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Fatigue, ambulance perspectives in a comparative study between air and road transports

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**Fatigue, Ambulance Perspectives in a Comparative Study
between Air and Road Transports.**

W.J.M^cKenna

2002

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To my supervisors and the staff at Edith Cowan University my sincerest appreciation. Study at a distance is challenging and without the support and encouragement you provided I would not have achieved this result. The colleagues who assisted me in the study and tolerated my obsession with little else, I thank you.

To my wife and family who structured their life around my work my gratitude is indescribable. My greatest appreciation however, is to my three young children Samantha, Alexander and Catherine. Despite having no concept of what it was that I was striving to achieve, they accepted it and tried to help at every opportunity, albeit in some of the most obscure ways. Thankyou.

ABSTRACT

The study of fatigue in the health and transport sectors has predominantly been focused on night shift or day shift operations. This study has been applied to the hours of operation of Ambulance Officers who perform both night and day shifts, while also being required for on-call. The Officer on-call is on stand-by between shifts, to be available to respond for duties from the completion of one shift until the commencement of the next, usually a ten-hour shift. Studies of a similar focus have not been identified so a comparison of these specific findings has not been possible. However trends in sleep debt, peaks in the drive for sleep and recognition of fatigue are consistent with findings of other studies. The initial impetus for the study, to compare the degree of fatigue between air and road long distance transports, provided no significant output. The data collected did however provide clear identification of the various precipitators of fatigue in the Ambulance Officers workplace. To adequately address the hazard of fatigue, the introduction of integrated systems that address sleep deprivation and circadian cycles are required to aid in managing fatigue. The identification and control of fatigue in the workplace is to the benefit of both the employer and the employee.

The study consists of fourteen Ambulance Officers utilising both road and helicopter transport mechanisms to undertake transfers to major medical facilities. The Officers were required to answer questionnaires at the completion of each shift to record the precipitators and indicators of fatigue. Findings indicate there is no significant difference between the levels of fatigue induced by air or road transport.

The influences of the time of day and the degree of sleep deprivation are however indicative of fatigue in the individual. Day shifts accounted for 70% of data collected with results of fatigue as more prevalent in the 1501-1800 hours period, coinciding with a trough in performance and alertness. Their adherence to non-performance indicators suggests an unwillingness to identify anomalies in their performance or an inability to self-determine a level of fatigue. Performance of duty during “on-call periods” induces sleep deprivation that may develop into a sleep debt if the restorative sleep is not obtained. Individuals generally function for 16-hours and sleep for 8-hours, to replenish the organism. When this ratio is redistributed the individual develops a sleep debt and left unaddressed develops into fatigue. Performance of long distance transports and reliance on on-call officers removes their ability to address their sleep debt. The introduction of rescheduling of transports and fatigue breaks reduces the influence of fatigue in the Ambulance Officers workplace.

The magnitude of fatigue is only evident when the consequences are realised. Officers performing transfers on empty expressways can wander on the lanes with only a fright to remember the experience. However a patient, of the belief that they are safe when in an Ambulance, will have more to remember if the expressway has a car in the other lane. Fatigue is evident in the Ambulance Officers workplace and remedies to address it, which incorporate a Safety Management System, have been outlined in the recommendations of the study.

DECLARATION

I certify that this thesis does not, to the best of my knowledge and belief:

- (i) incorporate without acknowledgment any material previously submitted for a degree or diploma in any institution of higher education;
- (ii) contain any material previously published or written by another person except where due reference is made in the text; or
- (iii) contain any defamatory material.

Wayne John McKenna

Date 11/14/02

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CHAPTER 1

INTRODUCTION

Fatigue is known to be a direct source of neurobehavioral impairment. It induces retardation in performance and alertness that is often undetectable by the individual. It is resultant of sleep deprivation, circadian cycles, work and social influences, yet is a condition that can be intimidating to manage because it is so difficult to define and accurately measure.

This study examines fatigue in relation to the work performed by Ambulance Officers, and in particular those outside of major metropolitan facilities. The greater the distance from medical specialists, the further the patients must be transported to receive the care that they require. As a consequence Ambulance Officers perform long distance transfers that often expose them to the effects of fatigue. The main focus of the study has been on officers who perform air transports, long distance road transports and on-call duties after normal rostered hours. Studies of a similar focus have not been identified so a comparison of these specific findings has not been possible. However trends in sleep debt, peaks in the drive for sleep and recognition of fatigue are consistent with findings of other studies. The initial impetus for the study, to compare the degree of fatigue between air and road long distance transports, provided no significant output. The data collected did however provide clear identification of the various precipitators of fatigue in the Ambulance Officers workplace.

The introduction of regulations on the duration of hours of work alone will not address the hazards associated with fatigue. A Safety Management System is required that focuses on education, training and the designing of work schedules that are mindful of the influences of circadian cycles.

Fatigue can result from numerous variables contributing to differing degrees of the condition between individuals. There is the added difficulty of ensuring that the signs or indicators of fatigue are self-identifiable and well known by individuals. Fatigue has the potential to have a similar impact on workers and drivers as driving while intoxicated. Studies already correlate the duration of prolonged wakefulness of 17 hours as a prescribed concentration of alcohol limit of 0.05%. Fatigue should no longer be worn as a badge of honour for courageous work efforts or exhaustive social obligations. The perception and acceptance of fatigue as a condition needs to be changed in the working community, so that it is no longer accepted as a sign of dedication or determination, but as an indication of susceptibility. Thus, the focus of a Fatigue Safety Management System should be to promote responsible work practices amongst employees and employers and to educate individuals that fatigue presents the same hazards to their safety as drugs and alcohol.

1.1 Background of the Study

Ambulance Officer's provide medical attention to the community 24 hours a day. Occasionally Officer's may come under the scrutiny of the public for treatment methods or delayed response times but mostly their duties are unnoticed. As

individuals they are the same as the other individuals in society. On their non-work days they assimilate with others being parents, spouses, siblings and community members. When they are on duty they wear a uniform that identifies them to the public but it does not provide them with immunity from social stressors, work demands or fatigue. Ambulance Officers are faced with the same personal limitations and catastrophes that each individual deals with in everyday life. Furthermore, they must also deal with a significant proportion of other people's catastrophes and limitations. It is important that when these situations arise the Officers are able to perform at peak proficiency and not be hindered by the effects of fatigue. The focus of this study is to identify areas of fatigue for officers and develop strategies to aid in its prevention.

The Transport Industry has regulations under the Roads and Traffic Authority (RTA) on duration of driving and rest periods. The Civil Aviation Safety Authority (CASA) has regulations relating to the duration of shifts, rest periods and flight hours that may be performed when flying an aircraft. Hospital Theatre regulations require an 8-hour break prior to commencement of shift. These regulations ensure staff members that have been called to an emergency duty have access to an adequate rest period prior to commencing their normal rostered shift.

In the performance of their duties Ambulance Officers provide care and treatment for sick and injured persons in both emergency and non-emergency situations. Officers may be required to transport critically ill or injured patients for extended periods of time, on board aircraft and extended shifts with minimal sleep. Officers have regulations that address the maximum number of rostered hours that

can be performed in a work period. The Officers also have a requirement for a rest period between shifts but there is no recognition of the impact of on-call and overtime on individuals. The results from this study have determined that officers routinely have periods of broken sleep between shifts, with 63% having periods of less than 8-hours. The effect of this on work performance is that persistent sleep debt is a major contributor to accidents, poor health and fatigue.

Ambulance Officers perform the majority of their work either driving or in the rear of an ambulance, and by nature of that duty, the ambulance is their place of work. The officers have a responsibility under Occupational Health and Safety Acts for those persons who are in their work place. This is inclusive of those people who are receiving treatment in the rear of the ambulance, the bystanders and other motorists. The person who is driving fatigued is not providing a safe work environment for any of these persons, including themselves. To provide a shield of protection to the community, one aim is to ensure that the actions of the officers do not put the community in further danger, as a result of their actions. Officers need to be aware of the impact of fatigue and that they may be inappropriately performing their duties when under the influence of fatigue.

1.2 Significance of the Study

Ambulance Officers, in the performance of their duties, are susceptible to fatigue. The duration of duty, shift work and on-call commitments combine to provide an environment that nurtures fatigue.

The current Industrial Awards of Ambulance Officers does not address the rest periods required by individuals to prevent sleep deprivation and fatigue. There is no regulation on the frequency or duration of air or long distance transports performed by Ambulance Officers. The industry standards that are applied in the transport and aviation sectors are not applied in the Ambulance Workplace. The culture of the environment in which Ambulance Officers work does not embrace fatigue as a significant issue. This study has heightened individual awareness of fatigue impact, but it has not changed accepted work practices of officers. This paper explores the levels of fatigue and its reflection on officers perceptions, interactions and work performances.

Previous studies have been undertaken to identify fatigue in individual areas of work of the Ambulance Officer but none specifically revolving around the roster, on-call and travel conditions. This study identifies that there are specific time frames within which fatigue develops and modes of transport that incur greater fatigue. Furthermore, it identifies time frames that place the officers in unsafe situations. This study provides clear indication of the required controls to make Ambulance Services a safer and more cost effective place to work.

1.3 Research Questions

1. Is fatigue identifiable in the Ambulance Officers Workplace?
2. Is fatigue more prevalent in air or road transports?
3. Are the indicators similar in both modes of transport?
4. Does one mode of transport precipitate greater fatigue?

1.4 Sub Research Questions

5. Does the fatigue revolve around an identifiable time period?
6. Does the proportion of completed shift reflect on fatigue?
7. Does the on-call component contribute to fatigue?
8. Is fatigue immediately identified or is it a delayed condition?

1.5 Results in Brief

1. Fatigue has been identified in 48.8% of transports undertaken in the study period.
2. Fatigue has been identified as more prevalent in air travel during the course of this study.
3. The indicators of fatigue are similar in both modes of transport. The weighting that each has been given is slightly different in the two forms, but

principally the indicators are the same.

4. Road travel precipitates greater fatigue than air. The frequency of road transports performed was less than that of air.
5. The time frame between 1501 and 1800 hours has been identified as the most fatiguing time for participants of the study
6. The proportion of completed shift is indicative of fatigue influences. The earlier a long distance transport can be undertaken the less fatiguing it will be on the officer.
7. The participation of on-call, after normal hours of work contributes to fatigue. Of call-outs, 87% indicated an instance of fatigue.
8. Sleep debt is an issue for the Ambulance Officers. This study identifies several instances where there was no immediate known cause of fatigue.

1.6 Limitations of the Study

1. Small Sample Population of 14 Officers, from a population of 2500 Officers.
2. Rural setting with no inclusion of metropolitan data.
3. Rapid Rotational Roster is not standard throughout the State.
4. Subjective evidence for indicator data.
5. Performance indicators may have attracted bias.
6. Participants questionnaire single source of data.

1.7 Reduction of Bias

1. Utilisation of centrally generated times from co-ordination centre for precipitator data.
2. Cross-referencing call-out and transport times with cases register.
3. Cross-referencing shifts and call-outs with sign on register and rosters.
4. Provide participants with anonymity.
5. Provide multiple indicators to ensure availability of recognisable signs and symptoms.
6. Apply no distinction between a major error and a minor error in treatment.
7. Supply information on how to complete questionnaire and promote consistency.

1.8 Definition of terms

Ambulance Officer	Personnel who treat and transport patients in emergency and non-emergency situations.
Attendant	Fully accredited Ambulance Officer, dedicated treatment officer for the shift.
CASA	Civil Aviation Safety Authority.
Circadian cycles	Subconscious cycle that regulates sleep preferences, that is makes us sleep at night and awake of a day.
Culture	The dominant learned, shared and interrelated behavioural beliefs within a society or organization.
Day shift	0800 hours to 1800 hours, 10 hours without designated rest period.
Driver	Fully accredited Ambulance Officer, dedicated driver for the shift.
Fatigue	Loss of alertness, which eventually results in sleep.
Hierarchy of Controls	Method of systematically removing hazards from the workplace
Indicators	The group of 14 identified observations that the participants were required to make about themselves in relation to the development of fatigue.
Indisum	The sum of all indicators of fatigue.
Microsleep	An uncontrollable sleep episode lasting only seconds.
Night shift	1800 hours to 0800 hours the following day, 14 hours with out designated rest period.

On-call	Officers available on standby to respond to a medical emergency after normal rostered shift.
Precipitators	The elements that hastened the occurrence of or possibly led to the identified indicators of fatigue.
Prevalence	Indicates the number of existing cases of condition.
Rotational Shifts	Combination of day and night shifts, typically three 10 hour days followed by a 14 hour night shift.
RTA	Roads & Traffic Authority.
Safety Management Systems	An integrated set of work practices, beliefs and procedures for monitoring and improving safety and health of all aspects of your organization.
SCN	Suprachiasmatic Nuclei, location of the mammalian Circadian Pacemaker.
Sleep Inertia	A feeling of disorientation and grogginess when waking from deep sleep.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The study focused on the impact of fatigue experienced by Ambulance Officers in the performance of air, road and on-call duties. The importance of why fatigue occurs is discussed so that it may be accurately measured and identified. The literature review covers areas such as driver and air fatigue, shift work, sleep deprivation, performance and alertness, circadian cycles, legislation and standards that are used in other industries to eliminate fatigue. The review provides explanatory evidence as to why and how fatigue affects officers. It also presents elements that support arguments for change in work behaviour that will be beneficial to the Ambulance Officers and Ambulance Services in decreasing the potential for fatigue, accidents and errors in the workplace.

2.2 Fatigue

A differentiation was required to ensure that General Fatigue literature could be separated from the other types of fatigue. General fatigue has recuperation ability and revolves around adequate rest, sleep and circadian rhythms.

Kroemer and Grandjean (1999), concentrate on human performances and outline the different forms of fatigue.

1. General, physical overloading of the entire organism, such as working extended shifts
2. Muscular, muscle unable to maintain performance as in running long distances
3. Chronic, an accumulation of long term effects such as repetitive long hours
4. Mental, induced by mental or intellectual work such as being in a busy dispatch and coordination centre
5. Eye, overstraining of eyes as in computer operation
6. Nervous, oversteering due to repetitive and fine skilled work, typing
7. Circadian, due to sleep wake cycle, when driving at night or early morning when normally asleep

They introduce a theory of a Neuro Physiological Mechanism that regulates an individual's functional state. The model illustrates the organism's level of activity ranges from a state of sleeping to that of alarm. The stages are influenced by the activation of the body's regulatory systems that activate the balance, either making the individual more alert, or inhibit it making them sleepier.

Sleeping ↔ Sleepy ↔ Tired ↔ Relaxed ↔ Fresh ↔ Excited ↔ Alarmed

Figure No.1 Model of Neuro Physiological Mechanism (Kroemer and Grandjean, 1999)

Kroemer and Grandjean (1999) discuss fatigue as, “a culmination of a number of events, not necessarily reliant upon one cause.” These events are those that are encountered in daily lives. Excessive physical and mental ability, sickness and physical limitations, inadequate nourishment, personal stressors, climatic influences and the time of day all impact significantly on fatigue. They acknowledge that there are various symptoms of fatigue that are both subjective and objective. It does however state that it is not possible to measure fatigue itself but merely the incidence of the indicators of fatigue.

Dawson, Fletcher & Hussey (1999), provide a comprehensive outline of fatigue. The study was undertaken of the transport industry and contains elements that can be applied to all workplaces. The principles involved in developing fatigue are discussed as well as the management strategies that can be adopted to deal with the problems. The major causes of fatigue have been apportioned to the loss of sleep due to the changing economic and social patterns over the last few decades. The increase in production demands has seen the requirement for longer hours of work and greater effort by those already in the workplace to optimise productivity. The number of employees has been minimised and their work demands have increased. This coupled with the greater access to a diversity of social and recreational activities results in individuals allocating more time to tasks than is available in a day. Dawson’s definition, “fatigue is as a result of inadequate restorative sleep,” is attributed to longer hours, changes in psychosocial expectations and night work because of its contradiction to the normal biological processes. The manner in which rosters are devised is also queried. The persons who construct rosters require an understanding of fatigue, biological processes and psychosocial demands of

individuals. The roster has an impact on an individual's personal obligations, which in turn influences their level of fatigue and performance. There are several consequences of fatigue that Dawson et al (1999), discuss and are described as individual, organisational and community.

Individual

1. Biological, the performance of individuals is impaired as a result of fatigue. The individual is unable to process information and make appropriate decisions in a timely fashion.
2. Psychological, the alertness of the individual is impaired which causes a decrease in the individual's ability to stay awake.
3. Social, there are mood changes experienced such as irritability, decreased morale and motivation.

Organisational

The impact is on the individual's effectiveness in the workplace and the higher utilisation of sick leave. Other influences include the poor promotion of morale, communication problems and a significant increase in accidents.

Community

Accidents and hazards that impact on the organization also impact on the community, hospitals, emergency services, rehabilitation and other parties that are indirectly involved with the accident. Dawson quotes 20-30% of all heavy vehicle accidents are directly or indirectly attributed to a fatigued driver.

The introduction of enterprise bargaining and the role that moving away from Industrial Awards has had on fatigue management is discussed. Dawson et al (1999), depicts the changes in work practices as a contributor to fatigue. The increased workloads, decreased staff numbers and the lengthening of shifts that are required to increase days off work also influence fatigue. The hours of work and hours of break strategies are not adequate answers to address fatigue. To affectively address issues of fatigue, the duration of work hours must be considered in conjunction with the influences of the time of day variable. The time of day is identified as a crucial component to the fatigue issue, and policies that disregard it will fail to adequately address the problem.

The responsibility of addressing fatigue is not isolated to management. Commitment is required from the employee and the employer when considering fatigue as a safety issue, under Occupational Health & Safety legislation. The employer must be responsible for ensuring appropriate management of workplace causes of fatigue and the employee must be responsible for addressing non work related causes. The management of fatigue is best adopted as an element of an integrated Safety Management System. The degree of risk that is attributed to typing a memo after being awake for 13 hours would be less than driving a vehicle for 2 hours continuously, having been awake for the same period of time. The management of fatigue requires all members of the organization to ensure that fatigue is no longer accepted as a sign of dedication. Fatigue is a Neurobehavioral altering agent that is unsafe in the workplace.

2.3 Endogenous Biological Process

Dawson (App. C, 1998), in the submission to the Rail Industry cites fatigue resulting from conflict between the Endogenous Biological Process and irregular work hours. His paper outlines that, the biological process is regulated by two separate mechanisms; the circadian rhythm and the homeostatic process of sleep. Circadian Rhythm is a result of a pacemaker situated in the suprachiasmatic nuclei (SCN) of the hypothalamus. The function of the circadian rhythm is to regulate the bodily systems around a 24-hour period. Most researchers support Dawson's theory of the circadian rhythm revolving around the 24-hour duration. Kroemer and Grandjean (1999), however, speculated the natural cycle was closer to a range between 22 and 25 hours when all extrinsic influences are removed. Recent research by Lavie (2001) acknowledges the 24-hour period of the circadian rhythm as being more accurate, with the deviations from this being in minutes rather than hours. Dawson describes the homeostatic drive for sleep, as being regulated by the neural system in the brainstem and basal forebrain. Akerstedt (1995), cited by Dawson (1998), has attributed the homeostatic drive for sleep and the circadian rhythm as being responsible for many of the periodic neurological-behavioural processes. The homeostatic drive for sleep is responsible for the level of sleep that is required for a person to remain alert. The level or quality of sleep and the duration of sleep obtained, which ultimately forms sleep debt if any of these variables are deficient, influences this process.

