UNIVERSITI SAINS MALAYSIA

UNIVERSITI SAINS MALAYSIA

A STUDY OF FATIGUE AMONG NURSES IN HOSPITAL UNIVERSITI SAINS MALAYSIA (HUSM)

by

FARAH NAFEESHA BINTI MOHAMED RASELI

Dissertation submitted in partial fulfillment of the requirements for the degree of Bachelor of Health Sciences (Environmental and Occupational Health)

June 2012

CERTIFICATE

This is to certify that the dissertation entitled 'A study of Fatigue among Nurses in Hospital Universiti Sains Malaysia (HUSM)' is the bonafide record of research work done by Farah Nafeesha Binti Mohamed Raseli, Matric Number 103155 during the period of November 2011 to May 2012 under my supervision. This dissertation submitted in partial fulfillment for the degree of Bachelor of Health Sciences (Environmental and Occupational Health). Research work and collection of data belong to Universiti Sains Malaysia.

ABSTRAK

Kajian ini dijalankan untuk mengkaji mengenai keletihan pekerjaan yang dialami oleh jururawat di Hospital Universiti Sains Malaysia (HUSM). Objektif khusus kajian ini adalah untuk mendapatkan prevalens keletihan pekerjaan dalam kalangan jururawat. Kajian ini juga bertujuan untuk mencari hubungan antara keletihan dengan data pekerjaan serta untuk menentukan faktor risiko tertinggi yang menyebabkan keletihan. Responden kajian terdiri daripada semua jururawat sebagai satu kumpulan utama dalam perkhidmatan kesihatan di Hospital Universiti Sains Malaysia (HUSM), Kelantan. Seramai 219 responden telah dipilih secara rawak dari wad, klinik dan makmal untuk mengambil bahagian dalam kajian ini. Soal selidik telah digunakan untuk mengumpul data kajian dan kemudian dianalisis menggunakan 'Statistical Package for the Social Sciences' (SPSS).

Hasil analisis tersebut mendapati bahawa prevalens responden yang mempunyai keletihan tinggi adalah 56.4% manakala untuk keletihan rendah adalah 43.6% dan ini menunjukkan bahawa prevalens responden mempunyai keletihan tinggi adalah lebih banyak. Hasil kajian mendapati wujudnya hubungan antara pengalaman kerja dengan keletihan apabila nilai p adalah 0.043. Sementara itu, didapati tiada perkaitan antara tempat kerja dan keletihan apabila p-nilai adalah lebih besar daripada 0.05. Hasil kajian ini juga menunjukkan bahawa tiada perkaitan antara bekerja dalam syif dan keletihan. Bahagian akhir kajian ini telah menentukan lima faktor risiko tertinggi yang menyebabkan keletihan iaitu kekurangan tenaga jururawat, tekanan kerja, beban kerja berlebihan, tabiat tidur yang tidak betul dan harapan/permintaan yang tinggi daripada pesakit dan keluarga.

ABSTRACT

This research was conducted to study on occupational fatigue experienced by nurses in Hospital Universiti Sains Malaysia (HUSM). The specific objective was to obtain the prevalence of occupational fatigue among nurses. This research also aimed to find the relationship between fatigue with employment data and also to determine the highest risk factor that cause fatigue. The respondents of the study were consisting of all nurses as a major group in healthcare services in Hospital Universiti Sains Malaysia (HUSM), Kelantan. 219 respondents have been selected randomly from ward, clinic and laboratory participated in this study. Questionnaires were used to collect field data and then analyze using Statistical Package for the Social Sciences (SPSS).

From the analysis, it was found that prevalence of respondents having high fatigue is 56.4% while as for low fatigue is 43.6% and this showed that the prevalence of respondents having high fatigue is great. The result indicated the existence of correlations between working experience with fatigue represented p-value which is 0.043. Meanwhile, there is no association between work location and fatigue as the p-values are greater than 0.05. The result of this research also shows that no association between working in shift and fatigue. Last part of this study has determined five highest risk factors contributing fatigue which are; nurses shorthanded, work stress, excessive workload, improper sleep habits and high expectations/demands from patients and families.

ACKNOWLEDGEMENT

First and foremost, I thank God Almighty for the love and strength for me to overcome the hurdles and predicament in life and made me what I am today. To my supervisor, Ms Faridah Bt Naim from the bottom of my heart, thank you for your encouragement, guidance, critics and concerns. You have inspired me in many ways. You made me realize that everything is possible. Thank you for being a great teacher to me.

