CHAPTER TWO
REVIEW OF LITERATURE

This chapter reviews the literature related to nightshift duty and the ill-health effects which may happen to nightshift workers. This chapter also provides information about how nightshift workers can take care of their health and gain effective sleep when working the nightshift.

2.1 SHIFTWORK AND NIGHTSHIFT SYSTEM

Shiftwork is a working hour system wherein employee's working schedules are extended from the normal working hours. Nightshift duty can be done either permanently or rotationally depending on a company's needs and policies.

Categorization of Shiftwork Systems

Akerstedt and Knutsson (as cited in Levy & Wegman, 1995) as well as Witoon (วิฑูรย์ สิมะโชคดี และ กฤษฎา ชัยกุล, 2540) categorized shiftwork systems into 4 main types:

1. Day work system, work periods that fall between approximately 7 am to 7 pm
2. Permanent shift system or permanently displaced work hours can be either:
   - Permanent morning shifts (fall between approximately 7 am to 5 pm)
   - Permanent afternoon shifts (fall between approximately 2 pm to 10 pm)
   - Permanent nightshifts (fall between approximately 7 pm to 5 pm)
   - Split shifts at constant times
3. Rotating shift systems, nightshift can be included in this system. The characteristics of this system are divided into discontinuous and continuous systems.
   - Discontinuous systems are systems that provide a day off on weekends (either on Sundays and Saturdays or just Sundays.
   - Continuous systems are systems where the workers work every day.
4. Roster work systems are similar to rotating shift systems, but less regular, more flexible, and less geared to specific teams. Roster work systems are not used in manufacturing industries, but rather in the public service field, such as transportation, medical services, and call centers.

Necessity of Nightshift Work

1. Nightshift work helps maximize efficiency and productivity. Because some heavy machines take a long time to restart, running machines continuously save on costs. Also, in a high demand market, production lines need to run all the time in order to finish products on time; therefore, companies need to hire nightshift workers.
2. Some public services, such as medical services, security services, transportation, customs and immigration, electrical utilities, need employees to rotate around the clock in order to provide service to people.
3. Due to marketing strategies for customer convenience, some types of businesses, such as customer service, call centers, as well as some convenience stores, choose to run around the clock in order to increase sales and satisfy their customers.

2.2 CIRCADIAN RHYTHMS' EFFECT ON THE SLEEP SYSTEMS

A circadian rhythm is an approximate 24-hour cycle. Generally, the word "Circadian Rhythm" refers to anything that varies with a cycle length of a 24-hour day. The sleep-wake cycle is one circadian rhythm. The word "circadian" comes from the Latin word circa meaning "around," with the word dies meaning "day". Circadian rhythms influence many bodily functions of living beings, such as the biochemical, physiological and behavioral systems in humans, plants, animals, and also fungi. Most circadian rhythms are controlled by an endogenous oscillator, or the body's biological clock (Baxter, Raffle & Hunter, 2000), which helps maintain complex internal functions throughout a 24-hour day. Actually, without light or other external time cues, scientists have found that the body's biological clock works on a 25-hour cycle rather than a 24-hour one (Coren, 1996; Moore-Ede, & LeVert, 1998). However, because sunlight and external time cues can reset normal biological cycles, the body's biological clock follows the 24-hour cycle of sunlight instead of its innate cycle.

Circadian rhythm can be reset every 24-hour hours by environmental cues such as sunlight or other bright lights. Biological clocks can also be reset by other kinds of external time cues, such as an alarm clock, blaring sirens, the hammering of construction or the time of meals, sleep, or work. Scientists call these external time

cues, "zeitgebers[1]" (Moore-Ede, & LeVert, 1998). As a diurnal creature (Baxter, Raffle & Hunter, 2000) under natural conditions, human body temperature will increase in the daytime and decrease at night, which means by nature humans are active during daytime hours, while sleeping during nighttime hours.

The biological clock is located in the "suprachiasmatic[2] nucleus" (SCN), which is a pair of pinhead-sized areas in the hypothalamus. The hypothalamus is an old part of the brain and can be found in many primitive animals such as fish and reptiles. When the light reaches photoreceptors in the retina, it will create signals that travel along the optic nerve to the SCN. After receiving signals from the retina, the SCN will send information to hypothalamic nuclei, including the pineal gland, to modulate body temperature and the production of hormones such as cortisol and melatonin. Consequently, SCN influences the sleep-wake cycle as well as another bodily functions that are synchronized with the sleep-wake system, such as body temperature, hormone secretion, urine production, digestion, breathing rhythm, and changes in blood pressure (Carpentier & Cazamian, 1977).