Grossman (1997), supports Dawson's article in relation to the duration or cycle of a 24 hour circadian rhythm. The paper does not differentiate between the mechanisms that form the endogenous biological process but does discuss the

importance of retinal receptors to sense the external stimulus of light and darkness in triggering the hypothalamus in the regulation of the body's pacemaker. Grossman attributes the circadian rhythm with the stimulating of the sleep/wake cycle, core body temperature, digestive enzyme secretions as well as hormonal rhythms such as melatonin, growth hormone and cortisol. Dawson (1998), also discusses the relevance of the circadian rhythm and the role it has in the release of the pineal hormone melatonin and inverse relationship it has to body temperature. The hours of between 0200 and 0400 see body temperature at its lowest and melatonin production at its highest. Monk (1989), cited by Grossman, noted individuals confusion that arises when the 8-hour night-time sleep and the 16-hour waking time is disrupted. The paper also attributes a number of global disasters to night fatigue including the Challenger Space Shuttle, Chernobyl and Three Mile Island. The propensity for accidents and near misses is significantly increased when there is less performance ability and decreased alertness as experienced when working against the bodies Endogenous Biological Processes.

In considering the development of the sleep wake cycle Lavie (2001), presents support for findings of Akerstedt (1979) and Froberg (1977). The paper introduces new concepts in relation to the sleep wake cycle and endogenous rhythms that have not been discussed. Lavie (2001), introduces the concept of a drive for wakefulness and that sleep propensity is as a result of the greater drive, to sleep or wake. The drive for wakefulness, as Lavie (2001), cites Edgar, Dement & Fuller (1993), is as a result of influences of the SCN. The SCN is not only responsible for the circadian pacemaker but in affect is responsible for attempting to promote

wakefulness. It is only in the periods of the circadian cycle that are low that the homeostatic drive for sleep is overpowering and sleep eventuates.

The Endogenous Biological Process has outlined why sleep usually occurs at night and the hazards associated with that not being possible. The following article adds another dimension to the concepts of sleep, rhythm and what is normal. The research by Toh, Jones, He, Eide, Hinz, Virshup, Ptacek & Fu (2001), discusses new issues. Their paper discusses the relevance of the endogenous process and circadian rhythm but also discusses a mutation to the rhythm. Familial Advanced Sleep Phase Syndrome, (FASPS) has been identified that has a four-hour advancement of the normal sleep-wake cycle. Sleep onset occurred at 1930 hours when most individuals are active. When normal sleepers are at their heaviest period of sleep, individual's in the study spontaneously awoke 0430 hours. The mutation that has been discovered in humans supports the concept of "night owls" and "morning larks" but it may also provide a key to treating disorders of sleep, jet lag and shift work.

The endogenous biological process provides an indication of why fatigue is experienced at night when driving, despite having slept prior to departure. Fatigue is dependent on the competition of the drive for sleep, drive for wakefulness and the circadian cycles.

2.4 Time of Day

Dawson (1998), cites Akerstedt (1995), when discussing the importance of extended wakefulness and the effect that it has on decreasing performance and

alertness. Akerstedt (1995, cited Dawson 1998), points out that the night shift worker has extended hours of wakefulness. They may start a shift 10 to 16 hours after waking as opposed to a day shift worker who normally starts 1-2 hours after waking. Dawson's submission to the parliament in the Neville Report (1999) identifies that there is an increased risk of fatigue and accidents in the workplace because of the decreased recuperation time and the time of day. The circadian rhythm influence on performance and alertness is at its lowest between 0300 hours and 0700 hours. Dawson's (1998), findings are that the majority of the variance in performance and alertness are attributed to this "time of day" factor. As a result of this night shift workers are at a distinct disadvantage in their ability to perform and remain alert.

Rosekind, Gander, Gregory, Smith, Miller, Oyung, Webbon and Johnson (1996) paper explains the role the Circadian Cycles play in the manifestation of fatigue and why night shift is such a contributor. The circadian cycles encourage the body to sleep during the night and be alert during the day, which is the opposite of a night worker scenario. Maximal sleepiness is obtained in two distinct periods of the circadian cycle, one between 0300 – 0500 hours and another at 1500 – 1700 hours. Night workers are required to work through the strongest of the circadian cycles drive for sleep, 0300 – 0500 hours. The performance and alertness of individuals is at its lowest between 0000 – 0800 hours and this compounded with a drive for sleep makes it difficult to perform at peak proficiency on night shifts.

Brown (1997) presented a paper in the Canadian Medical Association Journal supporting Dawson's report indicating that the time of day is a critical element in fatigue. The paper revolves around a study of truck drivers by the United States and

Canadian Governments. The drivers in the two areas were allowed different periods of driving before mandatory rest breaks were enforced by local legislation. The Canadians were allowed to drive 13 hours before a rest period compared to 10 hours for the US drivers. The three-hour difference in duration was not reflected in the fatigue depicted. It was more attributable to the time of day rather than the duration of driving. The study found that it was significantly more difficult to stay alert between 0400 hours and 0600 hours.

Co, Gregory, Johnson & Rosekind (1999) paper gives a detailed account of circadian cycles and the effect the scheduling of flights has on promoting fatigue when flights are occurring at inappropriate times. The periods of maximal sleepiness are defined as between 0300 – 0500 and 1500 – 1700 hours with the inverse period of alertness and performance being between 0900 – 1100 hours and 2100 – 2300 hours. The recommendations suggest the importance of educating all members of the organization of the factors and dangers of fatigue. Those performing the tasks and those making the schedules needed to be aware of the effects of fatigue and the need to allocate work at appropriate times.

Federal Motor Carrier Safety Administration, FMCSA (1996) released a Study of Commercial Motor Vehicle/Driver Fatigue and Alertness Study in December 1996. The study was designed to measure and observe the depression of alertness and performance in a realistic field study. The study utilised various shift initiation times, durations and combinations between night and day, amongst 80 drivers over 360 trips and 4000 hours of driving.

The study found the strongest influence on driver fatigue and alertness was the time of day variable. Drowsiness observed using the video monitoring system was significantly greater during night driving compared to day driving. Midnight to dawn was associated with the worst period of drowsiness encountered during the study. The duration of driving was not as a consistent indicator as the time of day. The difference between 13 hours duration and 10 hours duration was not significant. The self-awareness of performance indicators showed little correlation to the video imaging and physiological indicators. Drivers had a tendency to rate themselves more alert than they actually were. The study also determined that of the 80 participants there was no correlation between fatigue and age. The recommendations of the study were that there is no single way to address fatigue and the effect it has on performance and alertness. A systematic approach needs to be adopted that identifies education, rescheduling, hours of duration and fitness as the key concepts to address fatigue.

2.5 Restorative Stages of Sleep

Dawson argues that sleep loss from sleeping during the day and after a night shift, is 1-3 hours less than sleep obtained during the night. When devising the roster these elements should be included in the compilation process. The circadian cycle for sleep propensity is greater during the night and it is therefore more beneficial to have hours of rest during the night. A 12-hour break from 0000 hours to 1200 hours is of more benefit than a break from 1200 to 0000. The first break allows for a sleep period in the normal times of sleep. The commencement of sleep would be similar to other members of the house, which could make it more conducive to rest. The 1200 - 0000 break allows for a sleep period when most other members of a household

would be awake. The inclination to become involved in family obligations reduces the influences to sleep. The normal circadian rhythm plus the social elements often retard the ability and inclination to sleep after night work. These issues develop into sleep debt and need to be considered when devising a roster that includes night work.

Lavie (2001) cites Akerstedt (1988), in the discussion of the differences in day sleep and night sleep. Akerstedt (2001) identifies day sleep as being shorter, more fragmented and having a different structure especially in relation to the Rapid Eye Movement (REM) sleep stages. There is an influence by the inability to darken the room, day noises, family commitments and social obligations but the major cause is the displacement of sleep to day and when the circadian sleep pressure is at its minimum.

Hietmann (2001), cited in Rossier (2001) provides explanation of the sleep process and its applicability to fatigue. Sleep is composed of two forms, REM or Rapid Eye Movement and Non-REM. The period of Non-REM is then defined by four stages of sleep; light sleep stages 1 and 2 followed by deep sleep stages 3 and 4. The sleep cycle alternates between REM and Non-REM up to 6 times during a night's sleep. Should the individual be woken from a deep sleep, period of stage 4, then this will present as sleep inertia. The individual will wake finding it difficult to function and a feeling of disorientated and grogginess. Waking from the deep sleep deprives the individual of sleep that will be recuperated during the following two sleep episodes, but should this sleep not be obtained then a sleep debt develops. The development of a sleep debt will eventually be recovered by the body's natural sleep process. The individual's willingness to allow the body to recover will determine

whether this recovery is a controlled sleep or uncontrolled sleep event. The microsleep eventuates when an individual does not acknowledge the indications that its body is providing. Microsleeps in an armchair after dinner are of no consequence, however a microsleep in bad conditions at night as a single pilot when flying may have significant consequences. The controlled sleep episode, a nap, can be beneficial if taken at the appropriate time and duration. Heitmann suggests that the optimum duration of a nap should be no more than 30 minutes as waking after this may be from stage 3 or 4 sleep. Alternatively if at least 90 minutes is available the sleep cycle would be complete and the individual would wake from a stage 1 or REM sleep feeling refreshed. The article provides mechanisms that may be utilised both for prevention and operationally to combat fatigue. The importance of exercise, diet and sleep restoration are highlighted as well as simple methods such as talking, sips of beverages and stimulating the senses with smell or light.

2.6 Sleep Deprivation

Feyer (2001), provides descriptions of fatigue and the problems that it presents to individuals. There are comparisons made between drivers, school children and medical staff who all admit to having periods of insufficient sleep. Figures representing 10% of 68,000 road crashes, during the 1994-1998 period, that involved a single vehicle in good conditions are attributed to fatigue. In the United Kingdom 29% of drivers randomly surveyed admitted to having felt close to falling asleep, while in New York one quarter of the surveyed participants admitted to falling to sleep at some stage while driving.

The accumulation of modest amounts of sleep loss over a week may provoke an uncontrollable sleep episode. The risk that this places on an individual is dependent upon the circumstances and surroundings of the sleep episode. Unfortunately, because they are uncontrollable sleep episodes that can occur when driving, the results can be catastrophic. Feyer (2001), attributes the acceptance of this risk by individuals by three main factors,

1. Fatigue is a common experience and that not all occasions are accompanied by devastation. The driver of a vehicle who suffers an uncontrollable microsleep awakens to return to the right side of the road and is unnoticed by any other traffic. The driver continues and will subconsciously expect to be as fortunate on subsequent occasions.
2. Fatigue in itself provides an aura of control. The degradation of control, alertness and performance are gradual and are not easily recognisable. Individuals are not hindered by their own level of fatigue because they are unable to sense its development.
3. There is no simple objective test for fatigue. Individuals can be breath tested to determine a blood alcohol level indicative of alcohol consumption and thus determine their suitability to operate a vehicle, but the same test is not available for fatigue. The irony of the testing is that the comparison has been established that a Blood Alcohol Concentration of 0.05% is the same as being fatigued from being awake for 17 hours.

Feyer (2001), discusses the need to address fatigue and educate people that a lack of sleep should not be seen as a “badge of honour” but a risk to personal well being and safety of others. The time of day is also supported by Feyer (2001), as a

precipitator of fatigue and that the duration of wakefulness is not the sole catalyst of fatigue.

Studies undertaken to deprive individuals of sleep in the 1970's have highlighted the effects of the lack of sleep on performance and alertness, Lavie (2001). The studies showed a profound increase in sleepiness and decrease in alertness in the early mornings in a rhythmic 24-hour like pattern. This has led to the understanding of the concept of sleep debt and the effects it has on performance, alertness, propensity to sleep and the dangers of performing hazardous tasks after long periods of wakefulness.

Dawson et al (1999), makes a correlation between the hours of wakefulness and Blood Alcohol Concentration (BAC), in regards to performance, alertness, vigilance, response times and hand eye coordination. A BAC of 0.05% is equivalent to having being awake for 17 hours. Twenty-four hours of wakefulness is the equivalent of a BAC of twice the legal limit to be in charge of a vehicle. Dawson et al (1999), acknowledges that industry is slow to accept the similarities between fatigue and alcohol as a source of Neuro-behavioural impairment.

Rosekind et al (1996) also identify lack of sleep and sleep deprivation as a precipitator of fatigue. This comprehensive study outlines the role sleep has in preventing fatigue and the resultant effects on performance, vigilance and mood. Sleep is essential to human functioning and despite the ability of some to delay sleep, the reality is that eventually the body will sleep. The sleep may take forms of

microsleep lasting seconds or naps lasting minutes, which can both present as uncontrollable sleep episodes. There are strategies that can be undertaken to prevent these uncontrollable sleep episodes. The taking of planned naps can acutely improve alertness and performance, but may also cause a feeling of not being well rested on wakening. To prevent this from occurring it is suggested that when there is a possibility of the sleep being interrupted to perform call-out duties, that the duration be limited to approximately 45 minutes, to prevent falling into a deep sleep. Sleep deprivation and eventual forced sleep by the body is considered attributable to such disasters as the Exxon Valdez, Challenger Space Shuttle and Nuclear Accidents at Three Mile Island. Rosekind et al (1996), support the structure of this study and provides evidence to suggest that the current practice of working shifts and then being recalled to duty nurtures fatigue.

Olson and Ambrogetti's (1998), research support the findings that fatigue is manifested as a result of a lack of sleep. They correlate medical errors with the degree of fatigue endured by medical staff. They raise an argument against average hours of work in hospitals. A parallel is drawn between an average amount of duty in a hospital and an average prescribed concentration of alcohol. A roster that allows a maximum of 160 hours per month but allows 80 hours to be worked in one week is unsafe. Similarly, permitting a person to drive a vehicle with a Prescribed Concentration of Alcohol of 0.2% provided over the next four weeks it averages below 0.05% is also unsafe.

Olson and Ambrogetti (1998), identify that errors arising as a result of fatigue are most likely to occur during routine or mundane tasks, unlike trauma cases or

cardiac arrests, which require attention and stimulate response. The performance in a crisis is preserved until the fatigue is extreme and this is commonly associated with an adrenaline rush. The performance variability increases with fluctuations between poor decisions and good ones, good work and errors. The performance and alertness declines rapidly as the task duration grows and accuracy is replaced by a need to finish.

Bonnet (1999) believes that the taking of short naps may be detrimental to performance of sleep-deprived individuals. Those with sleep debt have a high disposition to fall into a deep sleep quickly and if woken from that sleep will experience sleep inertia or mental foggiess.

2.7 Shift Work

Blosser, National Institute of Safety and Health (1997), has cited shift work as being a major contributor to sleep loss and disruption to the body's circadian rhythm. The result of being overtired makes it difficult to concentrate and increases the potential to cause workplace injury and damages. Shift work also predisposes individuals to health problems, which may become compounded because of their shift work. The body's ability to digest foods is impaired. There may be increased heart problems as well as increasing the stressors from interference with family and social obligations, all a result of shift work. Working shifts which do not allow meals at regular times, often utilising fast food facilities and only having intermittent breaks to eat all add to the health problems associated with shift work.

Dawson (1998) provides a comprehensive outline of shiftwork and the disruption that it has on individual's endogenous rhythms. He also attributes 20 percent of the work force to have undertaken shift work at some point in time. Dawson (1998) makes a differentiation between the various shifts into 5 types.

1. Fixed Shifts, these are regular in nature and usually involve working the same hours per day, at the same time of day.
2. Partially Fixed Shifts, these are similar to the fixed except they have an element of prearranged overtime or additional shifts as a result of seasonal work.
3. Rotating Shifts, are those that have shift changes in respect to start times. The shifts may be rapid as in working 3 days and then a night or extended as in working 3 weeks of days and then a week of night shifts. The rotation may also be in forward manner as in day to night or in a backward manner as in a night to day.
4. Split Shift, are those that are traditionally used in the hospitality industry or by school bus operators. There is a cluster of hours worked with a break of unpaid hours in between.
5. Irregular Shifts, these are erratic shifts with little or no predictability to them. Situations that are similar to relief teachers where there is little notice that a teacher is going to be sick and require a substitute.

Dawson (1998) discusses issues in relation to sleep deprivation and the value of quality restorative sleep for shift workers. The study suggests that shift workers attempt to return to their normal sleep pattern as soon as possible. That is, the individual will grasp the opportunity to return to a normal sleep pattern as soon as

completing the night shifts. This is despite the modification that they have been forced to undertake during the period of night work. The short duration or rapid rotational shifts do not cause a change in the bodies melatonin release and, as such, are less assaulting on the circadian system. Coping mechanisms include the individual not attempting to sleep after completing a single night shift and only napping for a short time to enable realignment to the normal sleep pattern.

Akerstedt (1991, cited Dawson 1998), indicates that rarely will the sleep obtained after a night shift exceed 5 hours and that the sleep obtained is highly dependent on the initiation of the sleep period. This is predominantly due to the finding that there needs to be a break of at least 16 hours between shifts to enable a sleep length of 7 to 8 hours, (Kurumantani, 1994 and Knauth, 1983, cited in Dawson 1998).

Humm (2000) presents opinions that suggest that rotational night shifts are not necessarily the answer to the night shift predicament. The article involved focuses on nurses in the United Kingdom and argues that there may be more benefit in offering permanent nights to individuals that prefer nights. The paper indicates that the introduction of rotational shifts was as a result of difficulties obtaining coverage for these shifts. Humm (2000) presents figures, which suggest that only 10 percent of a workforce enjoy night shift and that 20-30 percent find it intolerable.

Humm (2000) also introduces the concept of discrimination and occupational health and safety into the area of night shifts. The paper, written in the United

Kingdom, alludes that making someone work nightshifts may be an act of discrimination. Humm suggests that a doctor may be able to support the claims that working nightshifts may be disabling them. This suggestion potentially provides the worker with grounds for appeal under the disability clause of the anti-discrimination act.

Learthart (2000) continues to introduce areas of legislation in relation to the hazards associated with shiftwork. Learthart (2000), points out that under Occupational Health and Safety legislation the employer has a responsibility to the employee to provide a safe workplace and a safe environment. Shift work has been proven to cause decreased performance and alertness but recent studies have also made the connection to heart disease, gastrointestinal disease, elevation in cholesterol and higher incidence of depression in rotational shift workers. The paper draws on numerous studies to support the argument of problems and health risks that the rotational shift procedure causes. Learthart (2001) suggests that, night shift is best undertaken by individuals who choose to do them. This is usually done for various reasons but irrespective of that reason they have established their own coping mechanisms to deal with the night shifts. The study also indicates that individuals who choose to do nights are more likely to have less detrimental health and accident rates than those forced to perform rotational night work. The rotational shift that Learthart (2000) makes reference to, is one that includes fixed periods of days, nights and evening shifts.

Furlan, Barbic, Piazza, Tinelli, Seghizzi and Malliani (2000), draw direct comparisons between heart disease and night shifts. The paper attributes decreased

performance and alertness with night-work as well as an increase in accidents and errors. The paper draws these conclusions by observation and attributes them to the disruption to the workers endogenous cycles. The changes in the endogenous cycles effectively alter the circadian rhythm, the sympathetic and parasympathetic nervous system.

Human Factors in Maintenance Advisory Circular 145.170, from the Civil Aviation Authority of Australia (1999), acknowledges the benefits of flexible rostering but also identifies some of the problems associated with shift work. The circular makes reference to maintenance staff in particular but can be applied to all work categories. It discusses the importance of sleep deprivation, biological rhythms and the importance of these elements to be considered when devising a roster. There is also discussion on the degree of health complaints endured by the shift worker including the increased propensity of gastrointestinal disease, cardiovascular disease and higher incidence of miscarriage, low birth weights and pre-term babies.

2.8 Driver Fatigue

Federal Office of Road Safety (1997), contracted Monash University to look at driver fatigue on Australian roads. It is acknowledged that there has not been enough significant research into fatigue to indicate its contribution to road crashes. The University's material indicates that fatigue is lowest in crashes where there are no casualties. Incidents that involve a vehicle running into the rear of another vehicle at traffic lights had the lower incidence of fatigue. The contribution of fatigue is

expressed as being highest in areas of single vehicle accidents or those involving single vehicles and semi-trailers.

