1 year post-enrolment. Those more likely to cross over to surgery had worse baseline pain, disability and fear that their symptoms

were getting worse, compared to those receiving non-operative treatment. The converse was found in those who crossed over to non-operative treatment (Weinstein 2006a).

The authors acknowledged they could not exclude the possibility that the baseline differences between the 'as treated' groups may have affected the results, even after controlling for important covariates (Weinstein 2008). These findings would support a hypothesis that pain intensity and fear of worsening pain are significant motivators for patients to choose surgery.

The SF36 Bodily pain score is not directly comparable to the numerical rating scale pain score used in this study, but the SPORT data showed that surgical patients still experienced residual pain at follow-up with a mean SF 36 bodily pain score (baseline plus mean change) of 68.2 in the surgical group and 63.7 in the non-operative based on intention to treat [100=no pain]. In the 'as treated' cohort mean residual bodily pain scores were 72.2 in the surgical group and 57.3 in the non-operative group. The SPORT study did not provide any data on the subset of patients who were pain free.

Soegaard in a study of outcomes of lumbar spinal fusion reported a highly significant improvement ($p < 0.0001$) in all dimensions of functional disability using the Dallas pain questionnaire, but did not use VAS or NRS pain score (Soegaard 2007b). He found that patients with a more severe disability at baseline reported a greater net benefit from surgery.

Glassman reported the outcomes of lumbar fusion patients stratified by diagnosis (Glassman 2009). The study reported mean improvement in NRS pain score within different diagnostic subgroups, but did not report baseline pain scores. The best mean improvement in NRS pain score was seen in the spondylolisthesis group with a mean reduction of pain score of 3.8 points (SD 3.3) at 1 year and 3.3 points (SD 3.2) at 2-year follow-up. Glassman used a Minimum Clinically Important Difference (MCID) for NRS of 1.6 points. At 2 year follow up, 60% of the spondylolisthesis and 70% of the scoliosis subgroup achieved a MCID in NRS pain score. The other diagnostic subgroups ranged from 50-57% of subjects reaching a MCID in NRS pain score.

This study reported the distribution of pain scores in the subject population, which included those who were pain free at time of follow-up. All other published studies have only reported mean patient pain scores or improvement in symptoms using a wide array of instruments. Success usually being defined as the mean improvement in various outcome measure scores, with no sense of the population distribution of outcome or those who were pain free and therefore “cured”. The clear conclusion to be drawn from the literature is that spinal surgery is a palliative procedure and not a curative one, and the findings of this study are consistent with the literature.

This study found self-reported success rates of 10% for the non-operative group, 59% in the decompression group, 66% in the stabilisation group and 38% in the decompression and stabilisation group. The total self rated success was 43%, but this was skewed by the low rate in the non-operative group. While the self-reported rating of symptoms revealed that 5 (10.6%) reported no symptoms, 20 (42.5%) reported symptoms as better, 12 (25.5%) reported no change and 10 (21.3 %) reported that their symptoms were worse. There was an inconsistency in that only two subjects reported no pain and 5 reported no symptoms. The most likely explanation for this is that three subjects had infrequent episodes of mild pain that they did not consider troublesome.

There is considerable variation in the types of primary outcome measure utilised in the literature. Stewart used three primary outcome measures; return to work, narcotic use and patient satisfaction, and claimed a 72% success based on improvements in those three outcomes, noting that pain scores correlated significantly with each of the outcome measures (Stewart 1996). Santavirta reviewed 80 spinal fusion patients 5 years post surgery (Santavirta 1996) and found the mean ODI decreased from 3.8 to 2.7. The mean Oswestry total index for the whole group was 41% reflecting severe disability before surgery and 25% at follow-up reflecting moderate disability. Half the patients returned to work and patients with previous surgery had the worst outcomes.

Fraser (Fraser 1997) in a 10 year follow-up study of discectomy patients noted that 78% of patients rated themselves as having complete relief or a good deal of relief, but when assessed on a functional basis this number fell to 34%. Clinical outcome was not associated with radiologic fusion or compensation status.

Fritzell reported that 63% of a lumbar fusion group rated themselves as "much better" or "better" compared with 29% in a comparative nonsurgical group ($p < 0.0001$). In the surgical group, 23.6% rated themselves as unchanged and 13.8% rated themselves worse, while in the non surgical group the figures were 45.2% unchanged and 25.8% worse (Fritzell 2001). Brox reported an assessed success rate of 70% at 1 year following lumbar fusion surgery and 76% after cognitive behaviour therapy and physiotherapy (Brox 2003).

At 4 year follow-up in SPORT, there was no significant difference in those who rated themselves as having "major improvement" in the intention to treat group (72.5% surgical vs. 65% non-operative), but in the 'as treated' group there was a significant self-reported improvement in the surgical group [79.2% vs. 51.7%] (Weinstein 2008). Weber reported "good" results in 70% of a surgical group and 51% in a conservative treatment group at 4 year follow-up (Weber 1983). Weinstein noted that there were no long-term studies reporting the same primary outcome measures as SPORT (Weinstein 2008).

Soegaard found greater improvement in subjective ratings of success in subjects with high levels of baseline disability (Soegaard 2007b), and suggested that subjects with higher disability were offered greater potential for improvement whereas those with moderate disability had less potential for improvement. This phenomenon would explain the somewhat paradoxical outcomes of this study and others, where despite high residual pain scores; a reduction in pain from extremely high levels to moderate levels would appear to have constituted success in the eyes of many patients.

This study also reviewed the military employment status of the patient cohort six years post-surgery and found that only 15 (25%) of the original cohort remained in military service. Many of those who were discharged would have taken up less physically demanding jobs, and only those discharged as medically unfit (MU) were likely to remain on invalid pensions. There were 6 MU discharges, indicating that up to 90% of the other soldiers may have returned to employment. If those who were discharged as below medical standards (BMS) are included, the number rises to 16/61 giving a worst case return to work status of 74%.