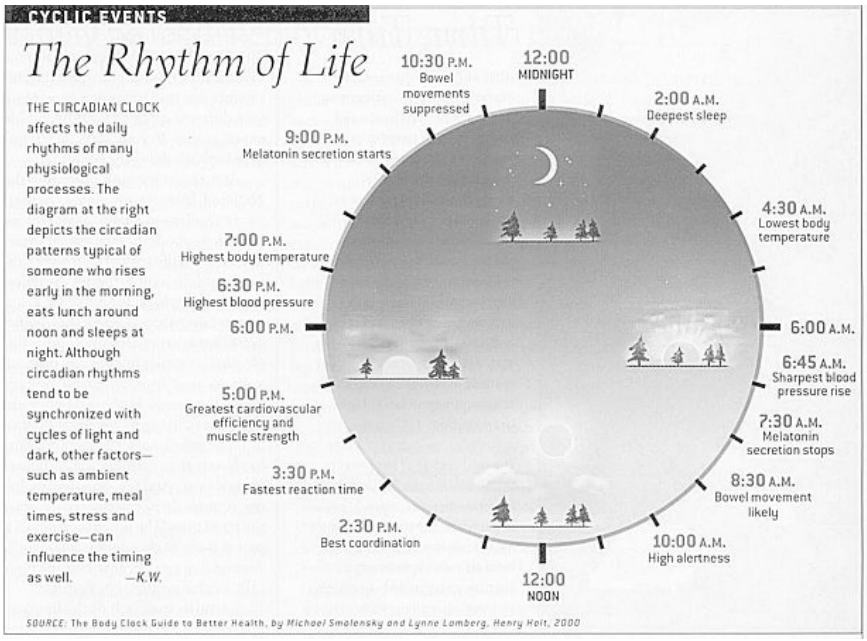


Illustration 1: The general cycle of the body's biological clock

From: The Body Clock Guide To Better Health, by Michael Smolensky and Lynne Lamberg, 2000, NY: Henry Holt And Company, LLC.

[1] zait-ge-bers, German word meaning "time-givers".
[2] su-pra: kai əs mæ tic

As the above illustration shows, humans normally feel sleepy at 9.00 pm. At this time the body temperature will gradually lower and rise again at 7.30 am the next day. Although our body's biological clock follows a 24-hour cycle, not everyone has the same pattern. This differences are genetic and due to the "Clock Gene" (พสุ เดชะรินทร์, 2548). This Clock Gene results in different patterns of circadian rhythms in each human. As a result, some people will be alert and active at 9.00 pm, while others need sleep. Because of this, understanding employees' biological clocks will help companies assign appropriate work schedules to employees.

Because of circadian rhythms, humans are meant to work during the day and sleep at night. People who have to work at night and sleep during the day will have difficulties adjusting themselves to the night atmosphere. However, knowing one's own biological clock pattern will help a person adjust to the night atmosphere and take care o f their health, including how to gain effective sleep when working the nightshift.

2.3 MELATONIN'S EFFECT ON THE SLEEP SYSTEM

Melatonin is a hormone produced by the pineal gland, which is a reddish-gray pea-sized part of the brain, located in the center of epithalamus. Melatonin maintains the balance of endocrine hormone, immune system integrity, and the metabolic system; it also helps the human body regulate the sleep-wake cycle.

Melatonin production is activated by darkness and inhibited by light. When the amount of melatonin secretion in your blood is high, it makes you feel drowsy and less active, and your body temperature will drop, which is an appropriate condition for sleep. The amount of melatonin will suddenly fall in the early morning because the light-dark cycle affects the amount of melatonin secreted. Young people appear to have more melatonin in their blood than older people. Melatonin levels peak at about 2.00 am in young people who are healthy, and about 3.00 am in older people. Therefore, variations in melatonin levels change according to age. This may be why young people have fewer sleep problems than older people.

Artificial light, even at low levels, will disrupt the body's biological clock and suppress melatonin production. Thus, artificial light exposure at night can suppress

normal melatonin levels and impair the normal sleep-wake cycle. It has also been reported that artificial light can increase the chance of developing cancer in night workers (Stevens, 2006). Women working at night for years are more prone to breast cancer, while men working at night may have a higher rate of prostate cancer.