I dedicate this thesis to my father, Mohamed Raseli Bin Hashim who gave me the ambition to reach for the stars and the opportunity to do whatever I wanted to do. Special thanks to my beloved mother, Wan Maznun Bt Wan Yahya for her relentless support, for loving and helping me and always being there for me. Also to my siblings, you have refreshed me, comforted me and being by my side, all the way discovering my true self. I love you all so much.

To my friends, thank you for a beautiful friendship. It was a bitter sweet experience and I hope it will last forever. Last but not least, to everyone who participates and contributes directly or indirectly in completing this study, your kindness means a lot to me. Thank you very much.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

NOMENCLATURE

Abbreviation

α	-	Cronbach's Alpha
M	-	Mean
Σ	-	Standard Deviation
>	-	More than
%	-	Percent
g	-	Gram
$	-	Dolar
ANOVA	-	Analysis of Varians
AORN	-	Association of periOperative Registered Nurses
CCOHS	-	Canadian Centre for Occupational Health and Safety
CFS	-	Chronic Fatigue Syndrome
CNA	-	Canadian Nurse Association
HUSM	-	Hospital Universiti Sains Malaysia
ICU	-	Intensive Care Unit
IMO	-	International Marine Organisation
OSHA 1994	-	Occupational Safety and Health Act 1994
SPSS	-	Statistical Package for the Social Sciences
WHO	-	World Health Organization

CHAPTER 1

INTRODUCTION

1.1 Background Information

Nurses are considered as the backbone of the health care industry and they have many job duties. A nurse is required to multitask all the time as well as be ready for anything at anytime (Weeney, 2011). However, at the same time nurses are also exposed to many health risks due to their work of practice such as fatigue, stress, lower back pain and others. Fatigue is one of the major complaints in primary care settings among nurses (Bates *et al.,* 1993). It is possibly can be obtained by nurses which can disrupt their job performance.

Occupational fatigue is defined as lassitude or exhaustion of mental and physical strength resulting from bodily labour or mental exertion which becomes a concern among workers in many occupations throughout the world (Matthew, 2010). Nurse fatigue can be defined as a subjective feeling of tiredness (experienced by nurses) that is physically and mentally penetrative. It ranges from tiredness to exhaustion, creating an unrelenting overall condition that interferes with individuals' physical and cognitive ability to function to their normal capacity. It is multidimensional in both its causes and manifestations; it is influenced by many factors: physiological (e.g., circadian rhythms), psychological (e.g., stress, alertness, sleepiness), behavioural (e.g., pattern of work, sleep habits) and environmental (e.g., work demand). Its experience involves some combination of features include physical (e.g., sleepiness) and psychological (e.g. compassion fatigue and emotional exhaustion). It may significantly interfere with

functioning and may persist despite periods of rest (Canadian Nurse Association and Registeres Nurse Association [CAN and RNA] , 2010).

Nurse fatigue may affect everyone in the hospital. A fatigued nurse is more likely to make errors in their work. They are more likely to have accidents on and off the job. They are really a danger to themselves and everyone around them (Weeney, 2011). In nurses or mixed nursing personnel, fatigue has been associated with shift work schedule and long working hours, as well as high demands, low autonomy, and low social support at work (Josten *et al.,* 2003).

Signs and symptoms of fatigue include; tiredness, sleepiness, including falling asleep against an individual's will ("micro" sleeps), irritability, depression, giddiness, loss of appetite, digestive problems, and increased susceptibility to illness (Canadian Centre for Occupational Health and Safety [CCOHS], 2007).

According to Patriko (2006), fatigue is hard to define and measure. Many issues can be incorporated with fatigue such as work, boredom, circadian rhythms and the quality and quantity of rest. It becomes more prevalent when lack of rest and fatigue can be accumulated and cause long-term fatigue even within recommended working hours.

The causes of fatigue might be any or all of the following such as lack of sleep, disruptive work or rest cycles, neurological conditions, excess mental or physical workload, exposure to extreme physical conditions, emotional stress, the use of drugs or alcohol, illness, and/or monotony (Boardman, 2007). However, lack of sleep, poor quality of rest, stress and excessive workload would be most common causes of fatigue

among nursing personnel. There are many other contributors as well, and each will vary depending on the circumstance (e.g. workplace factors and environmental) (International Marine Organisation [IMO], 2001).

1.2 Problem Statement

Fatigue has been shown to be a factor in work errors. Since nurses are major workforce in assisting the health care industry, they have high possibility to have fatigue. Because of fatigue cascades to other undesirable outcomes such as medication errors, degradation in performance, decreased mental acuity, personal problems and others, it can be considered as a critical issue for nurses (Jones *et al.* 2011). CNA and RNA (2010) declares that factors in today's health system environment contribute to nurse fatigue are including increased worker stress, increased workload, understaffing, increasing expectations from patients and families, high levels of patient acuity, unexpected emergencies with staffing or patients, sensory overload, functionally disorganized workplaces, and relentless change within the workplace.