Fritzell (Fritzell 2001) calculated a 'net return to work rate', which involved subtracting the number of patients who ceased work from those returned to work. The

net return to work rate was significantly in favour of surgical treatment, with 36% of the surgical group and 13% of the non surgical group returning to work ($p=0.002$). This patient population had been on sick leave for over two years, and this was reflected in the low return to work rates. There was no significant difference in the mean number of days of sick leave per patient in either group during the 2-year period of follow-up (fusion group 521 days (SD 204) versus non operative 534 days (SD 227)).

In the SPORT study, employment status was the only outcome measure which showed a small treatment effect in favour of non-operative care, but this was not statistically significant (Weinstein 2008). At 4 year follow-up, there were no significant differences in the percentage of subjects who were in employment between the two treatment arms on either an intention to treat (71.4% surgical vs. 75.1% non-operative) or on an 'as treated' basis (84.4% surgical vs. 78.4% non-operative). Weinstein commented that "return to work appears to be independent of treatment received and does not follow improvement in pain, function or satisfaction with treatment". This finding was consistent with the Maine Lumbar Spine Study which also that although spine surgery was associated with pain reduction, it was not associated with increased labour force participation (Atlas 1996).

SPORT also found that those treated surgically reported more diagnostic test use (53% surgery vs. 34% non-operative patients, $p<0.001$) and medication use (96% surgery vs. 89% non-operative patients, $p<0.001$) than non-operative patients, with use in both groups declining over time. These findings are consistent with the hypothesis that patients with greater morbidity incline towards surgery.

Hazard (Hazard 1994) examined the correlation between pain, impairment and disability in a cohort of 90 chronic LBP subjects. Correlation co-efficients between initial scores were all less than 0.50. At 5-year follow-up, pain and disability correlated closely but not impairment. Patient satisfaction scores correlated with current pain and disability, but not with improvements in pain, disability or impairment scores.

Carragee noted that surgical practice in treating disc herniation had changed since the 1980's, where a comparatively large surgical exposure was used compared with current surgical interventions, which are characterized by small incisions, minimal blood loss, and early hospital discharge (Carragee 2006a). The postoperative

convalescence after a modern uncomplicated limited discectomy may be only a few weeks compared with a few months in the study by Weber (Weber 1983).

7.7 Discussion

The evaluation of outcomes in spinal surgery is difficult and there is no agreement in the literature as to what should constitute standardised outcome measures. A number of studies have reported patient satisfaction, return to work and one of a number of different pain and disability assessment ratings. The myriad of reporting instruments reflects the failure to abolish pain, and therefore most are seeking to measure change or improvement in either pain or its associated disability.

While instruments such as the SF36 bodily pain scale and the Dallas pain questionnaire are validated, what do their scores mean in practical terms? Because they are composite items, the same aggregate score could represent different scores in different scales. They provide a reproducible score that can be statistically analysed, but is that a practical and socially desirable outcome?

This study reports the distribution of outcomes and it can be seen that there was significant variation in outcome on the key outcome measures of pain and return to work. The plethora of instruments used to measure pain and its impact are a reflection of the well reported disconnection between reported intensity of pain and its consequent effect on function. Hence there is a strong focus on measuring disability in many of the instruments that record outcome. The lack of a clear and reproducible relationship between pain and function has been the great conundrum of back pain research.

There is a strange dichotomy between pain and function, with no strong correlations between pain, self-reported satisfaction, treatment type and return to work. Nearly all studies have reported significant residual levels of pain but relatively high levels of patient satisfaction with the outcome of the procedure. These findings are most probably due to psychological factors, as reported by many authors.

Fraser (Fraser 1997) found that psychological status influenced the reporting of outcome and was strongly correlated with the functional low-back outcome score. Van

Susante, in a prospective study, confirmed the importance of psychological factors in determining the outcome of spinal procedures (Van Susante 1998). Patients were assessed preoperatively and at 12 months following spinal fusion, with those labelled as "psychogenic" preoperatively having worse outcomes in terms of pain and analgesic use than a group termed "organic". The authors commented that psychological stress worsened the outcome of lumbosacral fusion and all intending patients should be psychologically screened before surgery.

Andersen (Andersen 2006) found that pre-operative disability and emotional distress were potent predictors of a poor outcome. Trief (Trief 2006) in a prospective cohort study of 160 patients found that pre-operative emotional distress predicted a poor outcome, with similar findings reported in the Swedish Lumbar Spine Study (Hagg 2003). Grahn (Grahn 2000) reported that motivation was a predictive factor for a cost-effective outcome in patients with chronic musculoskeletal pain conditions, and it was important to specifically focus on patient motivation when discussing surgery versus nonsurgical treatment.

This study found a number of subjects who despite moderate to severe levels of residual pain rated their procedure a success, and managed to remain in employment. This observation could be explained by individual variation in pain tolerance or psychological robustness. For a given level of pain, individuals with higher pain thresholds will be able to function better and perceive more success, especially if they started from a high baseline of pain. Under this hypothesis it is not the effectiveness of the procedure, but individual patient characteristics that will determine the subjective outcome. This hypothesis will need to be tested in a randomised controlled study.

From a societal and individual perspective, return to work is perhaps the most important outcome in any intervention involving the spine. The Army subjects were young and, in normal circumstances could look forward to a long and productive working life. An outcome from spinal surgery that precludes return to work has significant economic impact not only on the individual (as shown in Chapter 3) but also for Government and Society. Soldiers with specialist military skills cannot quickly be replaced as there is no "market" for many of these skills.

Fritzell stated that “The main purpose when treating therapy-resistant chronic low back pain with surgery is to reduce pain and disability to a level at which it makes an important difference to the patient.....If these patients do return to work, then it may be considered as a bonus.”

The role and effectiveness of spinal surgery has generated considerable debate in the literature. The significant regional variation (up to 15-fold) in rates of spinal surgery in the United States and lower rates internationally raise questions regarding the appropriateness of some of these surgeries (Deyo 2005). The increasing popularity of spinal fusion surgery also warrants a more rigorous scrutiny of the benefit achieved for the cost incurred (Medicare Australia 2009).