Hartley and Arnold's (1996) paper has a strong suggestion that fatigue is not simply as a result of the duration of time spent in a motor vehicle. Conference findings promote government responsibility for community education on the severity of the consequences of ignoring fatigue. They encouraged that governments should play a pivotal role in the research and development of adequate fatigue monitoring devices to make detection easier. This included roads being made more conducive to travel and education programs to promote self-detection and safe driving.

Think Road Safety (2000), is a United Kingdom initiative that promotes a driver reviver mentality. Suggesting that persons should be aware of their propensity to sleep between midnight and 0600 hours and between 1400 – 1600 hours. Breaks are suggested of at least 15 minutes, a cup of strong coffee and a short nap. The program included radio, television, roadside billboards and posters in toilets.

Drivesafe, How To Avoid Fatigue (2000), is a Western Australian initiative to educate drivers of the hazards of fatigue. The program outlines the dangers of driving when normally one would be asleep, the need to rest and the importance of sharing the driving. The Traffic Board and the Western Australian Police have endorsed the document. There is a list of helpful tell tale signs of fatigue which reminds readers of the easily recognisable signs of fatigue.

2.9 Air Fatigue

Co *et al* (1999) undertook a survey of 1424 crewmembers and obtained their responses in relation to fatigue. The perspectives of the participants was similar to that obtained by participants in other areas of occupation. Fatigue was a problem and is experienced by the diversity of the group. There was also a correlation made between managers who believed that they had an impression of fatigue and those who had an absolute lack of understanding of what fatigue actually is.

The indicators of fatigue remained principally the same in the air industry but due to the nature of the work, the precipitators were different to other forms of transport. Scheduling of flights, long stopovers, long hours of duty and early return duty times were all attributed to causing fatigue. Additional precipitators such as the noise and high temperatures of the cockpit, the lack of autopilot and other automated equipment as well as a lack of available food and water was also attributed to causing fatigue. Further reinforcing the importance of providing nutritious beverages and snacks to maintain alertness. The benefits of ensuring that an adequate workspace is provided and that the cockpit is conducive to a comfortable place of work will significantly reduce the incidence of fatigue.

Parker (2001), consolidates a number of fatigue and sleep papers to explain the dangers of fatigue in the aviation situation. Parker's article recognises the Civil Aviation Authority's Orders, in relation to Flight Hour Limits, but suggests that their relevance is for the 1940's when they were written, rather than now. The research provides information on the effects that fatigue has on performance and alertness,

which has significant influences in aviation. The article also provides strategies to help promote sleep and combat the onset of fatigue.

Hayward's (1999) article, *Pilot Fatigue and the Limits of Endurance* attributes fatigue as being one of the four major factors that contribute to human error. The article explains how the American National Transportation Safety Board's Aircraft Accident Report identified fatigue as the cause of a 1993 accident that killed the crew. The crew had been on duty for almost 18 hours. The board found that fatigue had caused impaired judgement, poor decision making skills and hindered flying abilities resulting in the crash. The paper also acknowledges work undertaken by NASA's Fatigue Countermeasures Program in determining that even when a pilot may not feel fatigued the performance and alertness may be compromised from extended periods of wakefulness. The correlation between the effects of alcohol and prolonged wakefulness are also supported as well as identifying common indicators of fatigue. The paper concludes by providing strategies that can assist in offsetting fatigue, which include avoiding alcohol, avoiding sleep debt when working and utilising naps. Taking a thirty-minute nap can be used to augment sleep periods and erode sleep deprivation. The paper supports the previous studies on brief periods of sleep.

Rossier (2001) provides a personal account of a fatigue experience that resulted while performing a charter flight. The significance of fatigue in the aviation setting is illustrated from the perspective of a single pilot who experiences delays by passengers, bad weather, diversions, recalculations of flight paths and two aborted approaches. The pilot's experience of fatigue was made more significant because of

the surroundings in which it occurred. Rossier (2001), presents other cases and accidents that have resulted from fatigue and provides mechanisms that can aid in its prevention.

2.10 Individual Recovery Strategies

Sleep Strategies, an article in the Business and Commercial Aviation Magazine (2000), provides an account of an interview with Mark Rosekind, formerly of NASA's Ames Research Centre. Rosekind makes comparisons between the fatigue experienced in aviation industry and other workplaces. The article provides a informal discussion of fatigue and the limitations that it places on pilots as well as suggesting measures to combat fatigue. Rosekind suggests that to address fatigue there are preventative and operational strategies, which are undertaken during the course of the flight. Strategies include napping, strategic caffeine, diet, exercise and exposure to light and sleep medications. The importance of taking coffee appropriately is stressed. Coffee can be utilised to promote alertness and performance but administered prior to retiring can be more detrimental by not allowing adequate sleep. There are explanations of circadian cycles, sleep debt, how to address drowsiness and the importance of naps.

CASA in Flight Safety Australia (2000), projects fatigue as a condition that has an adverse affect on all aspects of human performance. The individual is more likely to be accepting of their poor level of performance, exercise poor judgment and be less cautious in relation to safety issues. Fatigue critically impairs judgement, it does not erode knowledge but it does make decision making less astute. The article

provides explanations of shift work and the strategies that can be utilised to aid in combating fatigue. The recommendation of a 30-minute nap is supported to deter the onset of fatigue and reduce the possibility of sleep inertia. Caffeine has been supported as a stimulant to improve alertness and performance but it is stressed that it may be detrimental if taken too late in the shift and deter sleep when first getting home. Sleep after night shift is recommended to be best if taken as soon after the shift has completed as possible. The article also suggests that monitoring personal sleep patterns for initiation of sleep, duration and sensation on waking will provide an indicator of the best sleep strategy for the individual. The consumption of alcohol to promote sleep is also discussed and is not recommended to obtain good sleep. The BAC of 0.025 promotes an initial deep sleep but it interferes with the sleep cycle and prevents REM Sleep. The result is that on waking, despite having had a sufficient period of sleep, the individual suffers from symptoms similar to sleep inertia despite having a relatively low BAC level. The completion of night shifts and returning to day shifts is also discussed and a short nap immediately after shift instead of a prolonged sleep is recommended. Remaining awake for the duration of the day and retiring in the evening, at the regular time, allows the body to recapture its synchrony to its circadian cycles. The article stresses the importance of adapting the work schedules to coincide with the periods of peak performance and alertness. The other important feature is to ensure that complex or fatiguing tasks are not undertaken during high fatigue periods.

Bonnet (1999), states that despite the proneness that sleep debt persons have to quickly falling into a deep sleep, 200mg of Coffee at 1 AM aids in preserving alertness through the night.

Lamberg's (1999) article advocates that caffeine is not a substitute for sleep but indicates circumstances that it may be of assistance. During military operations, prolonged shifts or rescue situations, the administration of caffeine may be a viable option to deter fatigue. He describes the different doses that their studies have undertaken and the positive results. Individuals were given varying amounts of caffeine after 48 hours of sleep deprivation to observe results over the following 12 hours. The three doses of caffeine examined in the study were 150mg, 300mg and 600mg, which is up to six times the normal 100mg in a cup of coffee. The 600mg dose provided evidence that there was improved performance, objective alertness and self-ratings of mood to the same extent as 20 mg of amphetamine. The caffeine had fewer side effects than the amphetamine and prolonged sleep for up to 12 hours. The caffeine has been supplied to the military in the forms of chewing gum, which allows for a specific dose to be easily measured, stored, carried and consumed. The gum has an uptake rate of within 5 minutes and has a shelf life of up to 3 years. The article also presents findings of another study by Bonnet (1999), (cited by Lamberg, 1999) which suggests that naps of as little as 2 hours prior to 64 hours of sleep loss with 2 cups of coffee can improve night time alertness to daytime baseline levels.

Zimmerman and Pierce (1999), draw attention to the relationship between rotating hours and injuries. The article provides a number of steps that can reduce the errors and possible injuries as a result of working abnormal hours and rotational shifts.

1. The adoption of short 15 to 20 minute exercise breaks is recommended during the shift to improve the on job alertness. The exercise is intended to be light and simple in nature such as the climbing of stairs or a brisk walk.

2. Drinking plenty of fluids, as fatigue is one of the earliest indicators of dehydration.
3. Have healthy snacks such as carrots and apples, which provide a good source of energy. Apples and carrots unlike potato chips and chocolates require a prolonged process of eating reducing the need to consume large amounts of chips to satisfy an appetite.
4. Sleep before driving home after strenuous and particularly long fatiguing shifts to avoid falling asleep at the wheel.

The paper also highlights the concepts of shift initiation and the inappropriateness of having shifts that require people to be waking before 0600 hours and that the most appropriate time of shift change would be between 0700 and 0800 hours. There is also the introduction of rostering staff in accordance to lifestyle requirements. Older persons tend to wake earlier and potentiate an early shift being more applicable than to a person with small children. The parent may appreciate a later start that may be more easily accommodated by carers. The final point that is delivered in relation to shifts is that shifts that finish in the middle of the night should be avoided.

Humm supports arguments of Zimmerman and Pierce (1999), in relation to the steps needed by individuals to combat fatigue and tiredness during nightshifts. The importance of exercise is highlighted and how it can be used to overcome the mood swings, health problems and errors associated with night work.

Arendt (2000) outlines the significance of melatonin in the regulation of the circadian rhythm. Arendt (2000) characterises melatonin secretion as the hands of the

circadian clock indicating the phase that the cycle is at by the levels of melatonin present. The melatonin is produced in the SCN and is normally produced during the night with greater production with the greater sleep period. Production of the melatonin during the day is associated with the daytime sleepiness or napping and furthermore should melatonin be administered the propensity for sleep is increased. The ability for the melatonin to induce sleep is a characteristic that has received considerable attention to determine if development may produce a treatment for sleep deprivation and fatigue.

2.11 Fatigue Management Strategies

In Queensland, Ambulance Service Employees Award (2000), Clause 4.2 (Overtime), subclause 5 provides a degree of protection from fatigue for Ambulance Officers. The award outlines the responsibility the employer has to ensure that the employee has had sufficient opportunity to rest prior to commencing duty. The employee is entitled to an eight-hour rest period prior to commencement of shift. That is, should the employee be recalled to duty at 0300 and completing duty to return home at 0400, the employee should not present to work until 1200 hours. The award also penalises the employer for recalling the employee to work prior to completing the rest period, should this occur the entire shift would be at overtime rates. The award does not take into account the time of day issues in relation to fatigue but it does provide opportunity for the employee to obtain sufficient rest to combat fatigue.

New South Wales Government, Public Hospital Nurses (State) Award (1995), also addresses fatigue on duration of duty hours policy. Clause 21, Overtime subclause (ix)(b) utilises similar legislation to the Queensland Ambulance Service. The employee at completion of overtime shall be entitled to a break of eight hours before returning to work. Should they be required to work, the payment will be at a rate of double pay and at completion of set task will again be entitled to a eight-hour break. This break is taken during working hours at no penalty to the employee.

The New South Wales Government Operational Ambulance Officers (State) Consolidated Award (1998), address issues of maximum rostered hours but makes no allowance for overtime. Clause 11 subclause (b) outlines that there shall be a minimum break of 10 hours between shifts, except in the case of an emergency. There is no allowance to ensure that the officers receive a minimum rest period, following extension of shifts past normal hours of work.

The Civil Aviation Orders (1978), of CASA, have incorporated both duration of hours and time of day strategies into the Flight Time Limitations, Section 48.1, issue 7 outlines the limitations that are imposed on pilots and is broken into sections dependent on the number of pilots and the tasks performed. The orders make reference to the various stages of operation that a pilot undertakes which are stand by, duty time and flight time. The numbers of hours that are flown at a particular time determine the total number of hours that a pilot can be on duty for. CASA issues strict regulations in relation to the hours of rest that pilots must obtain prior to commencement of shift. The operations of emergency rescue helicopters have specific exemptions under the Regulations but they are still bound by hours of

operation. The pilot must have 9 hours rest prior to commencement of shift, with no more than 8 hours flying time before requiring rest on the ground. Should the tour of duty exceed 8 hours flight time or 11 hours duty time a rest of at least 12 hours embracing the hours of 2200 to 0600 is required. Alternatively the pilot is required to rest for a period of 24 hours prior to commencing duty again. This then determines the number of hours that the pilot must rest prior to being able to fly again. Flying between the hours of 0000 and 0400 are considered more fatiguing than other times and attract greater requirements of rest time and decreases in duty time. The orders are complex and incorporate the time of day variable in determining the policy. The Civil Aviation Safety Authority has attempted to address all precipitators of fatigue in a Safety Management System for pilots. The system addresses issues including rest periods, duration of hours and the time of day variables.

Rosekind et al (1996), outline a program that was devised for the United States Aviation industry. The paper provides a template, which can be applied to devise and implement an Integrated Fatigue Management System. This adheres to the recommendations previously made on how to combat fatigue by using an integrated systematic approach. The template identifies 6 distinct factors that are required for the system to be functional in a 24-hour environment.

1. Education and Training. Provides the information, which may change a culture. The material should provide information explaining fatigue, and addresses misconceptions whilst providing information on how to address these issues. The information must be in a means that is applicable to the recipient and in a language that is appropriate to that workplace. The

information should be in a multitude of mediums. Follow up must be performed to ensure the correct message has been received.

2. **Hours of Service.** This factor may be determined by company policy or government regulation, but should still reflect current scientific research. The maximum hours of duty prior to established rest periods must be determined and adhered to by the workplace. These policies must ensure that the performance and duration of duties are performed in a manner that is safe to the employer, employee and the community. The factors with potential to cause the greatest controversy between employer and employee should be resolved on scientific evidence while trying to meet economic and social demands.
3. **Scheduling Practices.** Policies should reflect current scientific research in relation to fatigue. Practices should reflect the demands of the workplace but should also be designed to ensure that the safest option is always used. Where necessary work contracts may need to be renegotiated to ensure that the workload and scheduling policies comply with non-fatiguing practices.
4. **Countermeasures.** Involve personal, corporate and regulatory assistance with each playing a vital role in the success of the strategy. Companies may need to provide trainers, educators or time to ensure that the message is delivered. Individuals need to participate and ensure accordance to the respective regulations. Regulatory Assistance may be in the form of accepting new awards or workplace agreements.
5. **Design and Technology.** The advances in technology have not been reflected in the human's evolutionary process. Automobiles have been designed that can be driven for 4 –5 hours without the need for stopping for refuelling.

Humans function to the limitations of the circadian rhythm and the need for sleep. When implementing the strategy there may be emphasis on performance and alertness monitors to ensure that operators are performing safely. Other considerations would be to provide adequate rest areas for after extended shifts and facilities to store healthy food reserves.

6. Research. To ensure that the system follows and applies the results of current research and encourage participation in the process of developing new strategies.

The template provides the foundation for a Safety Management System, but is not unique to any particular workplace.

Fatigue and SAR Research (1995) released a comprehensive outline of sleep topics. Specific recommendations form another Fatigue Management System.

1. Develop Educational Program in relation to fatigue and sleep
2. Incorporate sleep and fatigue physiology into training standards
3. Include calculations of sleep time in search preparations
4. Obtain protocol to provide hotel or sleep area from return after search
5. Establish nap area close to staging area
6. Encourage and support to take naps

This is a system that is predominantly designed to function in a search and rescue situation, however facets of the system are applicable to other workplaces.

The Western Australian Government Code of Practice on Fatigue Management for Commercial Vehicle Drivers (1998) outlines what fatigue is and how the operating standards are designed in accordance to the OH&S act, Section 57. The Code of Practice on Fatigue Management for Commercial Vehicle Drivers (1998), also outlines the penalties associated with not adhering to the standards and also how best to identify fatigue in the workplace. The operating standards which prevent drivers from working more than 14 hours in a working day, no more than 168 hours in a 14 day period and an average of no more than 14 hours per day over 12 days are outlined in detail.

The Code of Practice on Fatigue Management for Commercial Vehicle Drivers (1998), also provides a template that can be used to design a Fatigue Management System. The template was designed and modelled on the transport industry but is easily applied to other workplaces following the same basic guidelines.

1. Scheduling, the booking of tasks should be done to ensure that the transports occur when fatigue is minimised. Delivery schedules should not put the delivery of goods before the safety of the individuals.
2. Rostering, the drivers should have access to their roster at least a week before enabling them to plan for extended journeys.
3. Readiness for Duty, the employee should present themselves in a condition which is deemed safe and suitable for work.

4. **Health**, the fitness of a worker to perform their duty must be maintained. A health program to support and monitor health issues in the workplace to offer assistance where needed.
5. **Workplace Conditions**, ensuring facilities that encourage rest and recuperation are available. The working conditions are appropriate for the task at hand. The workplace needs to be conducive to work and not promoting fatigue. Ergonomic options are considered when designing a workplace to ensure efficiency and safety.
6. **Training and Education**, the package is structured so that it meets the needs of all participants in the workplace. The process needs the receivers of the information to understand and act on the knowledge that they have been given. Lecturing a group or distributing a hand out does not guarantee compliance. The education process is vital for the Fatigue Management System to succeed and should be applied appropriately. Different messages need to be delivered in different means to the employees, employers and directors. All members of the organization are required to understand the system well enough to operate in it. It is essential to encourage and monitor feedback.
7. **Responsibilities**, the Fatigue Safety Management System's success is dependent upon all the participants in the workplace. The employer has a responsibility to implement and monitor a system while the employees have a responsibility to adhere to it.
8. **Documentation and Records**, the recording of all trips needs to be recorded and irregular bookings need to be examined for appropriateness. This will

allow for constant review of the system and provide impetus for modifications.

9. Management of Incidents, all hazards, incidents or accidents identified are required to be recorded. These records provide the support that is required to persuade employers and legislators of the need to make changes to ensure workplace safety.

The template provided by the Western Australian Government can be adapted and used in the formulation of Fatigue Safety Management Systems.

2.12 Conclusion

The literature review provides the foundation for the study of fatigue from the Ambulance perspective. Summary of articles and their relevance can be found at Appendix II. The information that has been presented supports the inference that officers would experience reduced levels of performance and alertness as a result of fatigue. The papers, articles and research have been drawn from areas that reflect similar work roles as Ambulance Officers who participated in this study. The evidence presented identifies fatigue as a possible issue in respect to on-call, shift work, air and road duties. Fatigue emanates from this is as a result of sleep deprivation and interference with the body's endogenous periods. Introduction of a Fatigue Management System and the introduction of legislation will aid in addressing the issues of fatigue.

CHAPTER 3

METHODS

Ambulance Officers performing long distance air and road transfers are the impetus for the study. The duration, frequency, mode and time of undertaking the transports all influence the fatigue experienced by the officers in the area. The study undertaken has been to identify what elements, if any, are responsible for this fatigue. To ensure unbiased participation the following methods have been applied to provide validity, reliability, and compliance.

Methods utilised for this study to evaluate Ambulance Officers fatigue levels comprised of voluntary participation in an anonymous survey over a 3 month period. SPSS Statistical package was used to analyse the data and draw conclusions from the participant's responses. The following points summarise the key features of the methodology and application of the survey data.

3.1 Setting

The study has utilised the support of a rural Ambulance Station of 19 Officers, which provide emergency and routine transport services to the community. The township contains a Base Hospital that provides specialist services, however limited, and requires frequent transfer of patients to major metropolitan facilities.

1. Township of 45 000 people that provides primary medical facility in an area with a 6-bed capacity intensive care unit.
2. Limited Paediatric, Neurological and Spinal facilities resulting in regular transfers to larger medical centres.
3. Completed air transports take a 4-6 hour duration.
4. Completed road transport take a duration of 8 hours.

3.2 Sample

The sample of 14 Officers was randomly selected from a 19 Officer rural Ambulance Station, which undertake air and road transports, while also performing on-call. The general Ambulance Duties that are undertaken by the Officers is representative of the functions of the 2500 Officers in the state. Participant data was selected utilising the following criteria.

1. Seven Officers who perform road duties and on-call only.
2. Seven Officers who perform road duties, helicopter duties and on-call.
3. Selection of participants by including all road staff and randomly selecting 7 air Officers.
4. Two Air Officers did not meet the criteria for inclusion.