Nurses are more susceptible to Chronic Fatigue Syndrome (CFS) because stress from excessive workload is the primary cause. Nurses assigned to rotating shifts are more prone to greater health problems than workers on permanent shifts, regardless of the time of day of the permanent shifts (Anita and Dalip, 2010). This study can promote awareness and understanding of fatigue among nurses at Hospital Universiti Sains Malaysia (HUSM) that may lead CFS. Since HUSM is one of the research hospital in Malaysia, the cases of patient care might be high. The increasing of duties and task might be the factors of fatigue among the nurses. The result of fatigue prevalence among

HUSM nurses can be analyzed to know the trend of the case. Recommendation can be also provided to overcome fatigue. Nurses with fatigue could increase the number of incidents and errors in their practice. Consequently, a healthy work environment can be provided.

1.3 Significance of the Study

The significance of this study is to help management bring assessment to improve awareness and understanding that nurses are at risk for fatigue and may lead to CFS. Besides, this study provides recommendation to manage and overcome fatigue. Other significance is to promote a healthy work environment in HUSM especially in wards and clinics. This study is important because nurses have the potential to develop fatigue which also can harm the patients and people at hospital, therefore this study is important for everyone.

1.4 Objectives of the Study

1.4.1 General objective

The general objective is to study on occupational fatigue experienced by nurses in Hospital Universiti Sains Malaysia (HUSM).

1.4.2 Specific objectives

1. To obtain the prevalence of occupational fatigue among nurses.
2. To find the relationship between fatigue with employment data.
3. To determine the highest risk factors of fatigue among nurses.

1.5 Hypothesis of the Study

H_0: There is no association between fatigue and employment data ($\mu_1 = \mu_2$).

H_a: There is an association between fatigue and employment data ($\mu_1 \neq \mu_2$).

1.6 Thesis Organization

This report consists of six main chapters where each chapter will focus on the relevant topics as follows:

Chapter 1

Chapter 1 describes the background of the study will be elaborated briefly. The objectives and the scope of this study also will be stated clearly in this chapter.

Chapter 2

For the purpose of understanding and knowing on the topic of the project in details, this chapter will focus on theoretical and any findings which related to the research topic. This chapter constitutes a literature review of related issues of fatigue including definition, concept, effect, sources and measurement can be read in this chapter. For better understanding, there are also a lot of information related to nursing practices and information on science of sleep, circadian rhythms and fatigue in this chapter.

Chapter 3

This chapter presents the details of the research methodology where will be focused on the processes of executing the project or study from drafting the questionnaires, data

collection, result processing and method of analysis. At the end of this chapter, the analysis of pilot study also will be presented.

Chapter 4

In chapter 4, the final result where the evidence of the sources of fatigue is shown. The details of analysis of the data and result will be presented in details. All the figures, tables and chart which represent the analysis of the data will be shown and the details description of the analysis will be given clearly in this chapter.

Chapter 5

Chapter 5 discusses the result which shown in previous chapter in detail. The discussion to be made based on the result obtained in chapter 4. The arguments and evidences on the results also will be discussed further in this chapter as well.

Chapter 6

Chapter 6 presents the overall conclusion and some recommendations for future research. This chapter will formulate the findings and the objectives of the project. At first, the objectives of the project will be reviewed and conclusions will be made based on the outcomes of study. To reinforce the outcome of this project, some recommendations were made at the end of this chapter where the proposed future studies to be carried out.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction to Fatigue

Fatigue is defined as "a state of tiredness associated with extended periods of being awake and consequently being without sleep" (Pigeon *et al.*, 2003).

'Fatigue' is a generic term used to encompass a range of experiences described as anything from 'sleepy,' 'tired,' or 'exhausted' to 'beat'. Sleep loss and circadian rhythm disruption are two major physiological phenomenons that have clearly been demonstrated to create 'fatigue' (Transportation Safety Board of Canada, 1997).

According to International Maritime Organization (2001), there is no universally accepted technical definition for fatigue. However, general to all the definitions is degradation of human performance.

IMO (2001) defined fatigue as a reduction in physical and/or mental capability as the result of physical, mental or emotional exertion which may impair nearly all physical abilities including: strength; speed; reaction time; coordination; decision making; or balance.