The Cochran review of lumbar surgery (Gibson 1999) noted that after a search of the literature over a 32 year period from 1966 to 1998 there were only 26 randomised controlled trials (RCT) examining lumbar disc prolapse and 14 RCT studying degenerative lumbar spondylosis. In both groups, the reviewers commented that there were many weaknesses of trial design and that conclusions must be drawn with caution.

The reviewer’s thoughts are worthy of quotation; “Currently, there is no adequate scientific knowledge about the efficacy or long-term effects of either surgical decompression or fusion. This is of particular concern given the magnitude of the clinical problem and costs of surgical procedures being performed. There is no acceptable evidence (Strength D) of the efficacy of any form of fusion for degenerative lumbar spondylosis, back pain or “instability”.... There are major gaps in knowledge concerning the costs, cost effectiveness, and work outcomes of all forms of surgical management for lumbar disc prolapse and degenerative lumbar spondylosis.” (Gibson 1999).

In a later review, Gibson noted that recently published RCT used appropriate methods of randomization, blinding and independent assessment of outcome (Gibson 2005). He noted that “More of the recent trials also reported patient-centred outcomes of pain or disability, but there is still very little information on occupational outcomes.”

Spinal instability is a major indication for lumbar fusion. The surgical literature abounds with the view that true fusion is responsible for pain relief, and much effort is

directed at achieving radiological fusion. However a number of studies have reported patients who continue to have persistent pain and satisfaction rates at least 10% lower than radiological fusion rates. (McCulloch 1998, Kim 1999, Liljenqvist 1998).

The quest for improved radiological fusion has resulted in an expansion of techniques to achieve it, but with little or no evidence to justify the newer techniques. Fritzell found that instrumented fusion increased hospital costs by 66% (posterolateral) and 103% (circumferential) respectively, compared to non-instrumented fusion, with no statistically significant difference in clinical effects. He concluded that "There is a widespread belief among spine surgeons that an instrumented fusion carries potential advantages of both earlier rehabilitation and return to work, and it should therefore be an urgent and important mission to compare non-instrumented posterolateral fusion with an instrumented procedure."

MacDonald-Wilson found that instrumented fusion surgery was more costly and had higher complication rates (Macdonald Wilson 2008). He noted that "We were able to demonstrate no benefit in outcome for patients undergoing more complex and expensive surgery with the three surgical groups experiencing very similar outcomes..... It seems sensible to use the least technically demanding procedure, which is most cost-effective, with the least complications."

The natural history of "discogenic" back pain is controversial. Smith followed a cohort of 25 patients who had a positive discogram but declined surgical treatment (Smith 1996). At 3-year follow-up, 68% had improved, 8% were unchanged and 24% worse. Of the 6 who were worse, 4 had a psychiatric disease. He noted that these results were comparable or better than reported surgical results. The SPORT study found similar levels of improvement in those subjects who opted for non-surgical treatment (Weinstein 2008).

The New Zealand Accident, Rehabilitation and Compensation Insurance Corporation guidelines for the management of acute low back pain note that "surgery seems to be a luxury for speeding recovery of patients with obvious surgical indications, but benefits fewer than 40% of patients with questionable physiologic findings. Moreover surgery increases the chance of future procedures with higher

complication rates." (Accident Rehabilitation and Compensation Insurance Corporation 1995)

Effective surgical treatment requires the precise diagnosis of a surgically correctable lesion. Szpalski states that "surgery should not be performed to treat a symptom (pain) but only to treat an objective condition or disease" (Szpalski 1998). Surgical management is the subject of many controversies, and even in agreed diagnostic conditions such as disc herniation, spinal stenosis and spondylolisthesis there is a wide choice of techniques and procedures for each indication and there are conflicting results in the literature. As stated by Gibson, "There is no scientific evidence on the effectiveness of any form of surgical decompression or fusion for degenerative lumbar spondylosis compared with natural history, placebo, or conservative management." (Gibson 1999).

Failure to abolish pain calls into question the theoretical paradigms underpinning current surgical procedures. If the current hypotheses driving procedures for spinal stabilization were correct, then correction of spinal instability should abolish pain, not merely palliate it. Would society accept palliation in the management of appendicitis or fracture? The difference in the latter cases is that the causative pathology is clearly known.

When considering the issue of diagnostic discipline it is useful to review Koch's postulates which have historically formed the basis for disease causation. Koch's postulates state that;

- (a) the disease is present if the organism/factor is present,
- (b) the disease is absent if the organism/factor is absent,
- (c) the disease is abolished if the organism/factor is removed, and
- (d) the disease is created when the organism/factor is introduced.

While originally invoked to define causation in bacterial disease they are readily applied to any medical condition, including procedures used to treat a hypothesized cause. The application of Koch's postulates to the putative diagnostic and treatment criteria governing spinal surgery, should give the surgical fraternity pause for reflection.

Little has changed in the intervening decade since this thesis commenced, as Glassman noted in a recently published paper; “added diagnostic specificity is a critical component in building an improved evidence base for lumbar fusion surgery. In particular, broad categories such as degenerative disc disease, chronic low back pain and discogenic disease need to be divided into clinically relevant entities such that the reported outcomes can be interpreted more effectively”(Glassman 2009).

The editors of the Spine Journal commenting in reference to Glassman’s paper noted that, “Patients and payors have questioned the broad application of spinal fusion for “back pain syndromes”. The administrative argument often lacks any specificity, treating all diagnoses (e.g. spondylolisthesis) and syndromes (back pain with common degenerative changes) as a monolithic group. Proponents of fusion, nonetheless, often quote “80%”, as a somehow reasonable estimate of spinal fusion success- independent of our frequent failure to accurately diagnose the structural cause of pain beyond broad diagnostic categories such as ‘Low Back Pain’ or ‘Degenerative Disc Disease’.”

Hagg found that back pain subjects selected for surgery only differed from the general population of patients with back pain in the severity of their pain and disability symptoms (Hagg 2002). Weinstein observed high levels of patient cross-over the SPORT study and the significant difference in baseline bodily pain scores suggest that patients with higher levels of pain and a fear that the condition would worsen opted for surgery, while those with less pain and less fear opted to wait and see (Weinstein 2008). This suggests that patient concerns regarding pain and disability, rather than clear therapeutic criteria guided the decision for surgery.