3.3 Subjects

Officers participated in the study after completing a consent, which was supplied in an information package. The package outlined the study, instructions on completion of the questionnaire, commitment required and contact details of the researcher and university representative. The consent form also included a pre-study survey for completion to ascertain possible sleep disturbances of the participants (Appendix IV, p115). The following summary provides information of the participants sleep patterns, ages, gender and the number of children at home, that may influence the levels of fatigue.

- 1. Officers were all fit for normal duty.
- 2. Mean age of 46 years and 4 months, SD of 9 years and 9 months, Table No.1

Table No. 1
Comparison of Subjects

Road Participants					Air Participants				
Age	Male Female	Single Partner	Child < 3 @ Home	Child > 3 @ Home	Age	Male or Female	Single Partner	Child < 3 @ Home	Child > 3 @ Home
30	M	P	0	0	36	F	P	0	0
54	M	P	0	0	36	M	P	0	0
54	M	P	0	1	36	M	P	0	3
56	M	P	0	0	39	M	P	0	2
57	M	P	0	0	40	M	P	0	2
58	M	P	0	1	43	M	P	0	4
63	M	S	0	0	47	M	P	0	1

- 3. Pre-survey period, participants obtained Mean sleep of 472 minutes, SD of 37 minutes, on non-work days.

4. 13 males and 1 female is a reflection of the male to female ratio of staff at the station, not a selection bias.
5. Sleep disorders were not identified from pre-study survey of sleep patterns (Figure No. 2.) and were not a precipitator of bias.

Off	Off	Off	Off	0800	0800	0800	1800	Off	Off	Off	Off	0800	0800
Minutes		Minutes	Minutes							Minutes	Minutes		

The Study Commences here ↑

Figure No.2 Sleep Pattern Template

3.4 Research Design

The study utilised a questionnaire (Appendix III pp.113-114), to obtain data from the participants of the survey. The questionnaire required subjective information from the participants, in the form of indicators of fatigue. The indicators were comprised of performance and non-performance based identifiable signs or symptoms. The precipitators were objective data, which identified times or tasks undertaken that may produce fatigue. The design of the questionnaire was to allow completion to be as inconvenient as possible, while providing accurate data. A summary of the compilation points of the design is outlined below.

1. Precipitators section of questionnaire provided transport duration times, shift performed, call-out initiation and completion data.
2. Precipitator time data transposed to SPSS 8.0, statistical software, in periods

of 1-hour intervals, from questionnaire.

3. Indicators section provided the identified signs and symptoms of fatigue.
4. Indicator data recorded frequencies in 3-hour time intervals, which coincided with transportation work practices.

3.5 Validity

The methods used have provided data that is reflective of the conditions experienced by the Ambulance Officers. The questionnaire enabled the participants to indicate the influences of events and the responses that followed. The following points support the validity of the methods applied.

1. The precipitators provided objective data.
2. Officers routinely use the time frames that were utilised in both air and road transport.
3. Precipitator data provides distinction between modes of transport, the duration of transport and time of transports.
4. The shifts field provided indication of the influences of day, night and overtime shifts.
5. The questionnaire allowed for the differentiation of the influences on fatigue.
6. The indicators provide subjective data.
7. Indicators obtained from correlation of current research covering subjective

methods of identifying fatigue.

8. Performance and non-performance indicators utilised to provide easy association with symptom and illustrated indicator.
9. Multiple indicators to reduce biased identification of a common indicator.

3.6 Reliability

To ensure that the data that was provided by the participants was consistent, an information package outlining how to complete the questionnaire was supplied. Accompanying this package, was the added support to the participants of the researcher. Participants were given individual instruction on completion of the questionnaire. The completed questionnaire was examined and cross-referenced against other objective data for accuracy. The sign-on register records the commencement and completion of call-outs, which was checked against the data provided. Similarly the case records indicating a commencement of journey, to facilitate the checking of duration data. Subjective data however was difficult to cross-check. The only element that could promote accuracy was to reinforce the anonymity associated with the data. The means to obtain reliability are outlined below.

1. Single source of objective data collection.
2. Cross-referencing of data with sign on register, cases register and rosters.
3. Transport times are centrally generated in the co-ordination centre.

4. Call-out times are utilised for payment outside normal rostered hours.
5. Information on completion of questionnaire distributed prior to commencement of study.
6. Participants provided with individual instruction prior to commencement of study.

3.7 Bias

The sample population is a small proportion of the number of Ambulance Officers, however it is the significant majority of the staff at the station of study. The number of males in the study are considerably higher than females, however this is a reflection of the male to female ratio at the station. The incentive of extra staff is not an outcome that would be financially beneficial to the individual participants. The income from working overtime and call-outs is a substantial proportion of take home wages. The data supplied by the participants may have been influenced by the following.

1. Researcher present in the sample population workplace.
2. Performance indicators required participants to indicate personal indiscretion.
3. Performance indicators difficult to self appraise.
4. 50 % of indicators are performance orientated but account for only 10.4% utilised.

5. Perceived improvement in working conditions and additional staff may have influenced degree of fatigue reported.

3.8 Ethical Considerations

The identity of the participants has not been divulged to anyone other than the researcher. The naming of the organization or the station that the participants reside at has not been identified, to ensure anonymity of the individuals involved. The study has been performed, and data obtained, with the permission of the employee's and employer involved. These measures, and others below, have been devised following consultation with participants and university representatives.

1. Unique Identifier to provide anonymity.
2. Unique identifier destroyed on correlation of data.
3. No differentiation between major and minor errors in indicators.
4. Data collected retained for 5-year period.
5. All participants informed of context of study.
6. Participants provided consent. Aware of being able to withdraw at any time.
7. Permission to perform study obtained from participants to perform study.

3.9 Pilot study

A pilot study was not performed prior to the commencement of the data collection, however the participants were consulted during the design process. The results of an informal survey in the local area provided the ideology for the study of fatigue.

3.10 Data Collection

The data collection has been from a questionnaire that was explained to the individual participants, prior to and during the survey period. The data collection sheets (Appendix III pp.113-114), were made available for staff to easily access and complete with little inconvenience. The collection was through a central point, and only done so by the researcher. The reliance on the data collection sheet, as the only source of data, made it necessary to collect and correlate the data regularly. The data collection sheets were then transposed into the statistical package for analysis.

1. Questionnaire completed at cessation of shift on a daily basis.
2. Questionnaires collected over a 3-month period.
3. Completed returns equivalent to 79% of questionnaires delivered. 530 returns and an average of 33.1 per person.
5. A total of 32 (or 4.8%) of returns were ineligible, 498 utilised as valid data.
6. Use of 24 hour time

3.11 Data Analysis

Frequencies have provided the main form of analysis for the data of the study. SPSS statistical software was utilised to perform frequency calculations, cross tabulations, filtering and transform data into graphical representations.

The significance of association between precipitators of on-call duties, proportion of completed shift and modes of transport has been determined using the Chi Square Test. Enabling support of evidence that these factors are or are not chance associations with fatigue. Yates Correction has been used on the 2x2 tables to compensate for the small size of frequency of data.

1. Question 1, the frequency of transport was compared to those transports with an indication of fatigue ≥ 1 .
2. Question 2, the frequencies of fatigue was cross tabulated with the two modes of transport.
3. Question 3, the sum of the indicators was cross tabulated with the different modes of transport to ascertain if the indicators were the same in each mode.
4. Question 4, the sum of cases performed with an indication of fatigue was divided by the sum of cases performed. The percentage of air transports compared to road transports provided which mode precipitated the greater fatigue.

5. Question 5, the sum of indicators was established for the eight time periods. This result was then cross tabulated against the modes of transport, the shifts worked, and on-call to determine if there was an established pattern.
6. Question 6, the sum of the initiation of transports was correlated per mode of transport. The data was then filtered to determine those transports of greater than 2 hours, which was then compared between those with and without fatigue.
7. Question 7, the data was filtered to remove any air and road transports of greater than 2 hours duration. The sum of local area data with no fatigue was compared to the sum of cases undertaken with an indicator of fatigue ≥ 1 .
8. Question 8, sleep debt was determined by filtering out the data for call-outs, air or road transports of greater than 2 hours, night shifts and sleep less than 480 minutes. The remaining 12 cases presented with nil precipitators of fatigue but with an indicator of fatigue ≥ 1 . Total hours of sleep, on previous day of duty, compared with the recommended 8 hours rest determined the presence of sleep debt.

CHAPTER 4

RESULTS

The results identify that the participants are affected by the same influences of fatigue as employees in other workplaces. The illusion that the nature of the duties performed by health professional's shields them from fatigue is incorrect.

The data has revealed results that were not anticipated in the initial design of the study. The precipitators that have emerged as the main influences of fatigue were initially included to establish if a casual relationship existed between them. As the results will show, from the following questions, the comparison of transport modes provides little significant difference on the influence of fatigue. The greatest influences are from the time of transportation and the inability to obtain adequate restorative sleep.

The results of this study are consistent with findings other of studies previously undertaken. The uniqueness of the results of this study is that they have been obtained from Ambulance Officers in the performance of their normal duties, and are a reflection of the signs and symptoms that they experience in the course of that duty. The evidence that has been provided as a result of this study is a strong recommendation for managing fatigue as a workplace hazard.

Question 1 - Is fatigue identifiable in the Ambulance Officers' Workplace?

Fatigue was identified in 48.8% of the transports undertaken during the study period. The total transports include the Air, Road and Local transports undertaken for the 3-month period. Fatigue has been identified in the Ambulance Officer's work place.

Table No. 2
The Frequency of Fatigue

Transports	Frequency	Percentage
Fatigue Induced	243	48.8
Not Induced	255	51.2
Total Transports	498	100

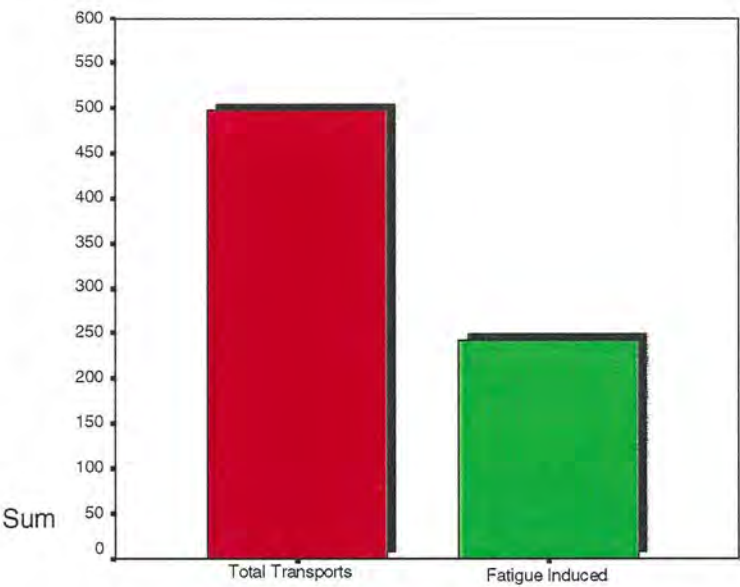


Figure No.3Frequency of Fatigue

Question 2 – Is fatigue more prevalent in air or road transports?

Fatigue resulting from air transports was more prevalent in the period of study by 236 %. There were 59 episodes of air fatigue identified compared to the 25 episodes of fatigue by road. This result is a reflection of the number of times that an officer completed a day shift and identified at least one of the fatigue indicators on the questionnaire. When identifying the prevalence of fatigue it is more apparent (Figure No.4), in the air transports that were performed than in the road transports.

Table No. 3
The Frequency of Modes of Transport

Mode of Transport	Frequency	Percentage
Road	25	10.3
Air	59	24.3
Local Duties	159	65.4
Combined	243	100

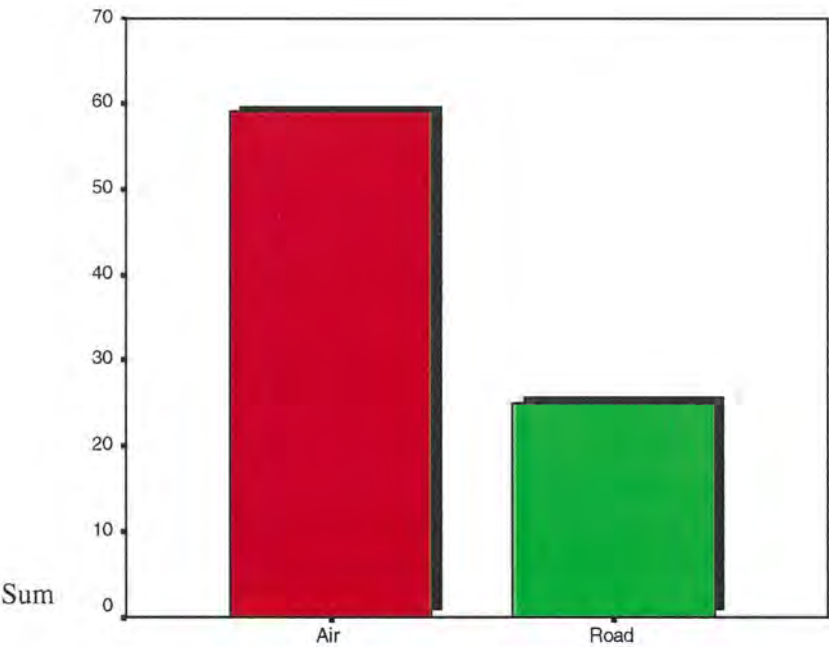


Figure No.4 Prevalence of Fatigue per Mode of Transport

Question 3 – Are the indicators similar in both modes of transport?

Principally the indicators are the same, however, the frequency does alter the primary indicator. That is, the sign or symptom that the individual experienced that allowed them to acknowledge their of fatigue. Air travel induces the Feeling of Lethargy as the main fatigue indicator; being 27.4%, figure no.5. Dry Sore or Irritated Eyes follow with 26%. Road travel identifies Dry Eyes as the main fatigue indicator with 34% and a Feeling of Lethargy as 27.2%, figure no.6. Essentially, the indicators of fatigue are the same in both modes of transport. The following table outlines the indicators that have been cross tabulated with all modes of transport including local transports. The combination of all modes is displayed in figure no.7 and maintains a close correlation the indicators of the air transports. Figures no.12-16 (Appendix I. pp 99-102), present the data in a abridged version highlighting the 5 most common indicators in each mode.

Table No. 4

Frequency of Indicators for all Modes of Transport

Indicator	Air	Road	Local	Combined
Difficulty Returning to Sleep after Call	22	1	30	58
Dry Sore or Irritated Eyes	77	50	188	315
Feeling of Lethargy of Fatigue	81	40	208	329
Diminished Cooperation Skills	13	7	24	44
Intolerant or Short Tempered	12	11	41	64
Poor Motivation or Apathy	46	9	104	159
Concentration Lapse or Daydream	19	12	24	55
Miscalculations in Speedo's or Times	4	3	27	34
Omissions or Errors in Treatment	1	2	10	13
Tunnel Vision	8	0	2	10
Misread Road Signs or Conditions	3	5	9	17
Surprise at Being Overtaken	2	1	0	3
Swerving on the Road	4	1	2	7
Fluctuating Vehicle Speed	4	5	17	26

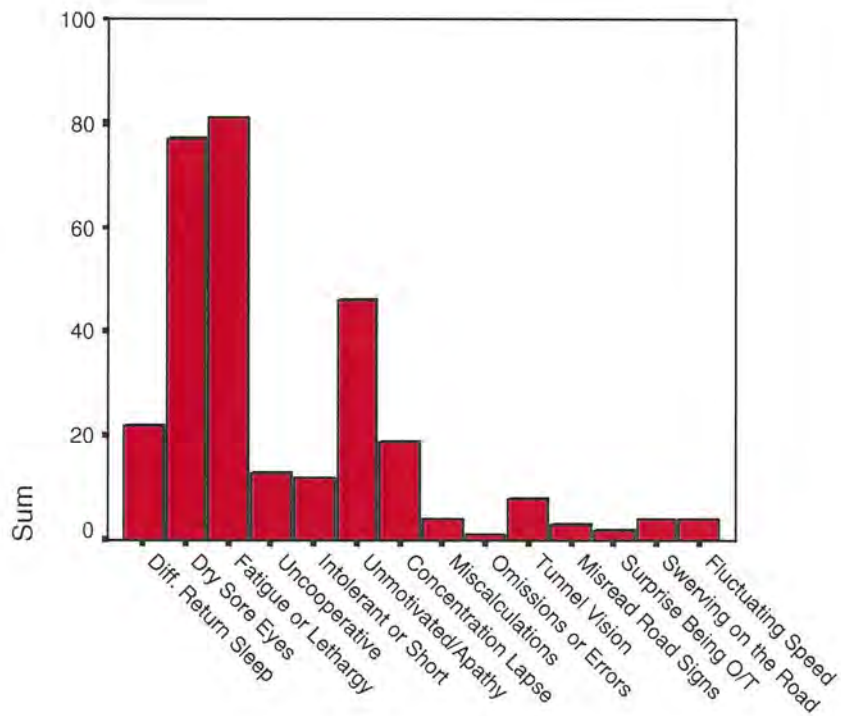


Figure No.5 Frequency of the Indicators of Air Fatigue

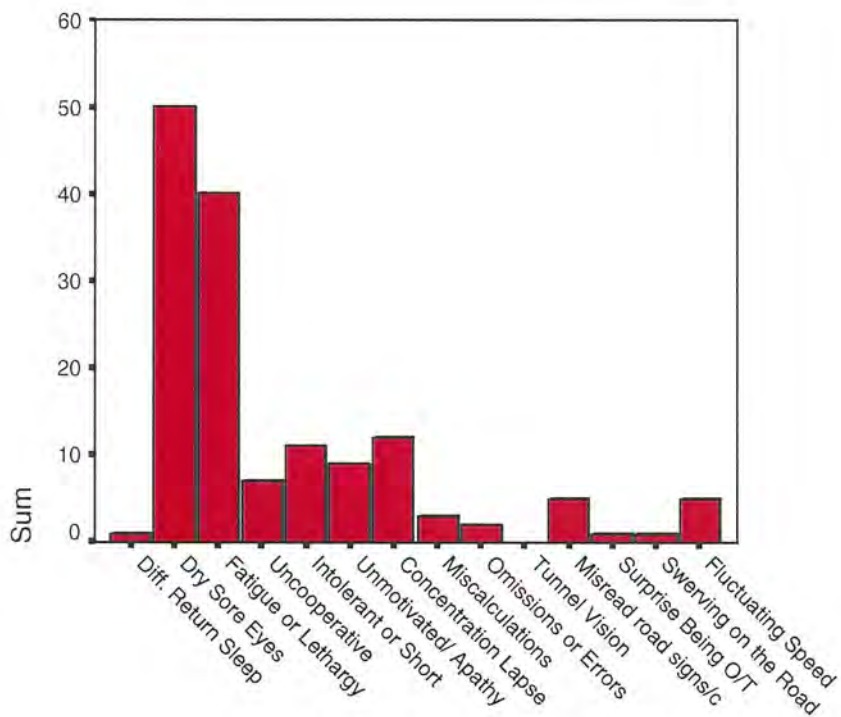


Figure No.6 Frequency of the Indicators of Road Fatigue

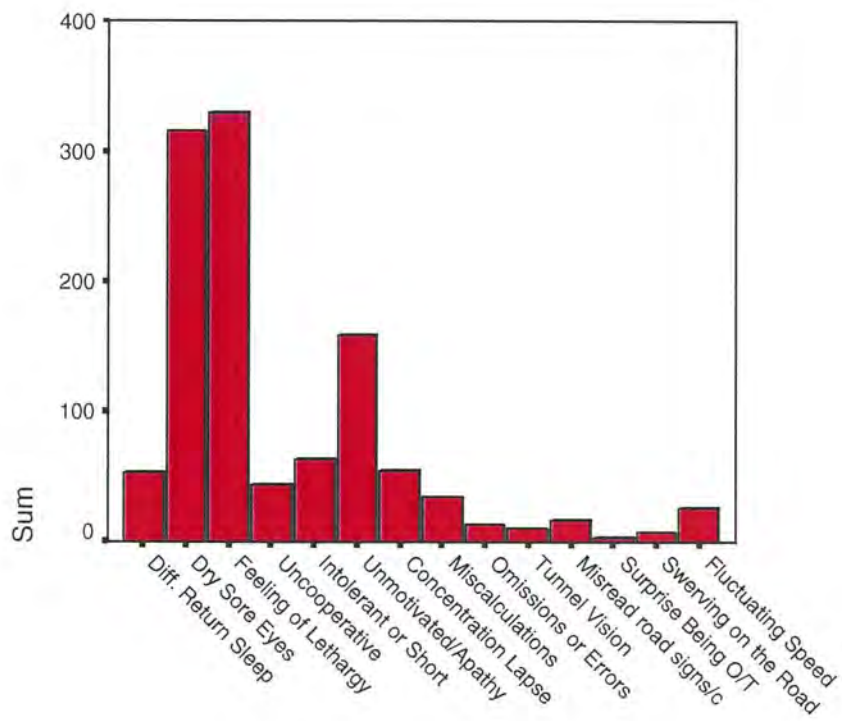


Figure No.7 Frequency of Indicators of all modes of Transport

Question 4 – Does one mode precipitate greater fatigue?