Mann (1999) stated that "rather than simply being a mental state that can be willed away or overcome through motivation or discipline, fatigue is rooted in physiological mechanisms related to sleep, sleep loss, and circadian rhythms." Three core physiological factors identified by Mann that contribute to fatigue are cumulative sleep loss, continuous hours of wakefulness, and circadian time of day. These three attributes

occur in many health occupations when individuals require being awake and alert during the night and sleeping during the day due to work long hours, work shifts and lessen the total amount of sleep.

According to the Patraiko (2006), a simple definition of fatigue could be long hours plus stress. The nursing profession has traditionally required long hours to be worked and this may give high potential to the nurses to experience fatigue.

The National Sleep Foundation (2007) have identified that women consider getting enough sleep one of their lowest priorities. The nature of the work itself may influence the increasing of fatigue. Greater fatigue might be felt by those who work with many physical demands at the end of a work shift.

Furthermore, fatigue have same characteristic with burnout which experienced as totally physically and mentally penetrative, different from all other kinds of tiredness, and impossible to "sleep off," and caused by a long-lasting process in which energy is successively drained (Ekstedt and Fagerberg, 2005). Physical and mental exhaustion terms are the result of fatigue frequently measurement (Dorrian *et al.,* 2006) which includes of staying awake or falling asleep (Scott *et al.,* 2006); and alertness, stress and sleepiness (McClelland, 2007). Fatigue may cause symptoms such as increased anxiety, decreased short-term memory, slowed reaction time, decreased work efficiency, increased variability in work performance and increased errors of omission (Kenyon *et al.,* 2007).

The core symptoms of acute fatigue are usually recognized as these three outcomes which are subjective perceptions, performance and physiological change. This has been

done by the reporting of fatigue and the objective outcomes then assessed. The prevalence of fatigue estimated is vary depending on which aspect of the fatigue process that uses as the indicator of fatigue. For example, one might simply use the number of workers doing shift work as an indicator of prevalence if one assumes that doing shift work is a risk factor for fatigue (Mukhtar, 2009).

However, Mukhtar (2009) also states that, this is based on the assumption that fatigue automatically caused by shift work which one finding is not always the case. Similarly, the measurement of fatigue is by the presence of negative outcomes, but the extent of the problem will often depend on the indicator chosen. All aspects of the fatigue process must be assessed and considered as there is no single "right" approach.

The lack of free time at work to refresh oneself, resulting in physical fatigue, sleep and mental fatigue were described as an accumulated fatigue factor (Kudo *et al.,* 2008). When one knows the signs, symptoms and causes of fatigue; sleep physiology and circadian rhythms; sleep hygiene; and preventive strategies for combating fatigue, it can be described as "managing fatigue" (Grogan *et al.,* 2004).

The definition of chronic fatigue in shift workers is stated as "a general tiredness and lack of energy irrespective of whether an individual has not had enough sleep or has been working hard, which persists even on rest days and holidays" (Barton *et al.,*1995). In contrast to the localized sensation of acute fatigue, chronic fatigue has a gradual, insidious onset and a long duration that persists a month or more, which is a global mind-body sensation, perceived without relation to activity or exertion.

Different kinds of fatigue can be conceived by one, such as local physical fatigue (e.g. in a skeletal muscle), general physical fatigue, mental fatigue (e.g. following sustained attention due to a long-lasting high mental workload) or "central nervous" fatigue (sleepiness). Thus, fatigue is often considered to be a generic term of which sleepiness is one of the major sub-components. In a driving context, sleepiness and mental fatigue are the most relevant fatigue components.

2.2 Concept of Fatigue

Underlying this project is a conceptualization of fatigue as a process. This process starts with risk factors for fatigue (e.g. work characteristics and conditions associated with fatigue), next moves on to subjective perceptions of fatigue (e.g. how and when an individual experiences and reports fatigue), and the consequences of fatigue both in the short (symptoms of fatigue such as loss of concentration) and longer term (e.g. ill health) are concluded. This process approach has been suggested elsewhere in relation to work characteristics, fatigue and ill health, and is analogous to the approach to stress widely used in studies of the general working population. The fatigues in this way are approached by the work described in this process (Smith *et al.*, 2006).

The fatigue measures of both subjective and objective were used, and then have been compared. However, in terms of health, only subjective measures were possible as the nurses identified at their medicals as having any illness or condition which cannot perform work at their best. The World Health Organization (WHO) defines health as "a state of complete physical, mental and social well-being and not merely the absence of

disease or infirmity" (WHO, 1948). The measures used in this research fit within this definition of health, and in this report the term "health" has been used in this WHO defined sense. Furthermore, clear findings supports this focus on perceived ill health and well being by showing that reduced psychological well being can increase the risk of some physical illness (Smith *et al.*, 2006).