Given the lack of evidence in favour of these procedures and the variable outcomes, why are these procedures continuing to be performed? Fairbank (Fairbank 1993) summed it up well “The patient usually takes the final decision to proceed. Nevertheless, this individual, however carefully advised, is far from “homo numericus economicus”. How can a young middle-aged adult who has tried and failed all the available treatments avoid grasping at any straw, even if the odds are clearly stacked against them? (Homo desperatus?)”.

Fairbanks comments are supported by the findings of later studies, that is, patients in greater pain seek surgery as the last option, and therefore in a number of

cases it is patient preference rather than surgical indication, which governs the decision to have surgery. If there were effective alternatives to reduce pain then the number of spinal surgical procedures should decrease.

Carragee formed the same conclusion in his analysis of the outcomes of the SPORT study "... whether to choose a surgical approach to sciatica due to disk herniation depends strongly on the individual patient's situation beyond the commonly considered medical and surgical comorbid conditions..... the apparently slower recovery without surgery may represent a hardship beyond physical pain. While curtailing activity can lessen sciatica if the patient can afford to do so, these individuals may be unable to meet important daily necessities over an extended illness; they may lose their ability to care for family, to earn a living, or to keep a competitive job." (Carragee 2006)

Resnick in a defence of lumbar fusion stated that , "The challenge is to determine the right procedure for a given patient population, define a clinically relevant difference in outcome using reliable and valid outcome measures, design a study with adequate power, and perform the study in an era of burdensome HIPAA regulations and public scrutiny." (Resnick 2007).

Whilst there are a number of clearly identified conditions associated with back pain (disc prolapse, spondylolisthesis, annular tear, facet joint dysfunction) there is no clear evidence for the specific pathological process of pain generation. The underlying pain generating process is not known and could include inflammation, trauma, and tension of nerve fibres or neuromas formed in scar. Nociceptive stimulation of nerve endings is a requirement, but the basic underlying process is not clearly understood. There are a number of other possible aetiologies that could cause pain and be amenable to alternative therapies.

Cholewicki (Cholewicki 1992) studied a group of power lifters lifting heavy weights (up to 200kg); while their lumbar vertebrae motion patterns were quantified using fluoroscopy. During lifting the subjects spinal segments remained 2-3° short of full lumbar flexion. During one lift a subject reported pain and discomfort, and the lift was aborted. The fluoroscopy records revealed that at the L2/L3 joint, full flexion had been achieved causing the spine to buckle. The authors attributed this to failure to

activate one of the segmental muscles, allowing excessive movement at a single point, which could lead to damage of the passive restraining tissues. This raised the issue of whether spinal stability was a dynamic or static process, and whether instability could be corrected with a dynamic strengthening approach rather than a static fusion approach.

Nelson (Nelson 1999) studied a group of patients who had been recommended for cervical or lumbar surgery and then participated in a 10 week outpatient program of aggressive resistance exercise. Of the 46 (75%) patients who completed the program, 38 were available for follow-up at 16 months. Only 3 subjects in the follow-up group required surgery. The authors noted that a large number of patients who had been told that they needed surgery were able to avoid surgery in the short term by aggressive strengthening exercise. The authors commented that it was important to define what constitutes "adequate conservative care." This study supports the hypothesis that dynamic muscle strengthening can effectively reduce pain and reduce surgical preference.

Takemasa (Takemasa 1995) compared 2 groups of low back pain sufferers; one group with identifiable back pathology and the other with no detectable organic pathology. Trunk flexor and extensor strength was significantly lower in both groups compared to matched controls. An exercise program increased muscle strength in both groups with excellent relief of pain in the group with no identified pathology and a lesser reduction in the group with organic pathology. The authors argued that decreased trunk strength is a major factor in chronic back pain.

Rask (Rask 1993) used pantaloons body casts to assess patients for lumbar fusion. Forty-five patients underwent casting for a 2-4 week period with 69% of patients reporting significant pain relief. Twenty-three patients subsequently underwent lateral bony fusion, and of these 17(74%) reported significant pain relief. This study was interesting in that it demonstrated significant pain relief with a resting cast, and implied that to truly compare the efficacy of spinal fusion would require a control group of casted individuals to determine if in fact prolonged rest was not a confounding factor in outcomes. In the absence of controlled studies of conservative management, it is not clear if the surgery is the cause of pain reduction or the prolonged immobilization and rest that characterises the immediate post-operative period. Rather than physiotherapy

as a control, bracing or strict bed rest followed by physiotherapy may be a better method for eliminating the potential confounding effect of prolonged rest.

In lumbar disc protrusions, other pathological processes have been shown to co-exist. Saal found mean levels of Phospholipase A2 in human lumbar intervertebral discs 10,000 greater than in the plasma of normal human controls (Saal 1990). Phospholipase A2 plays a central role in the inflammatory process through its regulation of the arachidonic acid cascade, and its activity levels are the rate-limiting step in the production of prostaglandins and leukotrienes. Synovial Phospholipase A2 has been shown to be inflammatory in its own right (Vishwanath 1988). The presence of large concentrations of inflammatory mediators suggests that anti-inflammatory approaches have the potential to reduce pain.

All health resources are to some extent rationed, and scarce resources should be allocated to interventions or procedures that produce the greatest good. Despite the availability of a plethora of surgical treatments for chronic pain in the lumbar spine, a satisfactory outcome remains elusive for many. A procedure that is performed for pain relief should be judged by its ability to eliminate or reduce pain. This study has demonstrated that pain elimination is rare (2/47), with 79% of respondents reporting baseline NRS pain scores of 4 or greater two years after surgery. Other published studies did not record the number of pain free patients, only reporting mean changes in pain or disability scores.

Understanding the cost and outcomes of a range of surgical procedures will become increasingly important as cost pressures mount on health budgets. Decision makers will be increasingly be in accordance with the views of Tosteson “Changing trends in spine surgery in the United States, combined with continued escalation in health care expenditures, highlights the importance of understanding the economic value of common surgical intervention.” (Tosteson 2008).