Road travel incurred slightly greater fatigue than air travel. Road transports were fewer in number than that of air transports. However, per transport, the air transport led to fatigue of Officers on 74% of transports where as the road transport led to fatigue indications on 76% of occasions. There were 80 air transports performed in the study period, of these 59 produced an indication of fatigue. Of the 33 Road transports performed, 25 produced indications of fatigue. The ratio of cases to indicators of fatigue (Figure No.8), show that road transports precipitated slightly greater fatigue than air transports during the study. However, the difference was not shown to be significant.

Table No.5
Fatigue Induced per Case Transported

Mode of Transport	No Fatigue	Fatigue Indicated	Total Cases	Percentage per Mode
Road	8	25	33	76%
Air	21	59	80	74%
Local Duties	226	159	385	42%
Combined	255	243	498	49%

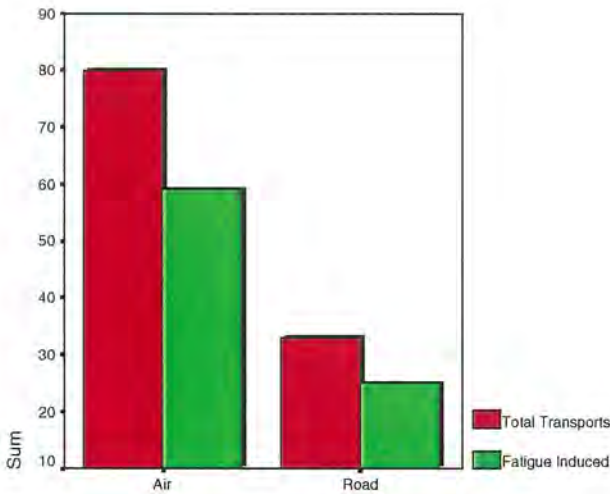


Figure No.8 Precipitation of Fatigue

The Chi Square Test suggests that Air and Road transports have a similar association to the levels of fatigue.

Table No.6

Comparison of Fatigue Induced by Air and Road Transports

	No Fatigue	Fatigue Induced	Total
Road	8	25	33
Air	21	59	80
Total	29	84	113

“There is unlikely to be a significant difference in the Fatigue experienced from Road or Air long distance transfers,

$$x^2(1, N=113)=0.00021, p>0.001.”$$

Question 5 - Does the fatigue revolve around an identifiable time period?

Overall fatigue is most prevalent in the time frame of 1501-1800 hours. Of the 1102 identified episodes of fatigue, 240 (21.8%) episodes of fatigue were entered for this time period (Appendix I. pp 102-105). This is a combination of air and road transports as well as day and night shifts. The 1501-1800 hours time period has consistently proven to be the period that officers have identified fatigue symptoms in. The only exception to this period is the night shift, which would only encompass this time period if participants had extended hours of work and started prior to the normal commencement of their shift. The 0800-1800 hours shift is the dominant of the two worked in that there are routinely at least 4 officers on duty of a day and only 2 on duty of a night. This taken into consideration, there are still considerably more episodes of fatigue identified during the 1501-1800 hours period. All modes & shifts identified 21.8% of incidents in the 1501 –1800 hours period with air transport providing 24.6 % and road transport a further 25.5%. Table No. 7 provides a breakdown of the time periods and the frequency identified per mode.

Table No.7
Frequency of Fatigue in Time Periods

Indicator	Air	Road	Local	Day	Night	Off	Call-out	Combined
0901-1200	19	6	62	75	6	6	43	87
1201-1500	34	22	77	127	5	1	61	133
1501-1800	71	37	132	219	16	5	96	240
1801-2100	34	28	72	83	48	3	23	134
2101-0000	33	10	82	40	73	12	17	125
0001-0300	38	10	81	34	82	13	41	129
0301-0600	31	17	89	20	104	13	35	137
0601-0900	29	15	73	16	91	10	26	117

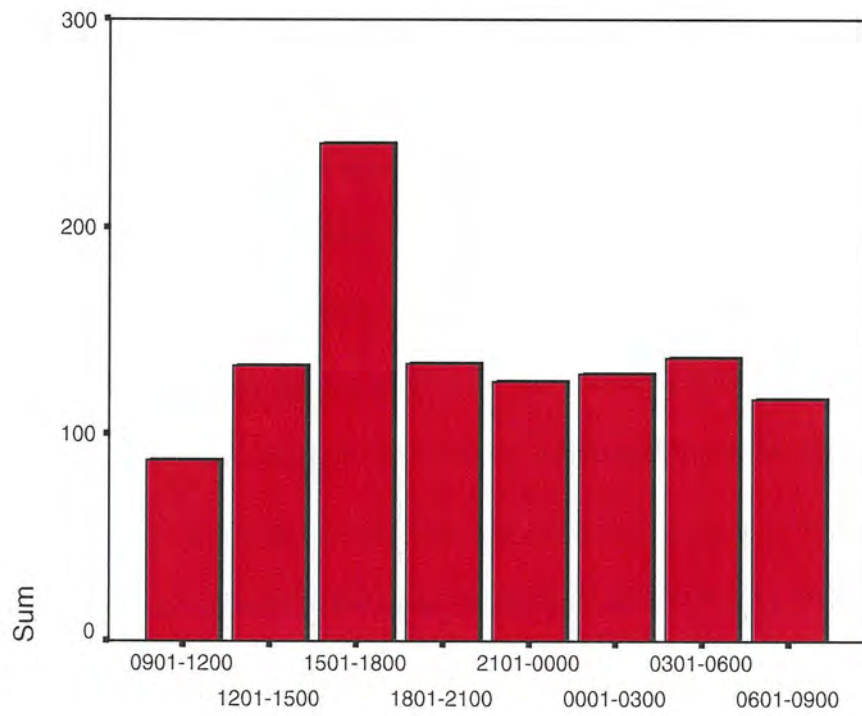


Figure No.9 Frequency of Fatigue in Time Periods

Question 6 – Does the proportion of completed shift reflect on fatigue?

The result of this question indicates that the later in the day that a long distance transport is undertaken, the greater the influence of fatigue. The transports that have been included in the data are of at least 2 hours duration. Of the 28 transports undertaken after 1701 hours every transport was identified as causing a degree of fatigue. The only exception involved was a casualty transport initiated in the 0501 & 0600 hours time bracket. The officer concerned does not identify any indicators of fatigue in this instance for this day. The following 3 days however, despite not having any call-outs, has been identified as having 12 instances of fatigue. 96% of transports that were undertaken within an hour of day shift completion or by the night shift led to fatigue symptoms. The proportion of completed shift reflects fatigue symptom detection. The earlier in the shift the transport is undertaken the least influence fatigue has on officers. Table No.8 outlines the degree of fatigue that is experienced from period of initiation. Figure No.10 enables the comparison of transports to identified experiences of fatigue. Transports of greater than 2 hours duration initiated before 1001 hours, significantly reduced the incidence of fatigue. Transports initiated after 1701 hours significantly increase the incidence of fatigue (Appendix I. p106).

Table No.8
Fatigue Determined by Proportion of Completed Shift
Indicators of Fatigue

Transport Initiation	0801	0901	1001	1101	1201	1301	1401	1501	1601	1701	1801	2001	2101	2201	2301	0001	0101	0201	0301	0401	0501	0601	0701	On Call
Fatigued	3	7	1	6	7	8	3	2	4	4	1	1	2	2	3	1	1	1	na	na	na	1	2	8
Transports	6	12	1	9	8	12	4	4	5	4	1	1	2	2	3	1	1	1	na	na	1	1	2	8
Percentage	50	58	100	67	88	67	75	50	80	100	100	100	100	100	100	100	100	100	na	na	0	100	100	100

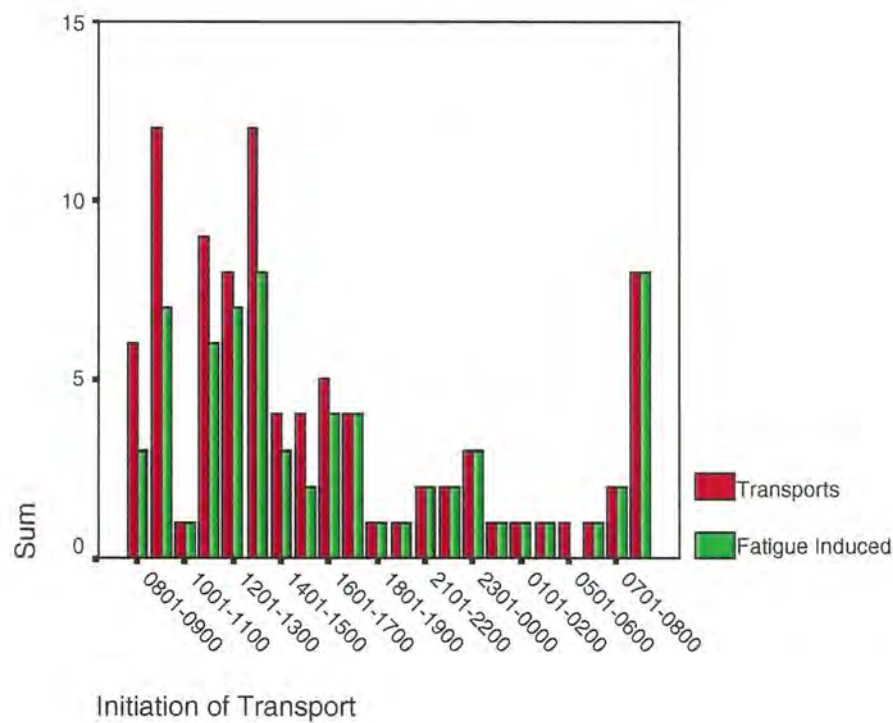


Figure No.10 **Fatigue Determined by Proportion of Completed Shift**
Indication of Fatigue

Application of the Chi Square Test identifies that there is an association between fatigue and the initiation of transports.

Table No.9

Comparison of Fatigue Induced by Initiation of Transports after 1001 Hours

	No Fatigue	Fatigue Induced	Total
Transport Initiated 0800-1001	8	10	18
Not Initiated 0800-1001	13	50	63
Total	21	60	81

“Fatigue is likely to be significantly increased if transports are not initiated between 0800 – 1001 hours,

$$x^2(1, N=81)=15.894, p<0.001.”$$

Question 7 – Does the on-call component contribute to fatigue?

On-call duties did contribute to the fatigue experienced by participants during the study. On-call duties resulted in officers indicating an incident of fatigue in 87% of call-outs undertaken in the local area. That is excluding all long distant road transports and air transports for the period.

Table No.10
Frequency of On-call Fatigue

Cases	Frequency
On-call Cases	55
On-call Cases with an indication of Fatigue	48

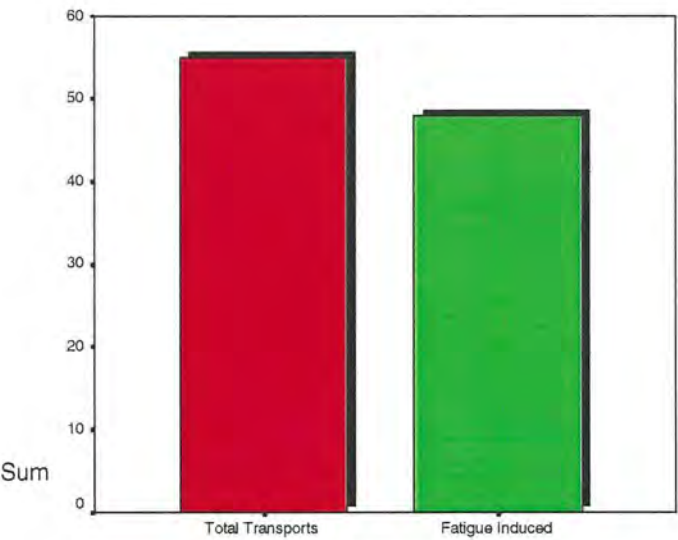


Figure No.11 Frequency of On-call Fatigue

The application of the Chi Square Test has indicated the performance of on-call duties has a significant association with the fatigue.

Table No.11
Comparison of Fatigue Induced by On-call Duties

	No Fatigue	Fatigue Induced	Total
On-Call	7	48	55
Not On-Call	248	195	443
Total	255	243	498

“On-call is likely to significantly increases the incidence of Fatigue,

$$x^2(1,N=498)=42.044, p<0.001.”$$

Question 8 – Is fatigue immediately identified or is it a delayed condition?

Sleep deprivation is evident amongst the responses from the participants during the course of the study and supports the argument of delayed fatigue. The period of sleep deprivation, determined over a 4 day cycle of the roster has presented 12 instances of fatigue. This is despite officers having had at least 480 minutes of sleep prior to commencement of the shift completed, not completing a long distant road or air transport and not performing a night shift or call-out. Of the 12 instances there was no precipitator of fatigue exhibited that could be correlated with the instance of fatigue. The results suggest that the indicators of fatigue were as a result of sleep lost from previous nights, and support the concept of delayed fatigue or sleep debt.

CHAPTER 5

DISCUSSION

The incidence of fatigue is significant amongst Ambulance Officers. The findings have identified that there are areas in Ambulance operations that induce fatigue. Furthermore, the results of the study have provided evidence that can aid in the design of policies to reduce fatigue in the Ambulance workplace.

5.1 Interpretations of the Findings

The presence of fatigue has been identified in the Ambulance Workplace. Of transported cases that were undertaken by the participants 48.8% induced a symptom of fatigue. The extent of the fatigue experienced by the participants varied throughout the study indicating the influences of personal, community and organisational obligations. The 14 participants underwent a preliminary survey of sleeping habits, age and number of children at home under the age of three prior to collection of data. There was no emergence of obvious sleep disorders or deprivation as a result of personal or community obligations. The results of the preliminary survey suggest the incidence of fatigue is primarily work induced.

Fatigue was more prevalent in air transports for the period of study. The severity of the cases in this period negated the transfer of patients by road, resulting in a higher frequency of air transports than road transports. The number of air transports undertaken provided officers with more exposure to a fatigue experience

than that of road transports. The mechanism of transport that was utilised by the hospital was the determining element in the greater prevalence of fatigue.

The indicators of fatigue are predominantly the same in the two modes of transport. The two main indicators of fatigue have been the feeling of fatigue or lethargy and the dry, sore or irritated eyes. The frequency had minor variance between the primary and secondary indicator in each mode. The performance indicators were not utilised to the same degree as the non-performance indicators. The bias may be representative of the participant having difficulty identifying the decreases in performance or their unwillingness to acknowledge them. The indicators in the study consisted of seven performance and seven non-performance indicators. The combined responses of the participants included 1129 indicators, of which 14.6% were performance orientated. There was a considerable bias associated with the utilisation of performance indicators by both modes of transport.

The transport of patients by air provided the greater prevalence of fatigue but did not precipitate the greatest degree of fatigue. Road transports undertaken in the study caused a greater incidence of fatigue per case than air transports. The two modes both induced fatigue on approximately 75% of transports undertaken. The difference in the two modes was not significant, in that road transports precipitated fatigue on 76% of occasions compared to the 74% of occasions for air transports. Therefore, the mode of transport is not the differentiating factor in determining the precipitation of fatigue.

The Time of Day and Sleep Deprivation of the individual are indicative of precipitating fatigue. The participants more readily identified fatigue with the time period of 1501-1800 hours. The data coincides with a trough in the circadian cycle of performance and alertness as well as a peak in the endogenous drive for sleep. The day shift accounted for 70% of the questionnaires returned and exposes more Officers to the 1501-1800 hours period than the night shift. Participants who developed a sleep debt from call-outs and overtime presented with incidents of fatigue in the 1501-1800 hours period. The night shift questionnaires also correlated with a trough in alertness and a peak in the drive for sleep, at 0301-0600 hours. The participant's data supports previously researched and determined troughs and peaks in the circadian cycle and the drive for sleep.

Transports that were occurring during the troughs in alertness and peaks in drive for sleep were initiated after the 1001 hours time period. The transports initiated prior to this period experienced fatigue on 54% of occasions. Transports that were initiated after 1701 hours experienced fatigue on 96% of occasions. That is, all transports after 1701 hours reported experiencing fatigue, with the exception of one transfer. The participant did not immediately identify fatigue but did report fatigue on subsequent days, where no precipitators were identified. The initiating of transports after 1701 hours, within an hour of day shift completion, presented as a means of imposing fatigue. The transporting of patients at any stage during a night shift imposed the same degree of fatigue. The indication of fatigue in the 0800 hours period identifies the propensity of Officers to become fatigued at any time. The time of day is only one catalyst that may produce fatigue. Sleep debt accumulation, as a result of working outside of normal rostered hours of work is another catalyst of

fatigue. The on-call component contributed to the fatigue experienced by the participants. On-call tasks, predominantly performed as transports to local hospitals, provided 87% of reported episodes of fatigue. When waking from a deep sleep to respond to the call-out the individuals were removed from the restorative stages of sleep and were subjected to the causes of sleep inertia. The call-out decreased the amount of time that was available to rest and sleep. The recommended 8-hours of sleep was redistributed to the 16 hours of wake time and the officers became susceptible to a sleep debt. Individuals who are unable to obtain sleep as a result of being recalled to work would benefit from an opportunity to sleep upon completion of the call. Not providing the individual with sufficient time to obtain adequate restorative sleep induces a sleep debt and prolongs the effect of fatigue.

Participants reported that effects of fatigue were not immediately apparent. They experienced episodes of sleep deprivation during the study that developed and presented as a sleep debt. Transports, initiated on 12 identified days, did not present with an incident of fatigue, on the day of transport. Subsequent days did however provide indicators of fatigue without the influence of external precipitators. Participants reported they were not fatigued after performing the transport, but identified symptoms the following day attributable to sleep deprivation and accumulating sleep debt.

The participants in the study experienced fatigue during the performance of their duties. The indicators and periods that were identified have provided the foundation elements that can be used in designing a Fatigue Safety Management System.

5.2 Comparison of the Findings

Searches for a similar study of the effects of fatigue on Ambulance Officers in relation to air and road transports were unsuccessful. The study has not been undertaken previously but elements in this study have been, which are outlined in Table No.12.