2.3 Contributing Factors to Fatigue

According to Schaffner (2006), 809 nurses identified in a study on the antecedents and consequences of perceived fatigue, with the following factors that contributed to fatigue which are sleep disturbance (snoring and night sweats), lack of exercise, home environment (window shade and bed surface), support (peer support and family support), work schedule (working more than 40 hours per week and on-call) and work environment (work 12-hours shifts, work more than 12-hours/day, work more than three 12-hours shifts in a row, rotating shifts and work 8-hours shifts).

The categorization of the fatigue causes can be in many ways. They have been categorized into four general factors in order to ensure thoroughness and to provide good coverage of most causes, which include work-specific factors, management factors, workplace-specific factors and environmental factors.

2.3.1 Work-specific Factors

A nurse's lifestyle behavior and habits, workloads and individual attributes are related to the work-specific factors. However, fatigue varies from one person to another and have often dependent of its effects on the particular activity being performed. The work-specific factors include the following:

a) Shift Works

In the key informant interviews and focus groups by nurses, the 12-hour shift and shift work were also identified as key contributing factors to fatigue in nursing. A study by Stone *et al.* (2006) found that nurses who are working 12-hour shifts experienced less emotional exhaustion than nurses working 8-hour shifts. On the other hand, other research involving critical care nurses found nurses who worked more than 12.5 consecutive hours may cause more prevalent of drowsiness and sleep episodes.

Besides, Scott *et al.* (2006) found that the risk of falling asleep at work almost doubled when shifts exceeded 8 hour and increased even more when shifts exceeded 12 or more consecutive hours. These findings were consistent with a broader study of hospital staff nurses by Rogers *et al.,* (2004) who sought to determine if there was an association between working hours and frequency of errors. They found that nurses who worked lasting 12.5 hours or longer were more likely to make three times more errors. Other consequences of 12.5-hour or longer shifts reported in this study included increased tendency to fall asleep, lapses in vigilance, decreased alertness, inability to stay focused, reduced motivation, compromised problem-solving, irritability, unusual tenseness, memory lapses, faulty information processing, diminished reaction time, indifference and loss of empathy and a tendency to make errors in repetitive tasks (Kenyon *et al.,*

2007; McClelland, 2007; Scott *et al.*, 2006). In a study examining the association between mental health and work outcomes among 4,279 female nurses in Japan, Suzuki *et al.* (2004) observed that between nurses who worked in night shift and those who worked irregular shifts are more likely to commit medical errors.

By identifying the structures and processes that facilitate and constrain nurses and agencies from safety in in-patient perinatal settings using grounded theory, Lyndon (2007) reported that the twelve nurses, five doctors and two nurse midwives studied attributed physical fatigue to working long shifts, rotating shifts and night shifts. Based on the result, mental fatigue was attributed to an overwhelming level of stimulation in the work environment especially during the day shift. The participants also reported that fatigue was increasingly difficult to manage with increasing age. In a study with 41 nurses, Dorrian *et al.* (2008) examined the relationship between sleep, work hours, sleepiness, stress, errors, near errors and observed errors of others. Thus, they found that the nurses struggle to remain awake to be the primary predictor of errors.

b) Improper Work Practices

Ergonomic problems can be contributed due to improper work practices when handling patients or working. IMO (2011) states that the following points must be considered when analyzing a specific job for improper work practices:

i. weight of objects being handled such as holding up the patients;
ii. proper handling of sharp object/instruments;
iii. body positions of nurses while working;
iv. repetitions of certain movements or tasks; and
v. how workers grip objects.

c) Work Stress

Causes of stress are including personal problems (family), problems with other colleagues, patients, long work hours and work in general. A build up of stress will cause or increase fatigue (IMO, 2001).

d) Excessive Workload

Fatigue can be also caused by working consistently "heavy" workloads. According to IMO (2001) workload is considered are heavy work when one works excessive hours or performs stressful tasks in achieving physically or mentally demanding.

e) Inadequate Rest

Rest can be defined as taking a break between work periods. This can restore one's performance levels. IMO (2001) states that fatigue occur due to insufficient rest periods or postponing assigned rest times.

f) Improper Sleep Habit

Poor quality of sleep is one of fatigue factors. This occurs when without any interruptions, someone is unable to sleep and/or he are unable to fall asleep when his body tells him to. Improper sleep habit also may cause by shift work. Sleep can maintain and restore the performance level. Fatigue will set in and alertness will be impaired if someone does not get enough sleep (IMO, 2001).