Given the reported effectiveness of non-surgical therapies, there is an opportunity to identify those patients whose pain can be palliated in a non-operative manner, and prevent the choice of surgery with its attendant risks and costs.

7.8 Conclusion

The consistent theme from the literature is that the expected outcome of spinal surgery is palliation not cure. This immediately raises the possibility of diagnostic error and/or a faulty paradigm that governs the decision. Clinicians in the future must look to offer more effective palliative therapies that do not involve surgery. The literature indicates that reducing pain and its associated fear and disability, is likely to reduce the patient preference for surgery. Efforts should be directed at reducing pain through non-operative means, allowing the decision for surgery to be resolved on strictly defined clinical criteria.

Reducing the incidence of spinal surgery will dramatically reduce the costs associated with injury to the lower back. The literature is very clear that only a small percentage of low back pain sufferers contribute disproportionately to costs, and this group are those who undergo spinal surgery. Given that back injury is the leading cause of disability in the Army, improved efforts to better palliate low back pain should be a priority.

Low back pain is a symptom, not a diagnosis. Much is made of the self-limiting nature of most acute episodes of low back pain, and the poor prognosis associated with chronic low back pain. But this approach defines the condition by its chronicity, not its aetiology.

The scientific method, which is the hallmark of modern medicine, requires that treatment of a condition should be based on its aetiology and pathology. A specific pathology will respond to a therapy designed to address it and if the diagnosis is wrong, logical treatment will not follow. Therefore a decompression procedure will only be successful if there is a compressive pathology, and a stabilisation procedure will only be successful if there is an underlying instability to be corrected. The literature consistently reports reductions in pain, but no or very small numbers of patients whose pain is abolished. How much of this improvement is attributable to the surgery and how much is due to enforced lifestyle change, forced rest or psychological adjustment cannot be determined.

Until we have a much better understanding of the aetiology of the various causes of low back pain, surgeons will continue to pursue a plethora of surgical techniques that may palliate but not cure. The human and societal cost of this is enormous. The literature contains contradictory evidence in favour of current spinal surgical procedures and some evidence suggesting that the outcomes of doing nothing are as effective as surgical intervention. An ineffective procedure becomes a candidate for elimination and potentially significant cost saving.

The non-operative group in this study (injection of epidural steroid, manipulation under anaesthesia) reported a self-rated success of only 10%, and these results do not lend any support for the routine use of these procedures. The decompression and stabilization procedure had a subjective success rating of only 38%, and the rationale for combining these 2 procedures is not clear. These results also do not lend any support for the continued use of this combination of procedures and recent published studies confirm that this procedure is now little utilised.

The findings of this study are consistent with other paper in finding that pain score was decoupled from return to work or disability, suggesting that individual psychological makeup and by inference pain threshold, determines functional outcome. The role of psychological factors has traditionally been linked to secondary compensation gain, but this study supports the view that pain threshold or tolerance may impact on functional outcome in the presence of severe levels of residual pain. This could explain the repeated finding that outcome in subjects with abnormal psychometric testing was consistently poor (Fraser 1997). It should be no surprise that a procedure that fails to abolish pain will have its functional outcome determined by the residual intensity of pain and the individual's response to that pain.

For many patients, low back pain is a self-limiting symptom. But for approximately 10% of patients the symptoms become chronic and the costs escalate rapidly. Data collection and research effort should focus on identifying why this select population have poor prognoses. Given that this group incur great direct costs and usually have residual permanent or partial incapacity, the risk factors and effective treatments for this group should be a national priority.

Research into unintentional injury received only 1.9% of total National Health and Medical Research Council (NHMRC) funding during 2002-3 (Aoun 2004). Funding for research into back injury is just a fraction of that overall expenditure. For a condition that causes so much pain and suffering to individuals and tremendous cost to government, employers and the community, it is poorly funded. As Mitchell noted "The gap between the size of the public health problem of injury and national efforts to reduce it needs to be addressed." (Mitchell 2008)

The main purpose of economic evaluations is to help setting funding priorities. A new treatment should be compared with the best available alternative, (Drummond 1997) which may be difficult because the best alternative for treating chronic low back pain is debatable, as evidenced by the plethora of surgical procedures available. Also, assessing the costs related to treatment of subjective entities, such as pain, quality of life, and function, is a complex undertaking (Ferrell 1996).

Patients in this population were younger than those who participated in other studies, but the residual pain scores and return to work rates were similar to other reported studies. Reporting the distribution of pain scores provides information useful to decision makers, and allows for the identification of sub-groups worthy of further investigation.

The cost of intervention did not govern success and a number of studies have found that increasing complexity of procedure increased costs but did not produce improved clinical outcomes. The benefit and role of more complex fusion procedures should clearly be reviewed.

Governments and society cannot continue to fund expensive procedures which have little or no impact on functional outcome. Patient preference (or desperation) is the driving force in this context, for if patients are in severe pain and perceive that pain to be worsening it is only human nature to want something done. Grasping at straws is perhaps an apt description for this scenario.

The cost of providing a service can be justified if the outcome is beneficial to the individual or society. The primary outcome for the patient is relief of pain, whilst the primary outcome for society is return to gainful employment (or a lack of

invalidity). In this study there were no statistically significant differences between the cost of successful and unsuccessful procedures, consistent with other recent studies which found no link between clinical outcome measures and return to work status. Working status is perhaps the best outcome indicator from an employer, insurer, government and societal perspective, if not also from an individual perspective.

The detailed review of the costs and outcomes of spinal surgery provide useful information for health system decision makers. It is one thing to be injured, it is another to receive the appropriate treatment required to facilitate a full. The cost of injury is significantly increased if expensive treatments that do not result in a rapid and sustained return to work are achieved.