Table No.12
Comparison of Main Findings

Author	Date	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Blosser, NIOSH	1997	✓												✓				
Brown	1997		✓			✓												
Co <i>et al</i>	1999	✓	✓	✓									✓					
CASA-Navigation Orders	1978					✓												
CASA-Advisory Circular	1999	✓															✓	
CASA-Flight Safety Aust.	2000	✓																✓
Dawson (App. C)	1998		✓			✓		✓	✓									
Dawson (App. D)	1998								✓				✓				✓	
Dawson <i>et al</i>	1999	✓				✓		✓				✓				✓		
Drivesafe	2000												✓					
FMCSA	1996				✓	✓					✓	✓						
Feyer	2001					✓		✓		✓								
Furlan <i>et al</i>	2000	✓															✓	
Grossman	1997	✓																✓
Hartley and Arnold	1996					✓									✓			
Haywood	1999	✓									✓							✓

Author	Date	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Humm	2000																	✓
Kroemer and Grandjean	1999						✓			✓								
Lavie	2001	✓						✓						✓				
Learthart	2000	✓															✓	
Olsen and Ambrogetti	1998	✓						✓										
Parker	2001	✓																✓
Rosekind <i>et al</i>	1996	✓	✓	✓	✓			✓		✓								
Rosekind	2000							✓										✓
Rossier	2001		✓	✓		✓												✓
Think Road Safety	2000			✓	✓	✓												✓
Zimmerman & Pierce	1999																	✓

Legend

- | | | | |
|---|--|---|---|
| A | Fatigue induces deterioration in performance and alertness | I | Individuals are unable to sense fatigue development |
| B | Performance and alertness trough between 0300-0600 | J | No correlation between age and fatigue |
| C | Performance and alertness trough between 1400-1700 | K | Fatigue induces a change in mood and motivation |
| D | Performance and alertness trough between 0000-0700 | L | Indicators of Fatigue |
| E | Time of day influence on fatigue | M | Day sleep is inferior to night sleep |
| F | Fatigue is a culmination of events | N | Management of fatigue is not isolated to one individual |
| G | Sleep debt results from inadequate quality and duration | O | Health concerns associated with shift work |
| H | Fatigue emanates from deficiencies in rest, sleep and circadian rhythms. | P | 8-hour sleep and 16-hour awake |
| | | Q | Strategies to control fatigue |

5.3 Implications of the Findings

The incidence of fatigue in this study may encourage Ambulance Services to evaluate their policies on fatigue management. The introduction of a Fatigue Safety Management System will provide a mechanism of addressing work-induced fatigue from the perspectives of productivity and safety.

The transferring of patients from peripheral hospitals to a major facility is a policy that is utilised by the Area Health Service. The practice of performing transfers is necessary for a patient to receive treatment that is not available at peripheral facilities. The Ambulance Service cannot refuse to perform the transport but Officers may benefit from the implementation of a rescheduling programme that focuses on safety. Transports would be undertaken at times that avoid troughs in officer performance and alertness to reduce the exposure to fatigue. The transport could then occur at a time when the Ambulance Officer is not negatively influenced by circadian cycles. Severe or critically ill patients requiring urgent specialist treatment could still be transferred, but fatigue management strategies would ensure the safety of officers throughout the transfer. Officers would not be required to perform single officer transfers during peak periods of high sleep propensity and would be provided with the opportunity to rotate from the driving responsibilities. The rotation of driving and resting tasks allows officers to utilise time for short periods of sleep recovery without compounding the hazards of driving. The utilising of 30-minute naps would enable the drivers to continually rotate and maintain alertness while driving.

The precipitation of fatigue has presented as similar in both modes of transport. The identification of a strategy to address fatigue in air and a separate strategy for road is not necessary. The difference between the two modes indicates that it is not the mode that is precipitating the fatigue, but the timing of the duty itself. The tasks undertaken at 0900 hours are the same as those undertaken at 2300 hours. The task is not the determining element of fatigue. The relationship between the circadian cycle and the level of sleep deprivation is of more significance. The Time of Day is more an influence to Ambulance Officers fatigue symptoms than the means of transport available. The strategies to address fatigue will be of greater benefit if the focus is on the Time of Day that the transports are undertaken rather than the particular mode.

The time that has produced the greatest levels of fatigue has been the 1501-1800 hours and the 0301-0600 hours period. Transporting patients for extended lengths of time that encompass these periods will expose the Officer to an increased propensity for sleep. The Endogenous Biological Process is endeavouring to sleep between 0000-0700 hours and replenish the time exhausted during daylight hours. To prevent the effects of the circadian rhythm and the drive for sleep, the officer requires to be rested in order to eradicate the sleep debt. Ideally, long distance transports would not occur during these periods, especially by on-call officers.

The urgency of a patient transfer requires the scrutiny of Ambulance Services to determine the applicability of time and mode. Patients may not warrant immediate transfer and may be able to be transported during daylight hours. This will remove Officers from exposure to the periods of high sleep propensity and will also allow for

recuperative sleep prior to the transport. Urgent patient transfers will still be required. This could be undertaken as either an air transport or a road transport with 2 drivers and additional medical crew. The condition of the patient determines the necessity of the transport whilst the health and safety of the Officers determines the staffing requirements. The employer is required to consider the safety of the Officers before accepting a transport that exposes them to a high incidence of fatigue that may lead to poor judgement and decision making.

The performance of on-call duties provides officers with the greatest influence of fatigue. Officers who complete a 10-hour shift require a period of deep sleep to recuperate and be available for duty the following day. Officers who perform call-out tasks during the night reduce their availability to this restorative sleep and are exposed to sleep deprivation. The performance of on-call duties induces fatigue as the Officers have a reduced ability to recover from the previous days work.

The performance of call-out duties and overtime is mandatory under award requirements. The Officer is obliged, through an Industrial Agreement, to perform tasks after hours which impede their ability to recover from fatigue, irrespective of the number of hours sleep obtained between shifts. The current Industrial Award does not contain relevant legislation to facilitate a rest period prior to commencing normal day or night shifts, which are specific to those Officers who performed duties between rostered shifts. The incorporation of an eight-hour fatigue break, prior to resuming duties after a call-out or overtime would address the decreased availability to sleep.

Current literature would suggest that the performance of nightshifts should be eliminated, however in the area of Health and Ambulance Services, this is not possible. The night shift, isolated from on-call duties, provides a safer option for individuals than a day shift followed by on-call commitments. The incidence of fatigue reported in this study highlights the fatigue resulting from performance of on-call duty and the inability to obtain the necessary sleep to replenish sleep reserves. The incidence of fatigue amongst individuals in this study would reduce with additional staff performing night shifts rather than abolishing them. The review of literature has identified that of the possible roster combinations the rapid rotational is the most acceptable. The roster utilised by the participants in this study is the least burdening on the body as well as allowing the most normal lifestyle. The utilisation of a nap after completing the single night shift and then proceeding to remain awake for the duration of the day is the most effective sleep strategy to combat fatigue and the night shift.

The study confirms current literature perspectives that reduction in sleep forms a debt, which accumulates over several days and can influence the Officer's ability to remain awake. The on-call duty and extended shifts may not be the only precipitator of a sleep debt. The domestic and social obligations of Officers also contribute to establishing a sleep debt. The sleep debt is of greatest significance when the Officer is performing duty in the period when the drive for sleep is at its highest. The appropriate utilisation of rest strategies, identification of fatigue indicators and transfer schedules is required to affectively reduce the incidence of sleep deprivation.

The quality of sleep during the day is less because the endogenous processes are attempting to remain alert and are hindering the deep restorative stages of sleep. Considering the problems that are associated with obtaining sufficient sleep during the day it may be beneficial to evaluate the expectations of the night shift. The performance of intricate tasks should be avoided if there is to be no detriment by waiting until the day shift can perform the task. The convenience of transferring patients at night cannot take precedence over Officers' safety.

Irrespective of the participant's unwillingness or inability to identify the performance indicators, they were not well used in the survey. To be effective an education package requires the utilisation of indicators that are easily identifiable. The main indicators are 1) a Feeling of Fatigue or Lethargy, 2) Dry, Sore or Irritated Eyes, 3) Unmotivated or Apathy and 4) Intolerant or Short Tempered. Officers who have experienced periods of sleep deprivation, broken sleep or transports during troughs in cycles may be prompted by these indicators and identify them as a sign of fatigue.

The Occupational Health and Safety Acts have been introduced to address the hazards in the workplace to employees. Fatigue has been identified as a hazard to the employees and stakeholders of Ambulance Services. The introduction of the hierarchy of controls can provide an immediate and a long-term solution to control the threat to employee's safety. The decision is to determine what system of work can be redesigned or substituted to address this issue. The following recommendations address the short and long term options.

CHAPTER 6

RECOMMENDATIONS

6.1 Interim Strategies

1. Cease single Officer transports that will allow the transfer to encompass an identified peak period in the endogenous drive for sleep. Initiate two Officer, and Nurse escort, transfers to facilitate the rotation of driving in this period.
2. Provide memorandum from Managers instructing Officers and Coordinators to perform duties within the Roads and Traffic Authority guidelines, for duration of driving and rest periods.
3. Develop a transfer protocol that is focused on safety and scheduling, which is designed to diminish the influences of the circadian troughs in performance and alertness. Reschedule non-urgent night transfers to 0830 hours departure.
4. Adopt flexible work practices to allow utilisation of informal rest periods. Managers to authorise the utilisation of downtime to nap and control the effects of sleep deprivation.
5. Initiate negotiations with employers and employee groups to incorporate a formalised fatigue break in Industrial Legislation.
6. Educate staff on the hazards of fatigue and the methods of recognising it in the workplace. Disseminate the signs and symptoms of Fatigue in newsletters and training packages.

6.2 Permanent Strategies

1. Personal Preventative Strategies.

1.1. Maintaining the Organism

Provide water cooler or fountains on stations for Officers to address dehydration. Provide adequate refrigeration facilities to store fresh food.

1.2. Monitor Personal Performance

Direct Officers to stop performing duties and ask for assistance when tired or signs of fatigue become evident. Provide assistance with driving and relief from duties for Officers who have identified signs or symptoms of fatigue.

1.3. Performance and Alertness Aids

Educate Officers of the enhancements in performance and alertness from appropriate caffeine administration. Place a thermos in each vehicle to facilitate safe storage and transport of coffee on transfer

1.4. Driving Home

Provide areas for Officers to rest after shift, prior to driving home. Alternatively provide transport home for Officers and prevent them from driving whilst fatigued.

1.5. Participation in the System

Distribute questionnaires evaluating the fatigue strategies for feedback on introduction. Facilitate collection of ongoing feedback by utilisation of hazards identification register. Evaluate and discuss new strategies through consultative workshops between employees, employers and OH&S committees.

2. Cultural Initiatives

2.1 Change

Initiate a change in culture to accept fatigue as unsafe. Provide Officers with research material that identifies fatigue as a condition, which induces hazards in the workplace similar to drug and alcohol abuse. Incorporate findings into training packages, newsletters and informal discussion.

2.2 Dedication

Discourage the acceptance of fatigue as an indication of dedication. Managers are to highlight the dangers of operating under the influence of fatigue and the possible ramifications to the service and individuals.

2.3 Commitment to OH&S

Promote the recognition of fatigue as an indication of commitment to OH&S. Supervisors and OH&S committees to educate of hazards of fatigue and the obligations to stakeholders of performing duties safely.

3. Introduction of a Transport Protocol

3.1 Transfer Initiation

Write a policy to ensure the initiation of Long Distance Transfers prior to 1001 hours.

3.2 Booking Requirements

A condition of transfer is that bookings are required by 1700 hours the previous day. Enabling Officers to be aware of the pending journey and be appropriately rested.

3.3 Sleep Requirement

Establish, from overtime and sign on register, that Officers have had sufficient sleep prior to the commencement of the transfer. If sufficient sleep has not been obtained then the transport will not occur until the Officer is suitably rested.

3.4 Night Transfers

Patients are only transported during the night when the condition requires urgent treatment at the destination hospital.

3.5 Confirmation of Urgent Treatment

Confirmation is required from the receiving hospital, prior to accepting the booking, that the patient will undergo active intervention on arrival at the destination hospital.

3.6 Crewing Requirement

Two Officers and an escort to perform road transfers at night to allow compliance to RTA guidelines and utilise nap provisions. Priority is given to the transferring of patients by air, rather than road and collecting fatigued Officers from the aircraft.

3.7 Off Duty Transfers

Utilise off duty Officers, with a minimum of eight hours rest, for long distance transports. In preference to using day shift Officers that have been fatigued from previous days work. Maintain a register of Officers that may be available to perform transfers on non-work days.

3.8 Specialist Duties

Introduce a driveline on the roster. Officers to do long distance transports for either helicopter or road cases. No call prior to shift.

4. Introduction of an Integrated Fatigue Safety Management System

4.1 Education

Design and implement a training programme for Officers, Co-ordinators and Managers of the elements of fatigue. Educate to improve recognition of signs and symptoms of fatigue and improved sleep practices to reduce sleep deprivation. The formal dissemination of material is to be through training schools and informal reinforcement of material through newsletters, memorandums and discussion.

4.2 Hours of Duty

Implement a fatigue policy to provide Officers with an opportunity to have 8 hours unbroken sleep after a callout or overtime, and prior to the commencement of shift. Establish a consultative committee of employer and employee groups to evaluate current accepted work practices of other services and determine applicability to their own workplace. Ratify the policy in appropriate Industrial Legislation.

4.3 Reschedule Workloads

Broadcast the Transport Protocol, as outlined in Recommendation 3, to hospitals and staff one month prior to determined implementation date. Provide transfer services to hospitals in accordance with the Transport Protocol. Allocate tasks on night shift to avoid high performance or prolonged periods of constant alertness.

4.4 Rotation of Driving

Provide two Officers for the performance of long distance transfers to facilitate alternate driving and utilise naps to combat fatigue. Incorporate the rotation of driving requirement into Standard Operating Procedures to promote compliance by Officers, Coordinators and Managers.

4.5 Readiness for Duty

Reinforce the obligations Officers have to present for duty rested and prepared for shift. Educate on the requirement to comply with strategies provided by the employer to improve workplace safety.

4.6 Health and Fitness

Encourage Officers to improve general fitness to combat fatigue. Introduce education programmes, posters and information that identify the benefits of healthy snacks and exercise to control the effects of shiftwork and fatigue. Supply access to fitness trainers and equipment to facilitate the adoption of a healthier lifestyle.

4.7 Workplace conditions

Utilise ergonomic options in the purchase of equipment. Provide rest area to address sleep debt. Provide comfortable working environment.

4.8 Review

Continually evaluate the System to ensure it is adequate and adjust or retrain as required. Reinforce the necessity of feedback and of identifying fatigue issues in the hazard identification register, in the initial education programme. Establish a review of feedback from Officers through the OH&S committee, thus providing regular monitoring of the System.

4.9 Research

Monitor, and implement as applicable, changes that develop as a result of scientific research into methods of controlling fatigue. OH&S coordinators to network with other Ambulance Services to determine strategies that they found to be effective in controlling fatigue.

CHAPTER 7

CONCLUSION

The identification of fatigue in the Ambulance setting is not an unexplainable phenomenon. The participants in this study have provided evidence that the performance of duty by Ambulance Officers can render the individuals fatigued. Recognition of the incidence of fatigue does not alleviate the hazards but it may be the impetus to prompt Ambulance Services to introduce strategies that will.

The mode of transport has not proven to be a significant factor in the precipitation of fatigue amongst the participants. However, the correlation that has been made between sleep debt, time of day, call-out tasks and long distance transports is significant. These elements can be attributed to the level of fatigue experienced by Officers. Furthermore, it has been established that the level of fatigue experienced by an individual is difficult to self-determine. The onus then, to implement the appropriate education, training and rescheduling systems, is on the Ambulance Services. They have obligations to all stakeholders, including the public and staff, to function safely. To accept fatigue as a component of daily operations is not upholding that obligation.

However, the management of fatigue is not the sole responsibility of an employer. The employer has an obligation to provide a safe workplace, whilst the employees have a responsibility to utilise the mechanisms provided, to perform their

duties safely. Currently, the action to decline a duty because of fatigue is not the expectation of the employee. Therefore, the strategies that are introduced to control fatigue will require the support of all members of the organization to be successful.

Working conditions contributing to fatigue have been identified in the Ambulance Workplace, and strategies outlined. The Interim Strategies contain recommendations that should be applied immediately to all workplaces, including the negotiations with the Ambulance Service, Employee Groups and Area Health Services. Permanent Strategies involve the application of immediate and long-term recommendations to ensure that the methods of addressing fatigue are effective.

The introduction of an Integrated Safety Management System that encompasses both the Interim and Permanent Strategies, is recommended to control the hazard of workplace fatigue.