2.3.2 Management Factors

The management factors are related to how the organizations are managed and operated. These factors can potentially cause stress and increase workload. Some of the factors are including of hospital policies and retention, role and responsibilities of nurses, working schedules for shift and breaks and ward/clinic culture and management style.

2.3.3 Workplace-specific Factors

Workplace design features is one of the examples of workplace-specific factors that can be also cause fatigue. It can affect workload (e.g. shorthanded and high expectation) and functionally disorganised workplace factors which decrease the nurses' ability to perform work well. The workplace-specific factors are including nurses shorthanded, high expectations or demands from patients and families and functionally disorganized workplace (ward, clinic or laboratories).

2.3.4 Environmental Factors

Environmental factors can be categorized as extreme temperature, humidity and excessive noise levels. Ward, clinics and laboratories that exposed to excess levels of these factors may consider as an uncomfortable workplace environment and directly can cause fatigue to nurses. This can give harm to a nurse's health due to long-term exposure to the factors. Based on IMO (2001), environmental factors also may produce physical discomfort as they can contribute to the disruption of sleep.

2.4 Effect of Fatigue on Job Performance

There are deleterious effects on all types of job performance caused by fatigue. Dowson and Zee (2005) identified that there are some negative effects of fatigue on alertness, vigilance, concentration, judgment, mood, and performance. According to Ellis (2008), while resident physicians work different types of shifts than nurses, the cumulative effects of work hours for physicians in training alert others to potential concerns for nurses who end up working long hours and have multiple shifts.

Besides, Kahol *et al.* (2008) also studied the effects of fatigue on the cognitive and psychomotor skills of surgical residents. Result found that there is significant decrease in memory, attention and coordination tasks when residents were in a post-call situation where they were identified as being fatigued. This can also applied to the nurses since the working hour are almost similar. Fatigue and sleep deprivation can give negative impacts to cognitive and psychomotor skills. According to the study of resident physicians (Arnedt *et al.*, 2005) a rotation of heavy call in which the individual worked an average of 80 to 90 hours per week with 34 to 35 consecutive hours of work every fourth or fifth day when on call resulted in decreases in attention, vigilance, and simulated driving similar to that from a blood alcohol concentration of 0.04 to 0.05g%. Regarding this, the researchers suggest that chronic partial sleep loss imposed upon acute sleep loss is at least partially responsible for this effect.

In 2005, the Association of periOperative Registered Nurses (AORN) surveyed its members regarding on-call hours and effects. Based on the result, 77% among respondents routinely took call, 68% said they had experienced sleep deprivation, 58%

reported feeling unsafe while delivering patient care, and 13% reported making patient-care mistakes related to their fatigue (Kenyon *et al.*, 2007). Furthermore, Muecke (2005) published a study to review the impact of fatigue on nurses which working in critical-care environments. Disturbance of circadian rhythm, physical and psychological issues, or disruption to family life are including in the fatigue problems categorization. The study described that a condition occurs when a person experiences a decreased amount of sleep for multiple days is sleep debt.

Study carried out by The Minnesota Nurses Association (2007) found that nurses are three times more likely to make errors if they work more than 12 hours per day or 60 hours per week. Besides making medical errors, nurses who work longer shifts experience more neck, shoulder, and back injuries compared to nurses who work eight hour shifts. The Arizona Nurses Association (2007) indicated physiological changes that caused by fatigue including impaired concentration, slowed reaction time and reduced problem-solving abilities.

Fatigue also can affect mind, emotions and body and recognisation may found some of these changes in others:

2.4.1 Physical

According to IMO (2001) the following is a sample of fatigue's known effect on physical aspect:

i. Inability to stay awake
ii. Difficulty with hand-eye coordination skills
iii. Speech difficulties

iv. Heaviness in the arms and legs or sluggish feeling

v. Decreased ability to exert force while lifting, pushing or pulling

vi. Increased frequency of dropping objects like tools or parts

vii. Non-specific physical discomfort

viii. Headaches

ix. Heart palpitations / irregular heart beats

x. Rapid breathing

xi. Loss of appetite

xii. Insomnia

xiii. Sudden sweating fits

xiv. Leg pains or cramps

xv. Digestion problems

2.4.2 Emotional

Fatigue's known effect on emotional are including increased willingness to take risks during performing task, increased intolerance and anti-social behavior among colleagues, needless worry, reduced motivation to work well and increased mood changes (IMO, 2001).