In a constrained financial environment where governments are seeking to maintain or reduce the growth in health expenditures, a fairly ruthless approach to effectiveness is required. Traditional cost effectiveness evaluations have examined the incremental cost in comparison to a standard treatment, but do not question whether the standard treatment or any of its competitors are effective from a primary standpoint. To justify the continued commitment of scarce funds to a procedure or group of procedures, decision makers must be convinced that there is a worthwhile absolute, rather than just relative, benefit to justify the cost.

The final word will rest with Gibson; "Surgical investigations and interventions account for large health care utilisation and costs, but the scientific evidence for most procedures is still limited." (Gibson 2005).

Chapter 8. Summary and Conclusion

8.1 Introduction

This is the first study to have determined a comprehensive estimate of the cost of injury to the Australian Army. Ironically, the data sources used in this analysis, while dated, are more comprehensive and reliable than those currently available through existing information systems within the Department of Defence. The included review of spinal surgery is also the first study to compare the cost and outcomes of a range of spinal surgical procedures reflective of general orthopaedic community practice.

This study adopted a government perspective as well including societal and individual perspectives in assessing the cost of injury to the Australian Army. Because the government pays salaries, medical costs, pensions, and bears the burden of productivity losses; its perspective is very similar to that of society. Capability loss is a uniquely Army intangible cost that cannot be currently quantified.

8.2 Cost of Illness Studies

Cost of illness studies summarize the economic burden of a particular disease and provide information for stakeholders, allowing them to make informed decisions on the allocation of scarce healthcare resources. Cost of illness studies serve a different purpose to that of health economic evaluations (i.e. cost-benefit analysis, cost-effectiveness analysis, cost-utility analysis) which are focused on evaluating the cost of an intervention rather than estimating the cost of a particular disease (Druss 2002).

The economic burden of injury is the sum of all costs associated with injury that would not otherwise have been incurred, had the injury not occurred. Estimating the economic burden of all injuries in a defined population can be difficult because the necessary data are often unavailable.

The cost of injury has three components; direct costs; indirect costs; and intangible costs. Direct costs considered in this analysis included external medical and

compensation costs, as well as compensation liabilities calculated by the Australian Government Actuary. Indirect costs included productivity losses, with invalid pensions also included because they constitute a significant cost to Government not usually included in (COI) studies. An additional analysis of the net present value of lost wages was conducted on a cohort of soldiers who were invalided from the Army. A novel approach, termed the Capital Investment Model, was used to estimate the loss of training investment as a result of premature separation from the Army due to injury. Intangible costs were not included in this study because of the difficulty in placing a monetary value on these aspects of injury.

Dagenais, in a systematic review of cost of illness studies, found that the greatest cost savings from a societal perspective may be obtained from interventions that promote early return to work and minimize lost productivity (Dagenais 2008).

8.3 Strengths and Limitations of this thesis

This thesis has categorised and captured costs associated with injury in the Australian Army in a comprehensive manner. Correctly categorising all costs represents the first step in improving the quality and comparability of cost information (Balas 1998). The cost data in the review of spinal surgery conformed to the requirements of Barber by presenting the data more precisely with arithmetic means and standard deviations, as well as the use of simple statistical analysis to determine any significance between two different mean costs of treatment. (Barber 1998).

Most of the datasets used in this thesis are proprietary and not publically available. It is a weakness of this study that a detailed breakdown of injury costs could not be obtained from the Defence Financial Management Information System (DEFMIS) database. Other cost of illness studies have been able to identify the individual components contributing to the direct cost calculation, but this thesis was forced to rely on a number of proportional estimates, due to the previous and continuing limitations of the existing datasets.

The DEFMIS database only accounted for externally generated medical expenses and did not take into account the services and costs incurred from salaried

members of the Defence Department who delivered health services. It was not possible to apportion a contribution of sunken health costs to injury.

The estimate of direct medical costs relied on assumptions based on data derived from a Canberra Area Medical Unit database, because it was able to capture individual episodes of injury using a unique referral number. Defence computer systems did not allow for the identification of discrete care episodes, thus not allowing for the distinction to be made between injury and illness.

This thesis used a cross-sectional prevalence approach to estimate the cost of injury across the Army. The use of a Canberra-based population containing a mixture of very young and relatively older subjects is likely to have skewed the estimation of injury prevalence, with the prevalence of illness likely to be higher in the older population compared to the younger populations located in other main troop concentration areas.

Clerical staff determined if the referral was for injury or illness, thereby introducing a potential source of bias, although this decision was informed by the content of the original doctor's referral and feedback from the patient. This process did allow for all costs associated with the episode of care such as radiology, pathology, anaesthetic, hospitalisation and ancillary costs to be recorded against the one referral number. This system was not utilised at any other military health facility, so the data is unique within Defence.

The only data available on the causes of medical downgrading came from an old Army database utilised by the Soldier Career Management Agency (Rudzki 1994). Data ceased being entered onto this database with the advent of the Defence Personnel Management system called PMKeys. This system adopted a "lowest common denominator approach" to the recording of data, and any data not collected or required by other groups and Services within the Department of Defence was not captured.

Data on compensation costs and invalid pensions was drawn from large organisational databases, and while cost data was accurate it was not possible to identify subgroups for detailed analysis. In most cases, Army costs were explicitly identified, but occasional pro-rata estimates were made. There was no data available

from the Department of Veterans Affairs on the type of conditions leading to the awarding of invalidity pensions, but medical invalidity data was available from the Military Superannuation (MSBS) scheme. Unfortunately the statistical reporting of causes of invalidity data ceased in the 1998/99 year. The estimation of compensation liabilities was required for the Department of Defence to satisfy its accrual reporting obligations, and the actuaries noted that data collection within the compensation organization was poor, with no regular matching of claims data with payments data.

One of the strengths of this study was the inclusion of transfer payments when calculating net productivity losses. The sensitivity analysis revealed that the level of disability pension impacted on the net residual loss to an individual's productive working life earning capacity. For Class A pensioners, the net residual loss was only 25-30% of the estimated net present value (NPV) of lost wages, while for Class B pensioners; there was a consistent 70% net residual loss across most age groups. Varying the discount rate from 2% to 10% had the most marked effect on soldiers who were invalided early in their careers, but the discount rate became much less significant once the member reached the age of 45 years.