CHAPTER 8

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CHAPTER 9

APPENDICES

9.1 Appendix I. Abridged Figures

Question 3

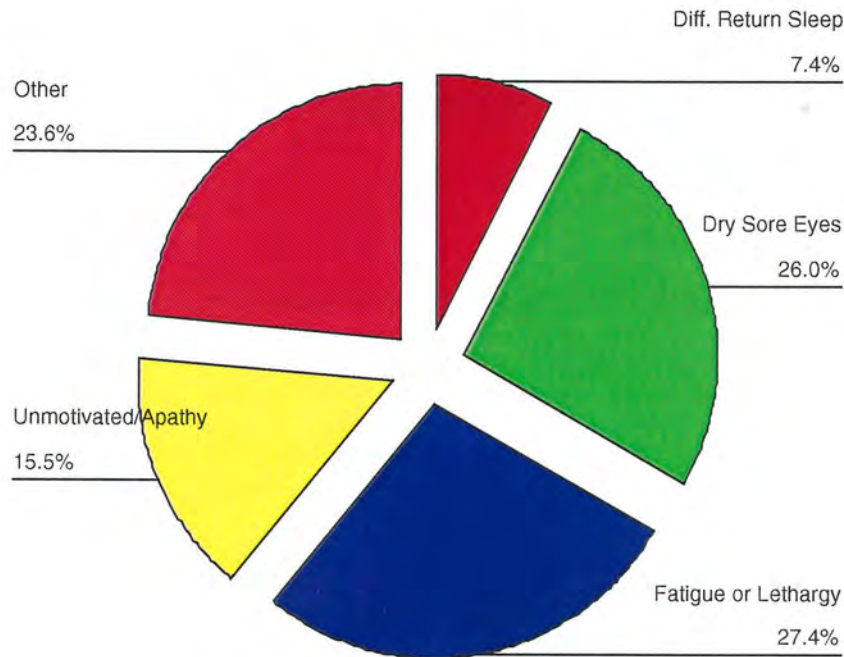


Figure No.12 Frequency of Indicators of Fatigue for Air Transports

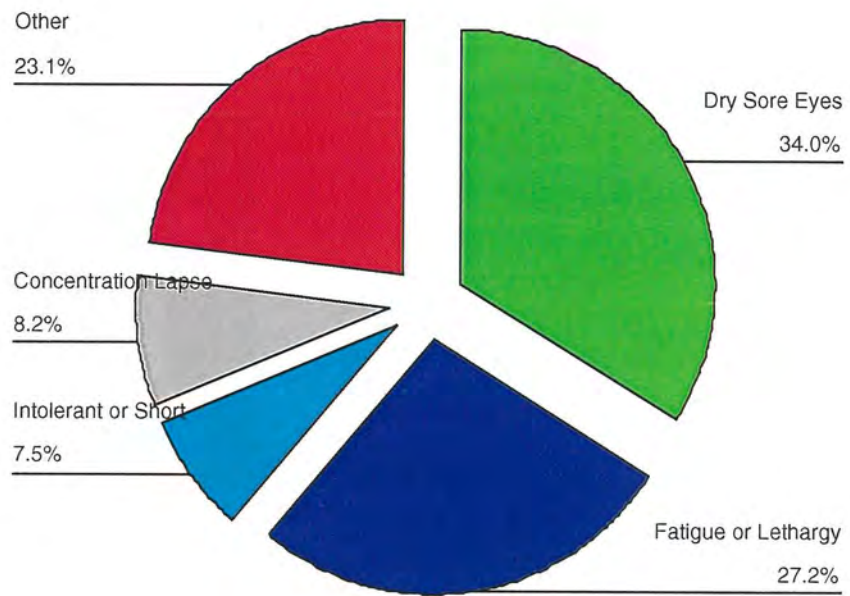


Figure No.13 Frequency of Indicators of Fatigue for Road Transports

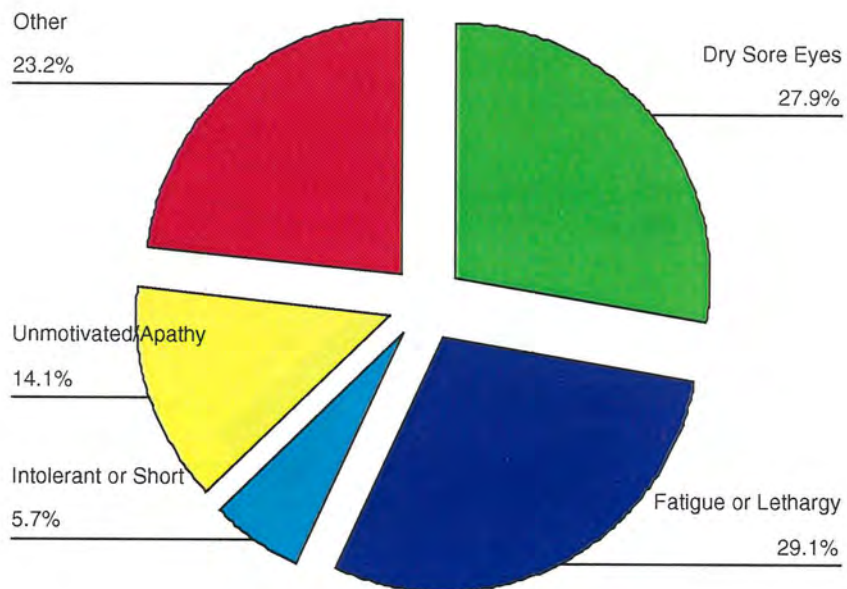


Figure No.14 Frequency of Indicators of Fatigue for All Modes of Transport

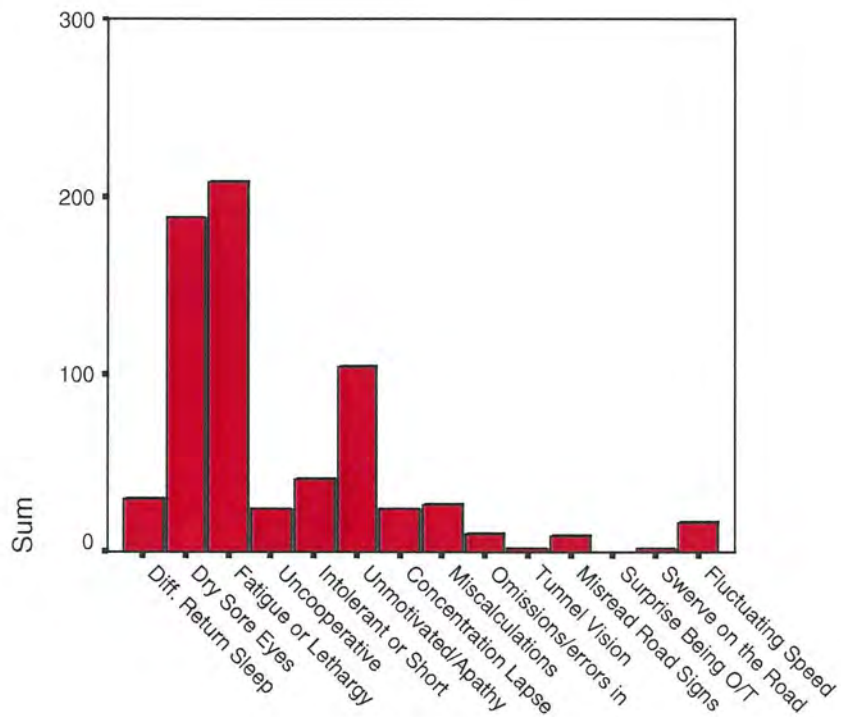


Figure No15 Frequency of Indicators of Fatigue for Local Transports

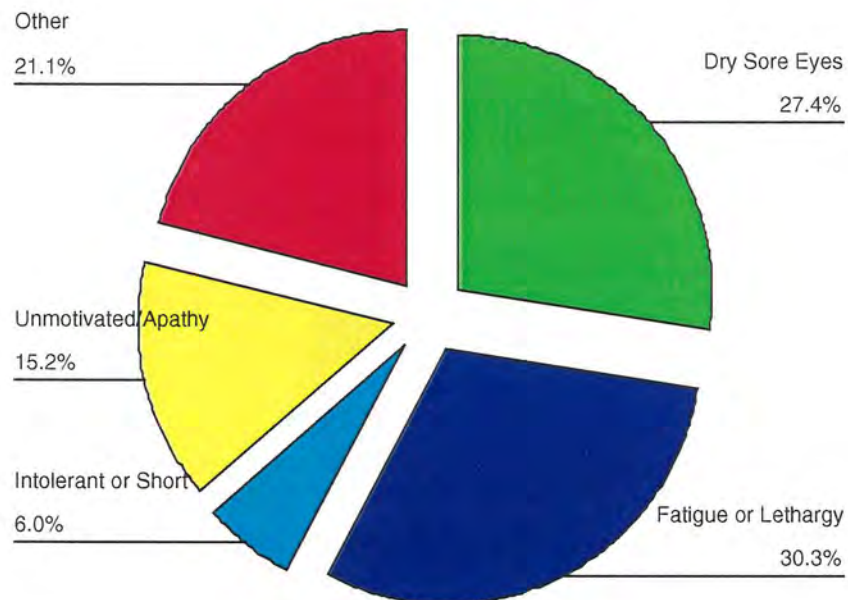


Figure No.16 Frequency of Indicators of Fatigue for Local Transports

Question 5

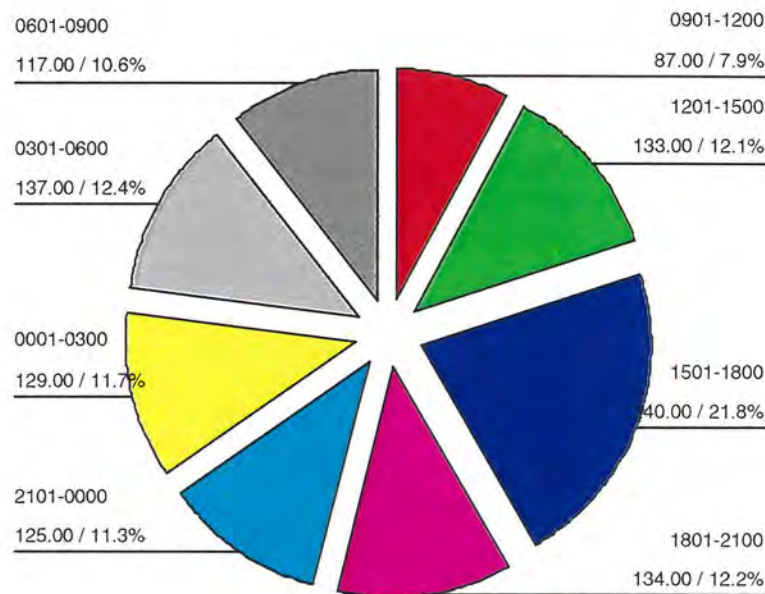


Figure No.17 Frequency of Fatigue in Time Periods for All modes of transport on all shifts