2.4.3 Mental

Fatigue's known effect on mental are including poor judgement of distance, speed and time, inaccurate interpretation of a situation, slow or no response to normal, reduced attention span and difficult to concentrate and think clearly to make decision (IMO, 2001).

2.4.4 Performance

According to IMO (2001) fatigue can also affect one's performance such as:

i. Individuals who experiencing fatigue become more susceptible to errors of attention and memory.

ii. Individuals who experiencing chronic fatigue will often select decision that have a high degree of risk on the basis that required less effort to execute.

iii. Fatigue can affect an individual's ability to respond to stimuli, perceive stimuli, interpret or understand stimuli. It can take longer to react to them once they have been identified.

iv. Fatigue also affects problem solving which is an integral part of handling new or novel tasks.

A person's performance can be affected by fatigue and it may reduce individual and others effectiveness and efficiency such as decrease productivity, lower standards of work and may lead to errors while working. It will remain long after the period of sustained attention and directly posing a hazard to patient's safety if steps are not being taken to alleviate the fatigue (IMO, 2001).

IMO (2001) also stated that excessive work hours and fatigue can result in negative effects such as increased accident and fatality rates, poor quality and disrupted sleep patterns, higher frequency of cardiovascular, respiratory or digestive disorders and also loss of appetite.

2.5 Science of Sleep, Circadian Rhythms, and Fatigue

Lerman *et al.* (2012) stated that insufficient sleep and disruptions in normal sleep cycle are two key contributors to fatigue. A person will have several cyclic sleep stages which contain about 90 minutes in length in each cycle during each sleep period. Fatigue can be lead if there is a disruption of the sleep cycle by shortening or even eliminating some stages. Electroencephalography is used to identify and evaluate sleep stages. There are five basic sleep stages with stages one to four comprising non-rapid eye movement sleep, and stage five rapid eye movement sleep. To be fully alert, most individuals require between seven and eight hours of sleep per night.

When considering health, safety and productivity, individual's intrinsic circadian rhythm sleep is also important as duration and quality of sleep (Lerman *et al.*, 2012). Humans operate on a daily cycle which known as circadian rhythm that is generated from within the suprachiasmatic nucleus and is generally slightly longer than 24 hours, but can vary to every individual. At night, sleep drive increases late and reaches a peak in the early morning hours (Czeisler and Gooley, 2007). In the early to mid afternoon, there is also a small increase in sleepiness. The circadian rhythm showing is described on Figure 2.1 when sleepiness tends to be at its peak and nadir (International Petroleum Industry Environmental Conservation Association/ International Association of Oil and Gas Producers, 2007).

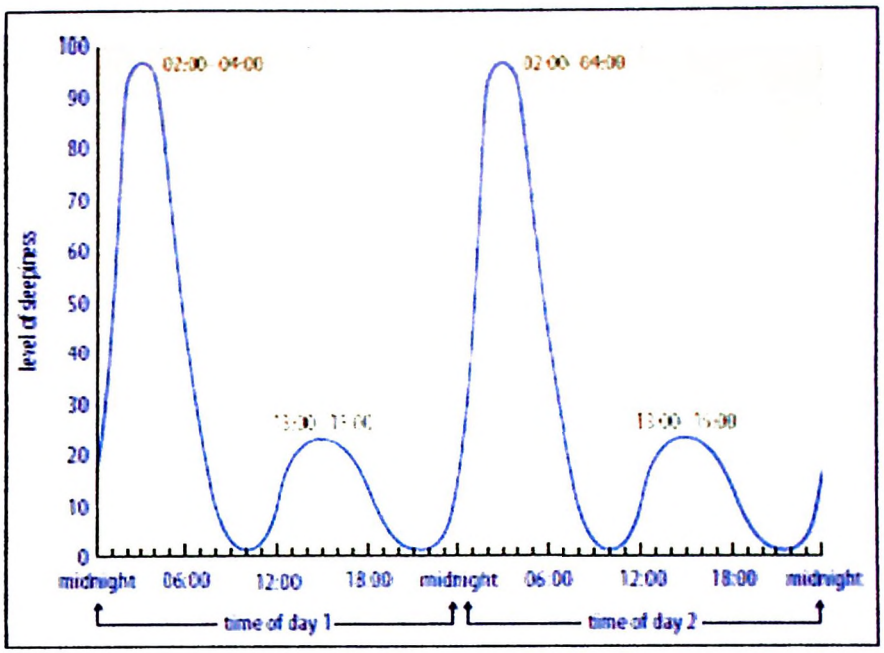

Figure 2.1. The circadian rhythm in sleepiness

(Source: International Petroleum Industry Environmental Conservation Association/International Association of Oil and Gas Producers, 2007)

Besides, daily rhythms in sleep and alertness, circadian signals also control core body temperature and secretion of some hormones. These rhythms persist in the absence of environmental time cues. However, they can be affected by environmental cues such as light or dark and by when these cues occur, for example, light early in the normal circadian day reinforces one's circadian rhythm. Some individuals are able to adjust to some degree when required to function during the normal circadian night but others are not and may develop a shift work sleep disorder (Sack *et al.*, 2007).