Another strength of this thesis was the use of a novel capital investment model to estimate the lost investment in training. The human capital model relies in investment by the individual in their own education or training, but Army funds all job related training while providing a salary. The investment in training is therefore significant, and this approach allows the value of the training investment to be quantified and an estimate made of the loss attributable to premature separation due to injury.

The review of spinal surgery in this thesis is the first to compare the cost of all spinal procedures performed within a community setting. It provides the first comparison of cost between non-operative procedures such as manipulation under anaesthesia and epidural injection of corticosteroid with the more common operative procedures of lumbar fusion and discectomy. Previous published studies have confined themselves to either discectomy or fusion procedures exclusively or compared conservative management to either fusion or discectomy. There is only one published study comparing epidural steroid injection to discectomy (Abdi 2007).

This spinal surgery study was a retrospective observational study, and suffered from the usual concerns regarding confounding, selection and recall bias. Retrospective cohort designs are common in the injury literature, and they commonly produce descriptive data (Caine 1996). This study was limited by its small sample size, but was restricted to the feasibility of following up patients from the three year window chosen.

The bottom up review of the spinal surgery cohort provided detailed data on the cost and outcome of spinal surgery procedures, and a number of important findings emerged. This study presented the distribution of investigations in the cohort and uncovered significant radiation exposures in 30% of the subjects. Other studies have only presented the total or mean number of investigations and the total and mean cost. There is a high incidence of multiple radiologic investigation in those with chronic low back pain, and the use of CT scans with their associated high radiation exposure remains prevalent today. The description of individual utilisation of investigational resources provides useful insights into individual variations in surgical management that could be useful to hospital managers who must manage tight budgets.

Direct medical costs outweighed indirect costs in cases of complex surgery and this was supported by other studies. There was no relationship between the cost of surgery and the clinical outcome, with many authors advocating the use of simple and less costly procedures to achieve the same clinical outcome. There was a dissociation between perceived surgical success and return to work status and this has been a consistent finding in the literature.

The detailed review of the costs and outcomes of spinal surgery provide useful information for health system decision makers. It is one thing to be injured it is another to receive appropriate treatment required to facilitate a full recovery (as determined by return to work). The cost of injury is significantly increased if expensive treatments do not result in a rapid and sustained return to work.

8.4 Assumptions

A number of assumptions were made to ascertain the proportion of total costs attributable to injury. The contribution of injury to direct medical costs was estimated from the 2-year sample obtained from the Canberra Area Medical Unit database. The

total Army cost was calculated by extrapolation of the injury contribution from the Canberra dataset to total Army health expenditure. Injury accounted for a mean of 27% of total cost in this sample, but the Canberra sample was not representative of the total Army population, with 50% of the Army in Canberra being over 35 years old, compared to 20% of the total Army.

Reported injury attendances in the British and United States Armies were 39% and 46% respectively, while data drawn from a small sample of Australian Defence Academy cadets showed a 38% incidence of injury attendance. An upper bound estimate of 40% was therefore adopted as the injury cost contribution and a sensitivity analysis performed.

The relative contribution of injury to overall compensation costs was based on data produced by the Australian Government Actuary. A figure of 72% was chosen and represents a rounding up of the 71.2% liability contribution from the combination of back, knee, lower limb and upper limb compensation categories, which were assumed to have arisen as the consequence of injuries. The rounding up acknowledged that many of the cases within the head category would also be classed as injuries, but were not included in this figure. Thus the estimate of 72% was considered to represent a reliable lower bound estimate.

DVA invalidity pension data did not provide detail sufficient to determine the contribution of Army injury. Given that Army's compensation costs were disproportionate to its numerical strength, it was assumed that its disability pension contribution would be similar to its compensation contribution. Therefore a figure of 72% of DVA pension costs was attributed to Army, a similar proportion to its compensation liabilities. It was also assumed that 75.6% of these pension costs will be the result of an injury, similar to the proportion of invalidity due to musculoskeletal causes.

Disorders of the spine accounted for between 37% and 47% of total invalidity in Army. The contribution of musculoskeletal conditions to invalidity was a 3 year average of 75.6% and this was used to calculate the proportion of DFRDB and MSBS pension costs attributable to injury.

8.5 The importance of injury

Injury is a leading cause of death and premature mortality, especially in young adults. Injury is predominately a male event, especially in the workplace, motor vehicle and sporting field. Work injuries have been estimated to cost Australia \$20 billion dollars annually, while sports injuries have been estimated to cost over \$1 billion per year. Back pain is the leading type of occupational injury, accounting for 25% of all work-related injuries.

Injury is a major problem for western armies. In Australia, the reported rate of injury in soldiers is four times higher than the mining injury, although the reporting criteria are different. In contrast to industry, lower limb injuries predominate in the Army, mainly due to the heavy emphasis placed on physical training. The US Army has demonstrated that injury rates in female soldiers are twice that of males, with days of restriction five times greater. The British Army has shown that while the incidence of illness was greater than of injury, injury resulted in two and a half times greater morbidity (days lost).

Systematic data on injury outcome is surprisingly scarce and it is of note that severity of initial injury is not automatically related to residual disability. The best way of reducing injury incidence and improving outcome is through a comprehensive system of injury surveillance

Injury can be prevented, it neither inevitable nor an act of god. An understanding of where, when and how injuries occur is critical for the development of interventions to prevent and control injuries. The establishment of effective injury surveillance systems is the only way in which the problem can be tackled in a rational and effective way. Unfortunately there is a paucity of accurate health surveillance and cost data within the Australian Army at an organisational level. This is primarily due to the lack of an effective electronic health record within the Defence Health Services.

Prevention of injury is the most effective way to reduce the cost of injury, and the power of effective prevention was demonstrated by the significant reduction of injuries in the 3rd Brigade achieved by the Defence Injury Prevention Program (DIPP).

Accurate data that is analysed and presented to decision makers with accompanying advice regarding injury countermeasures is a proven and effective strategy. Attempts to include the injury prevention data set into a revised occupational health and safety incident form will hopefully provide the dataset required to restore the DIPP as an effective injury prevention system.