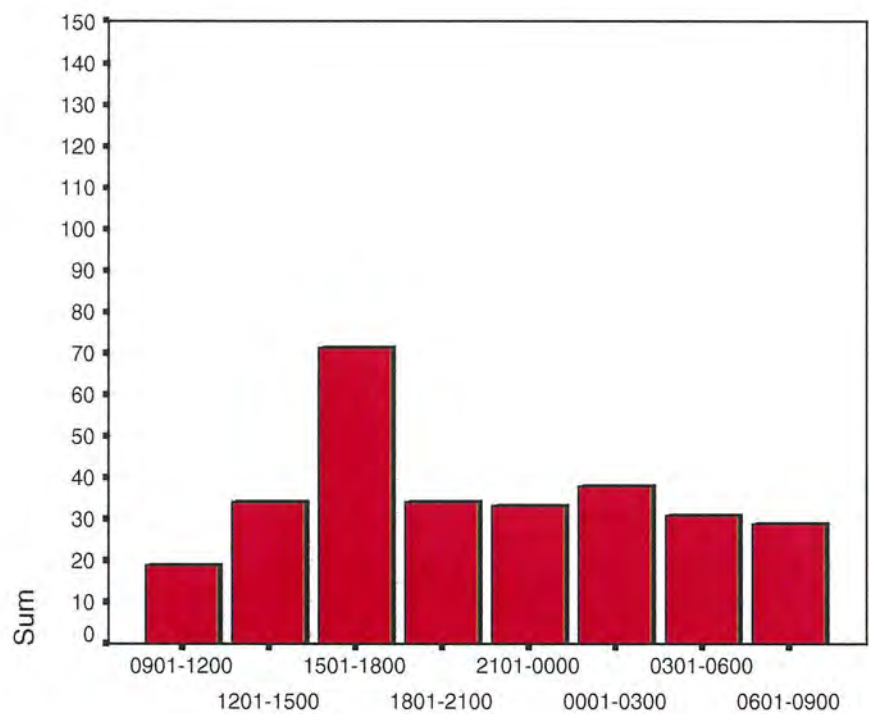


Figure No.18 Frequency of Fatigue in Time Periods for Air Transports

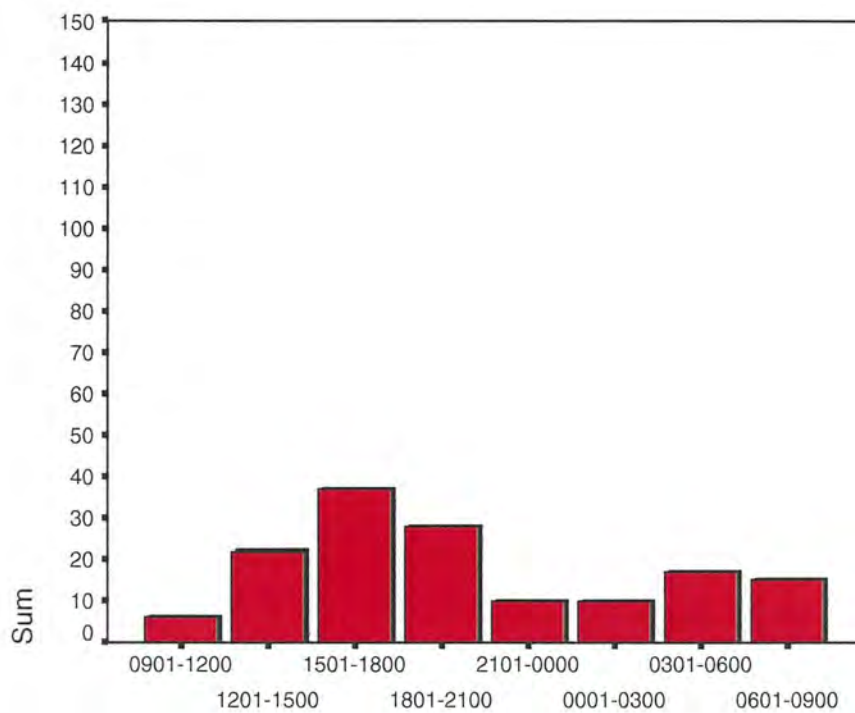


Figure No.19 Frequency of Fatigue in Time Periods for Road Transports

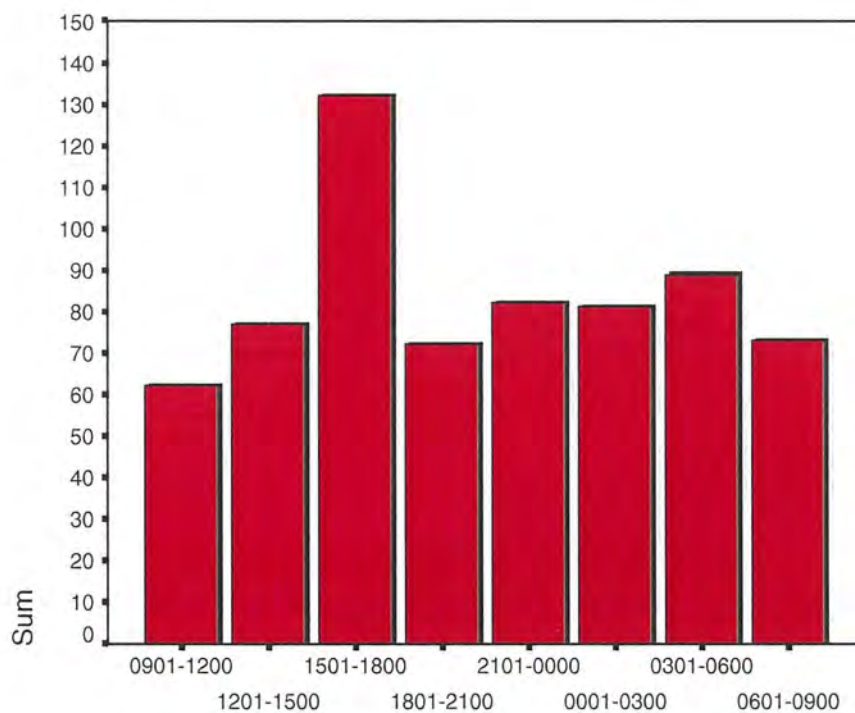


Figure No. 20 Frequency of Fatigue in Time Periods for Local Transports

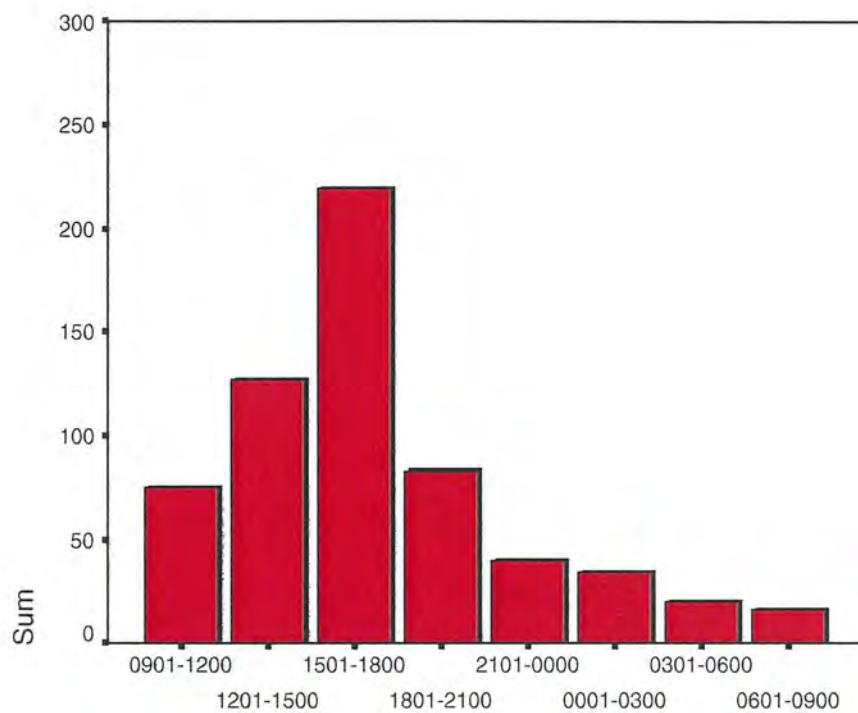


Figure No.21 Frequency of Fatigue in Time Periods for Day Shifts

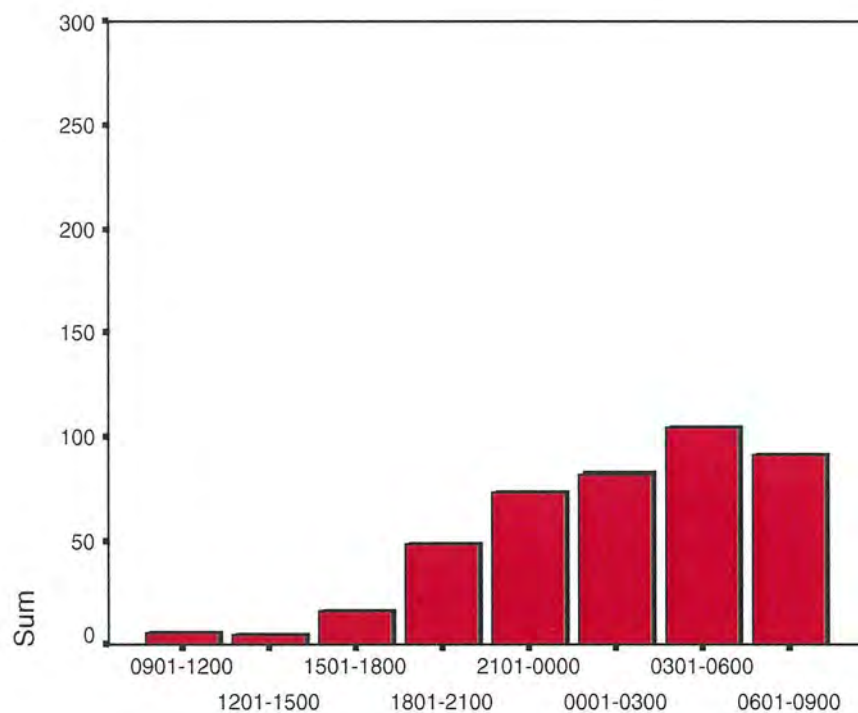


Figure No.22 Frequency of Fatigue in Time Periods for Night Shifts

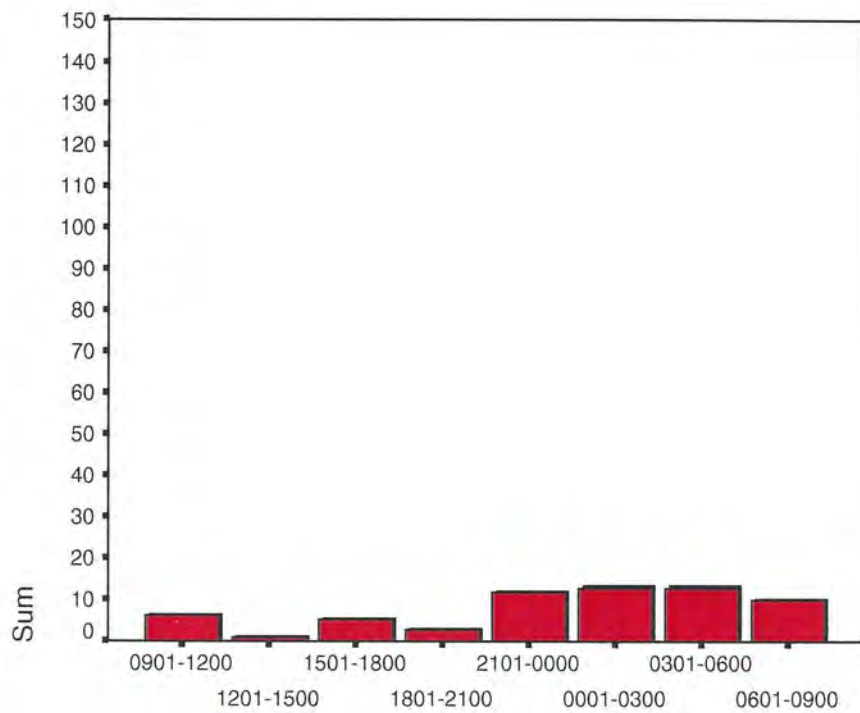


Figure No.23. Frequency of Fatigue in Time Periods for Overtime Shifts

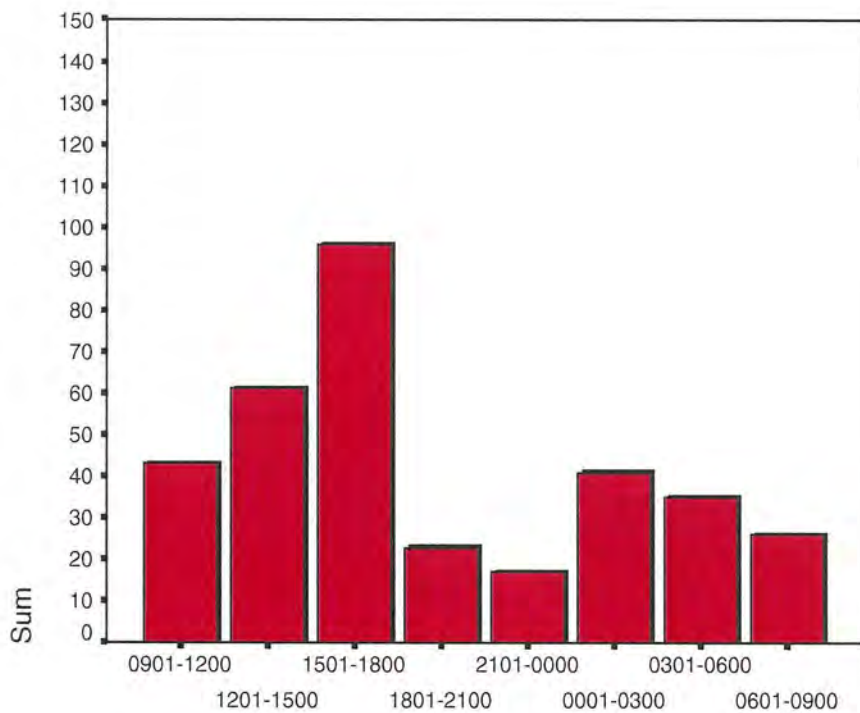


Figure No.24 Frequency of Fatigue in Time Periods for Call-outs

Question 6

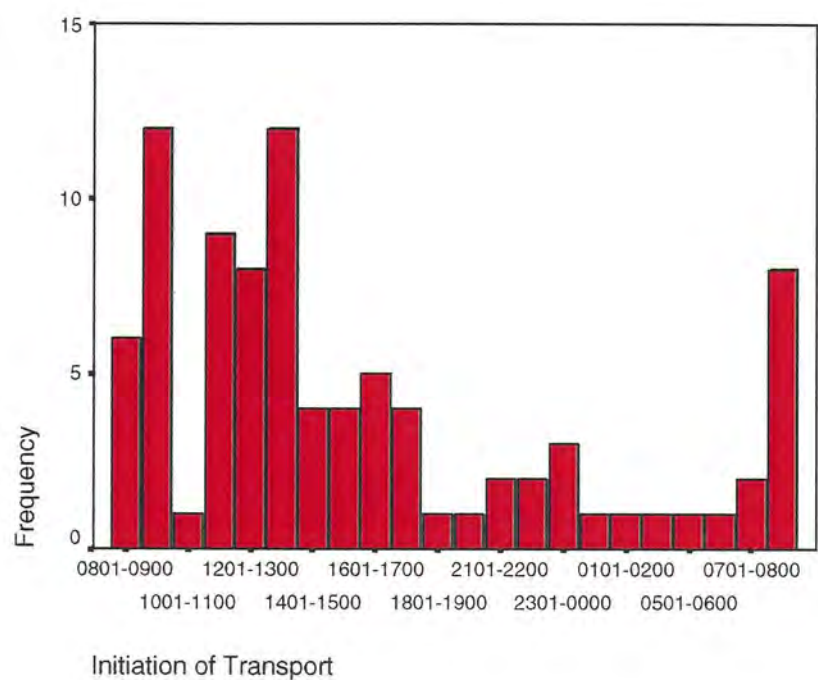


Figure No.25 Fatigue Determined by Proportion of Completed Shift
No Indication of Fatigue

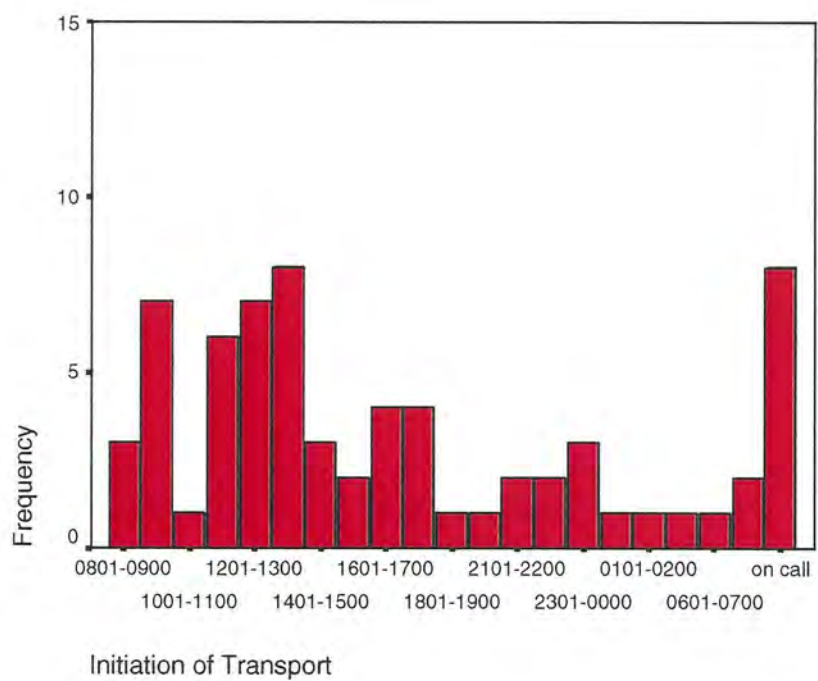


Figure No.26 Fatigue Determined by Proportion of Completed Shift
Indication of Fatigue

9.2 Appendix II. Summary of Literature Review

Table No.13
Summary of Literature Review

Author	Date	Main Findings
Arendt	2000	Strategies to combat fatigue
Blosser, National Institute of Safety and Health	1997	Day sleep is inferior to night sleep Fatigue induces a deterioration in performance and alertness Shift work decreases ability to obtain sleep
Bonnet	1999	Sleep inertia Strategies to combat fatigue
Brown	1997	Performance and Alertness trough between 0400-0600 hours Time of day influential in fatigue
Co, Gregory, Johnson and Rosekind	1999	Circadian Rhythm is a 24-hour period Education required to eliminate fatigue Fatigue experienced by the diversity of the group Fatigue induces a deterioration in performance and alertness Indicators of fatigue Performance and Alertness trough between 0300-0500 hours Performance and Alertness trough between 1500-1700 hours
Civil Aviation Safety Authority. Flight Time Limitations	1978	Hours of operation regulations Strategies to combat fatigue Time of day influential in fatigue
Civil Aviation Safety Authority. Human Factors in Manitenance	1999	Fatigue induces deterioration in performance and alertness Health concerns associated with shiftwork Identification of fatigue as an OH&S issue

Civil Aviation Safety Authority. Flight Safety Australia	2000	Fatigue induces deterioration in performance and alertness Strategies to combat fatigue
Civil Aviation Safety Authority. Aviation Safety Management	2000	Strategies to combat fatigue
Dawson (App. C)	1998	Circadian Rhythm is a 24-hour period Fatigue emanates from deficiencies in rest, sleep and circadian rhythms. Fatigue results in an increase in accidents Performance and Alertness trough between 0300-0700 hours Sleep debt results from inadequate sleep quality and duration Sleep is a balance between the Circadian Rhythm and the homeostatic drive for sleep Time of day influential in fatigue
Dawson (App. D)	1998	Circadian Rhythm is a 24-hour period Day sleep is inferior to night sleep. Fatigue emanates from deficiencies in rest, sleep and circadian rhythms. Rapid Rotational Shift Shift work decreases ability to obtain sleep 8-hour rest and 16-hour awake
Dawson, Fletcher & Hussey	1999	Correlation between degenerative affects of fatigue and alcohol Fatigue induces a change in mood and motivation Fatigue induces a deterioration in performance and alertness Management of Fatigue is not isolated to managers, it applies to the entire workplace Roster staff to accommodate lifestyle Sleep deprivation from change in workplace performance expectations Time of day influential in fatigue

Drivesafe, How to Avoid Fatigue	2000	Dangers of driving during normal sleep periods Indicators of fatigue
Fatigue and SAR	1995	Fatigue Management System
Federal Motor Carrier Safety Administration	1996	Circadian Rhythm is a 24-hour period Individuals are unable to sense fatigue development No correlation between age and fatigue No correlation between fatigue and 10 or 13 hours of operation Performance and Alertness trough between 0000-0600 hours Time of day influential in fatigue
Feyer	2001	Individuals are unable to sense fatigue development Time of day influential in fatigue Sleep debt accumulates from minimal amounts of sleep loss
Furlan et al	2000	Correlation between degenerative affects of fatigue and alcohol Fatigue induces deterioration in performance and alertness Fatigue results in an increase in accidents Health concerns associated with shiftwork
Grossman	1997	Circadian Rhythm is a 24-hour period Fatigue induces deterioration in performance and alertness 8-hour rest and 16-hour awake, individuals can experience confusion when altered
Hartley and Arnold	1996	Government has responsibility to address driver fatigue Time of day influential in fatigue, not duration in isolation

Haywood	1999	Fatigue induces deterioration in performance and alertness Fatigue results in an increase in accidents Individuals are unable to sense fatigue development Strategies to combat fatigue
Humm	2000	Identification of fatigue as OH&S issue Strategies to combat fatigue
Kroemer and Grandjean	1999	Fatigue emanates from deficiencies in rest, sleep and circadian rhythms. Fatigue is a culmination of events.
Lamberg	1999	Strategies to combat fatigue
Lavie	2001	Circadian Rhythm is a 24-hour period Day sleep is inferior to night sleep Fatigue induces deterioration in performance and alertness Sleep is a balance between the Circadian Rhythm and the homeostatic drive for sleep, plus the drive for wakefulness Social obligations impede day sleep
Learthart	2000	Fatigue induces deterioration in performance and alertness Health problems associated with shift work Identification of fatigue as an OH&S issue
New South Wales Government. Ambulance Service Award	1998	Hours of operation regulations
New South Wales Government. Public Hospitals Award	1995	Hours of operation regulations Strategies to combat fatigue

Olsen and Ambrogetti	1998	Fatigue induces deterioration in performance and alertness Sleep debt results from inadequate sleep quality and duration
Parker	2001	Fatigue induces deterioration in performance and alertness Strategies to combat fatigue
Queensland Government Ambulance Service Award	2000	Hours of operation regulations Strategies to combat fatigue
Rosekind, Gander, Gregory Smith, Miller, Oyung, Webbon and Johnson	1996	Circadian Rhythm is a 24-hour period Fatigue emanates from deficiencies in rest, sleep and circadian rhythms. Fatigue induces deterioration in performance and alertness On-call nurtures fatigue Performance and Alertness trough between 0300-0700 hours Performance and Alertness trough between 1500-1700 hours Performance and Alertness poor between 0000-0800 hours Sleep debt results from inadequate sleep quality and duration
Rosekind <i>et al</i>	1996	Fatigue Management System
Rosekind	2000	Circadian Rhythm is a 24-hour period Sleep debt results from inadequate sleep quality and duration Strategies to combat fatigue
Rossier	2001	Performance and Alertness trough between 0300-0500 hours Performance and Alertness trough between 1500-1700 hours Strategies to combat fatigue Time of day influential in fatigue Types of sleep requirement to achieve rest

Think Road Safety	2000	Performance and Alertness trough between 0000-0600 hours Performance and Alertness trough between 1400-1600 hours Strategies to combat fatigue Time of day influential in fatigue
Western Australian Government. Transport Authority	1998	Code of Practice for Fatigue Fatigue Management System
Zimmerman & Pierce	1999	Consider Endogenous Rhythm in roster design Roster staff to accommodate lifestyle Strategies to reduce fatigue

9.3 Appendix III. Fatigue Data Collection

Fatigue Data Collection

Identifier Code ___ Date __/__/__

Precipitators

Please enter "✓" in box or times as appearing on timesheet / casesheet

1. What shift have you just completed ?
- Off ☐
- 0800 ☐
- 1800 ☐
2. What was your total sleep obtained prior to start of shift? ____ hrs ____ mins
3. Was your sleep broken by callouts ?
- Yes ☐ 1 ____ hrs to ____ hrs
- No ☐ 2 ____ hrs to ____ hrs
- 3 ____ hrs to ____ hrs
- 4 ____ hrs to ____ hrs
- 5 ____ hrs to ____ hrs
4. Did you have trouble returning to sleep after the above calls ? *If yes, please circle.*
- Yes ☐ 1 2 3 4 &/or 5
- No ☐
5. Did you perform a helicopter case in this period?
- Yes ☐ 1 ____ hrs to ____ hrs
- No ☐ 2 ____ hrs to ____ hrs
- 3 ____ hrs to ____ hrs
- 4 ____ hrs to ____ hrs
6. Did you perform a road transport with greater than two hours continuous driving?
- Yes ☐ 1 ____ hrs to ____ hrs
- No ☐ 2 ____ hrs to ____ hrs
- Single ☐ 3 ____ hrs to ____ hrs
- 4 ____ hrs to ____ hrs

Indicators

Please enter number of occurrences in respective columns

	0901- 1200	1201- 1500	1501- 1800	1801- 2100	2101- 0000	0001- 0300	0301- 0600	0601- 0900
Dry/Sore/Irritated Eyes								
Feeling of Lethargy / Fatigue								
Diminished Cooperation Skills								
Intolerant or Short Tempered								
Poor Motivation & Apathy								
ConcentrationLapse/Daydream								
Miscalculations, Speedo's /Time								
Omissions / Errors in Treatment								
Tunnel Vision								
Misread Road Signs / Conditions								
Surprise at Being Overtaking								
Swerving on Road								
Fluctuating Vehicle Speed								

Please complete at end of each shift.

Return to A/O McKenna File, Thank you

9.4 Appendix IV. Fatigue Data Collection – Participant Information

Fatigue Data Collection

Participant Introduction Fatigue, Ambulance Perspectives in a comparative study between Air and Road transports

The data collected from this study will be the foundation for the thesis, “Fatigue, Ambulance Perspectives in a comparative study between Air and Road transports”.

The Study

Initiated by myself in consultation with supervisors from Edith Cowan University. The study is not associated with the any particular ambulance service , but the local Area Manager is aware of the study and has sanctioned Officer participation. The data obtained from the collection sheet, page 6 will not be available to anyone but the researcher, myself. The data which is obtained will be referred to until compilation of the thesis and then destroyed after a five year preservation period. Each participant in the study will have a unique identifier which makes no reference to the workplace or able to be identified by the employer. The unique identifier will then be correlated with another code which will only be deciphered by myself, to ensure confidentiality.

The Questionnaire

The questions in the precipitators section require ticks in boxes or times entered in the spaces provided. These entries are exactly the same as the call out times which are entered on your time sheet. That is, if you are called at 2311 hours and don’t sign off until 0439 then that is the entry that will be recorded in the number 1 field, irrespective of how many cases attended.

<u>Precipitators</u>	<u>Please enter "✓" in box or times as appearing on timesheet / casesheet</u>		
3. Was your sleep broken by callouts ?	Yes	<input checked="" type="checkbox"/>	1 2359 hrs to 0439 hrs
	No	<input type="checkbox"/>	2 ____ hrs to ____ hrs

The instances that require times to be entered which do not correlate with call outs, question 5 & 6, will need to be recorded as the time out until cleared from the case or arrive back at Station. That is, if you proceed from the station to pick up a patient from The Base Hospital at 0834 hours and do not arrive back at station until 1600 hours then that is recorded.

<u>Precipitators</u>	<u>Please enter "✓" in box or times as appearing on timesheet / casesheet</u>		
6. Did you perform a road transport of greater than 2 hrs	Yes	<input checked="" type="checkbox"/>	1 0834 hrs to 1600 hrs
continuous driving?	No	<input type="checkbox"/>	2 ____ hrs to ____ hrs

Should the Officers be required to perform another case, at 1536 hours before arriving at the station then the recorded time will be the on scene time of the next case, 1556 hours.

<u>Precipitators</u>	<u>Please enter "✓" in box or times as appearing on timesheet / casesheet</u>		
6. Did you perform a road transport of greater than 2 hrs	Yes	<input checked="" type="checkbox"/>	1 0834 hrs to 1556 hrs
continuous driving?	No	<input type="checkbox"/>	2 ____ hrs to ____ hrs

This data will give an indication of what factors have caused the fatigue. The indicators are the signs and symptoms that you can identify within yourself. These may be minor or subtle in nature but important to identify. The time frames are broken into 3 hour brackets and are used to identify periods that officers are most fatigued. This may indicate that officers are especially fatigued at 1600 hours when driving long distances. The number of occurrences is also important to record and reinforce the validity of the study. While poor motivation may only happen once in a day it will account for more than one bracket and can be recorded as a horizontal line between affected brackets.

Indicators *Please enter number of occurrences in respective columns*

	0901-1200	1201-1500	1501-1800	1801-2100	2101-0000	0001-0300	0301-0600	0601-0900
Poor Motivation and Apathy		-----	-----	----				

Omissions or errors in treatment when fatigued is common amongst all professions and ours is no different. The occurrence may be forgetting to do a BSL or putting the ECG lead on the wrong side. If both these occurred in the same time bracket, 1810 hours, the entry would be 2 in that bracket.

Indicators *Please enter number of occurrences in respective columns*

	0901-1200	1201-1500	1501-1800	1801-2100	2101-0000	0001-0300	0301-0600	0601-0900
Omissions / Errors in Treatment				2				

The nature of fatigue also makes individuals lethargic, apathetic and non-conformist which may make it difficult to complete the data collection sheet.

Your Incentive

While data collected will be dependant on this workplace, the study is entirely independent of the Ambulance Service. The information will be the first time a study of this nature has been undertaken and it is crucial that it is accurate. Results from this study once published will be available for examination to critically evaluate the validity of the results and recommendations. Fatigue has been identified in shift work, medicine, road and air transport. It is my intention to provide evidence that due to the nature of Ambulance Officers duties the effects of fatigue are compounded.

This study may then be used as an aid in initiating improved working conditions especially in long distance road and air transports.

Your Commitment

The Study is entirely voluntary and does involve considerable input from the participants. You will be asked to complete a questionnaire at the completion of each shift, which is equivalent to 42 over a 3 month period. I would expect as the study progresses the completion of the form will take very little time at all, while in the initial stages I would envisage you spending 4-5 minutes at completion of the shift. Some details, as in the recording of call outs from the previous night could be completed prior to completion of shift.

Should you have any questions, difficulties or hesitancy about the study, please call me.

My Appreciation

Realising the inconvenience that will be involved in having to complete the questionnaire I will, as a sign of my appreciation for you assisting me, provide 2 cartons of Crown Larger to be raffled at the completion of the study. Those who have participated in the study for the entire 3 months will receive one of 16 tickets.

Your Consent

The study is dependant upon Officers to volunteer information and time to provide viable data. To use this data I must obtain your consent. Should you choose to participate in the study could complete the attached consent form and sleep pattern information. Upon completion of this form could you please return it to my file, thank you.

Contacts

*Any questions concerning the project entitled, **Fatigue, Ambulance Perspectives in a Comparative study between Air and Road Transports** can be directed to Wayne M'Kenna, Masters student of Edith Cowan University on*

If you have any concerns about the project or you would like to talk to an independent person, you may contact the supervisor, Nicole Mcleod, Edith Cowan University on

Consent Form **Fatigue, Ambulance Perspectives in a comparative study between Air & Road transports**

Ihave read the information above and any question I have asked has been answered.

I agree to participate in the study, realising that I may withdraw at any time.

I agree that the research data gathered for this study is confidential, but the results may be published provided I am not identifiable.

Participant SignatureDate.....

Investigator SignatureDate.....

Participant Data

Could you please enter the sleep which you have had in the corresponding periods on your roster. This will provide me with a benchmark to measure the effects of sleep deprivation due to call-outs.

Off	Off	Off	Off	0800	0800	0800	1800	Off	Off	Off	Off	0800	0800
minutes		minutes	minutes						minutes	minutes			

The Study Commences here --/07/00 ↑

Thank you for your assistance

CHAPTER 10

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