2.6 Occupational Risk Exposure of Shift Work

Fatigue is also associated with extended hours, night shifts, and rotating shifts can have a negative impact on safety and performance (Lerman *et al.,* 2012). This occurs due to the shorter duration of sleep these individuals obtain and also related to circadian misalignment. Budnick *et al.* (1994) stated that among the shift workers, duration of sleep is less than ideal and worse for those on night shifts. The ability to sustain vigilance on some tasks can be affected by small amounts of sleep loss. Two hours less sleep per night than optimal over a week can lead to performance decrements equal to 24 hours of consecutive wakefulness (Belenky and Thorne, 2003).

Lerman *et al.* (2012) also stated that several fatigue and alertness studies have showed that incidents are more related to time of day than to time on task. This is worsen by the increased risk of fatigue-related incidents in the early morning hours. Sleep loss not necessarily occur amongst those who works extended hours or night shifts. It has been observed that these individuals showed difference levels of alertness and performance.

Nurses who work longer than 12.5 hours shifts are found to have a greater risk of decreased vigilance on the job, of suffering an occupational injury, or of making a medical error (Lockley *et al.,* 2007). They also found that errors or injuries are also to be increased in physicians in training when they work extended hours.

When the hours on duty exceed 24 hours compared to those who work for 16 hours, the risk of an occupational sharps injury, motor vehicle crash on the way home, or making a serious medical error increases significantly because there are twice as many attentional failures and 36% more serious medical errors (Lockley *et al.* 2007). There is also

reported that an increased risk of motor vehicle crashes in medical residents working extended shifts and consecutive night shifts (Barger *et al.*, 2005). Using the U.S National Health Interview Survey, Lombardi *et al.* (2010) found that decrements in performance leading to increased injuries have been found across multiple industries (refer Table 2.1).

Table 2.1: Estimated annualized injury rates/hours of sleep

	Estimated Annualized Injury Rates/100 Workers						
Hours of Sleep	<5	5-5.9	6-6.9	7-7.9	8-8.9	9-9.9	<10
Injury Rates	7.89	5.21	3.62	2.27	2.50	2.22	4.72

(Source: Lombardi *et al.*, 2010)

An increased risk of work-related injury is still remained even after controlling the factors of industry, occupation, type of pay, sex, age, education, and body mass which have been associated with reported decreasing number of hours of sleep and increased work hours (Lombardi *et al.*, 2010). Increased risks of work-related injuries also have been reported by others in those working extended hours (Dembe *et al.* 2005).

A positive association demonstrated by research between short sleep duration and a variety of medical conditions including diabetes, hypertension, cardiovascular disease, adverse reproductive outcomes and obesity and its resultant medical issues (Rohr *et al.*, 2003). International Agency for Research on Cancer (2010) reported that there is also association between shift work and circadian disruption to an increased risk of cancer. In a recent study in US, there is an estimation of a loss of $1967 per employee per year in loss productivity due to sleep loss (Rosekind *et al.*, 2010). The condition of specific productivity loss is increased threefold when fatigue coexists with other causes of lost

productivity (Newton and Jones, 2010). When work occurs at night, a loss of productivity has been found with the number of successive night shifts, the length of the shifts and the duration of time off work between shifts emerging as factors that may affect the degree of effect (Folkard and Tucker, 2003).

2.7 Measurement of Fatigue

In measuring fatigue, questionnaires in the form of self-report scales are the most widely used methods and tools in most of clinical investigations. These scales will measure the nurses' perceive level of fatigue and number of advantages that make them useful for clinical practice. According to Krupp (2001), the fatigue questionnaire is generally short, widely available and easily understandable by the respondents. The summary score or the mean of the individual question scores will be used as the result.

The most common approach is to use a Likert format with respects to scaling methods, in which subject are asked to report the degree to which they endorse a particular item as measurement of symptom's severity and intensity. Subjects can be asked to intersect the line of visual analogue scale (VAS) for the same purpose. The advantages of the Likert scale include respondents are easy to score and and have a better accessibility (Krupp, 2001).