8.6 The total cost of Injury to the Australian Army

Table 8.1 summarises the total cost of injury to the Australian Army in 1996. Direct costs were estimated from an examination of external medical costs and compensation costs. The estimated direct cost of injury for the Army in 1996 comprised estimated medical costs of between \$3.35M and \$4.96 M and a compensation cost of \$37.40M. The total direct cost of injury to Army was estimated to be between \$40.75M and \$42.36M, while the outstanding compensation liability for injury was estimated to be \$270.0M.

Indirect costs for 1996 were estimated from productivity losses and invalid pension costs. Total invalid pension costs attributable to injury were estimated to be \$9.38M, comprising \$7.16M from DVA pensions and \$ 2.22M from military superannuation disability pensions. Productivity losses, including on-costs, were estimated to be \$1.36M. The total indirect cost of injury was estimated to \$10.74M with estimated invalid pension liabilities of \$63.82M. The total capital loss due to premature separation due to injury was estimated to be \$10.1M.

1989 Dollars SA		
Direct Costs	AG39 Medical Costs	\$3.35M - \$4.96M
	Compensation Costs	\$37.40M
	Total Direct Costs	\$40.75 - \$42.36M
Outstanding Compensation Liabilities		\$270.0M

Indirect Costs	Veterans Affairs Pensions	\$7.16M
	DFRDB/MSBS Pensions 1995	\$2.22M
	Total Pensions cost	\$9.38M
	Army Lost Production (11,165days)	\$1.36M
	including on-costs	
	Total Indirect Costs	\$10.74M
	DVA Liability	\$44.71M
	DFRDB/MSBS Pension Liability	\$19.11M
	Total Pension Liabilities per annum	\$63. 82M
	Estimated NPV of lost wages of those soldiers in receipt of invalidity pensions for injury	\$26.75M
Capital Losses due to premature Separation		<u>\$10. 10M</u>
Total Cost		\$61.59M - \$63.20
Total Liabilities		\$333.82M

Table 8.1 Summary of estimated Total Cost of injury for Army in 1996.

8.7 Conclusion

The Australian Defence Force often uses the slogan “People are our greatest asset”. The Capital Investment Model used in this thesis, applies that slogan in a literal way by valuing the of training investment in Army members in the same way as capital assets are valued and depreciated. This differs significantly from the traditional human capital approach where an individuals invests in his or her own training to improve their own “human capital”. This thesis has shown the significant impact that injury has on the Army, in terms of direct and indirect costs, as well as attendant compensation and invalid pension liabilities. The loss of trained staff also has significant impacts on the ability of Army to staff its organisations and man its equipment.

A disturbing feature of the Army experience was the relative youth of those soldiers who were invalided as a result of injury, with 54% percent of Army invalid

pensioners being aged 29 years or younger. Effective prevention strategies are the only practical way of reducing the incidence and severity of injury in young soldiers and significantly reduce future costs.

The large sums involved, offer the prospect that investment in injury prevention strategies can be offset by reductions in the high recurrent costs of injury. The impetus for investment in injury prevention is two fold; reduce the burden of direct and indirect costs and reduce the burden on individuals who are prematurely invalidated and lost to the workforce. Injury is a lose-lose situation for both government and society, with the productive capacity of soldiers to engage in employment and with their families being severely disrupted by injury.

To a large extent, Army (and the ADF) is shielded from the true cost of the injuries suffered by its members, as it does not have its workplace injury record judged by its compensation costs and resulting insurance premiums. Most private sector employers strive to have their worker's compensation premium at or below 1.5% of salaries, but Army's actuarially derived notional premium of 3.8% is 2.5 times greater than the industry benchmark. This places Army in the worst category of employer from a compensation perspective, but it bears no consequence as government carries all compensation costs.

Because these costs are largely hidden, the impetus to reduce them is not great. Tackling the problem will require a number of structural reforms, including the introduction of a workers compensation premium. Such a move would introduce direct accountability for performance and provide a feedback loop of reduced premiums for improved performance.

To obtain accurate and reliable data, a comprehensive injury surveillance system must be introduced into the ADF, and be linked to cost data. For any meaningful change in policy approach or allocation of resources, the true extent and nature of costs must be visible. Current attempts to improve injury surveillance in the ADF by incorporating injury surveillance data into the Defence Occupational Health and Safety (OHS) reporting system offers some hope that this can be achieved. The introduction of an electronic health record is also critical to enable the linkage between clinical and cost data.

The detailed review of the costs and outcomes of spinal surgery provide useful information for health system decision makers. In a constrained financial environment, where governments are seeking to maintain or reduce the growth in health expenditures, a fairly ruthless approach to effectiveness is required. To justify the continued commitment of scarce funds to a procedure or group of procedures, decision makers must be convinced that there is a worthwhile absolute, not merely relative, benefit sufficient to justify the cost.

With disorders of the spine accounting for 40% of all Army invalidity, improved methods of diagnosing and treating back pain are clearly required. Until we have a better understanding of the aetiology of the various causes of low back pain, surgeons will continue to pursue a plethora of surgical techniques that may palliate but not cure. The human and societal cost of this is enormous. Reducing the intensity of back pain and its associated fear and disability, will likely reduce patient preference for surgery. Research efforts should be directed at reducing pain through non-operative means, allowing the decision for surgery to be made solely on the basis of strictly defined clinical criteria.

The literature would suggest that the findings of this study remain relevant today because of the paucity of data in this area. Published studies examining the cost-effectiveness of spinal fusion and discectomy have only been published since 2004, long after this thesis was commenced. That the problem remains real and unsolved, is the observation by some authors that, despite a plethora of new procedures, there is no evidence these complex and expensive procedures provide any advantage over older, simpler and less expensive procedures.

This thesis identified and aggregated costs that were not visible to policy makers. By identifying the large sums involved, it is hoped that policy makers will become engaged. It is hoped that by identifying and highlighting these costs, decision makers will be spurred to take action, not just in Army but in all the government agencies involved.

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