2.4 STAGES OF SLEEP

Sleep, which is a physiological process, is necessary for the human body and mind because it maintains many internal functions and helps them to work properly. While sleeping, body functions also go into the sleep mode and the body gains many benefits from this; for example, the metabolic system and urine production generally slow down, hormone secretion systems work properly, muscle tissues are repaired and rebuilt; and energy is restored for the next day. According to examinations of brainwaves using an EEG[3], at the onset of sleep the brainwaves are beta waves with a high frequency of about 17 cycles/second. When the body is calm and relaxed, brainwaves will change to alpha waves which are low frequency at about 8-12 cycles/second. Finally, theta waves are at the frequency of about 3-7 cycles/second (Moore-Ede & LeVert, 1998).

Sleep is divided into 2 types: rapid eye movement (REM) and non-rapid eye movement (Non-REM). The changes in brain activity that take place in the sleep-wake cycle can be categorized into 5 stages. Non-REM sleep is characterized by a reduction in physiological activity. As sleep gets deeper, the brainwaves become slower and have greater amplitude, breathing and heart rate slow down, and blood pressure drops. The non-REM phase consists of 4 stages as follows:

Non-REM Sleep

Stage 1 is a time of drowsiness or transition from being awake to falling asleep. During this stage, brainwaves, eye movement, and muscle activity begin to slow down, but are still easily active.

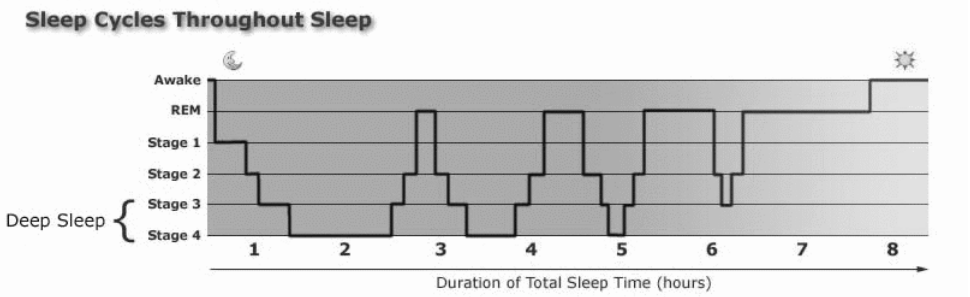
Stage 2 is a period of light sleep in which eye movement stops. During this stage, brainwaves and heart rate are slower with occasional bursts of rapid waves called sleep spindles. Body temperature decreases as well.

[3] Electroencephalograph; a piece of equipment that records the electrical activity of the brain

Stages 3 and 4 are deep sleep periods with no eye movement and decreased muscle activity, but retaining the ability to function. During this stage, slow brainwaves, called delta waves, are interspersed with smaller and faster waves, breathing and heart rate slow down, blood pressure falls and body temperature drops lower than in other stages. The body becomes immobile and difficult to awaken. People who are awakened during these stages may feel disoriented for several minutes after waking up. During these stages, some children may experience bedwetting, night terrors, or sleepwalking.

REM sleep

Stage 5 is an active period of sleep indicated by intense activity of the brain. Brainwaves become fast and desynchronized, similar to the waking stage. Breathing becomes more rapid, irregular, and shallow; eyes move rapidly in various directions and muscles become temporarily paralyzed. The heart rate increases and blood pressure rises. This stage is also the stage in which dreams occur. REM sleep activates the brain used in learning and creating memories. Dreams may be the way in which the brain sorts and selectively stores new important information acquired during waking time.



From: Powerful sleep secrets of the inner sleep clock, by Postawski, K. M. Retrieved September 10, 2008, from www.wonderfulsleep.com

During sleep time, these stages of sleep occur many times. According to the picture above, the progress of sleep will move through stage 1 to stage 5 about 5-7 times. On average, the first round of REM sleep (stage 5) will occur about 60-90 minutes after sleep begins depending on each person. Usually, the stage of sleep will first go back from the deep sleep period (stage 4 and 3) into a light sleep period (stage

2) before starting the first REM phase again. It takes about 30-45 minutes from stage 1 to stage 4, and then, another 30-45 minutes from stage 4 back to stage 1. The sleep cycles will repeat themselves continuously during the period of sleep. The sleep stages in each cycle go as follows: 1, 2, 3, **4**, 3, 2, ***REM***, …2, 3, **4**, 3, 2 ***REM***, …2, 3, **4**, 3, 2, ***REM***, …2, 3, **4**, 3, 2, ***REM***… .

As the night progresses, the REM phase (stage 5) becomes longer, while time spent in stages 3 and 4 becomes shorter. By morning, sleep time is spent in stage 1, stage 2 and in REM (stage 5). If REM sleep is disrupted during one night, REM sleep time is typically longer than normal in the following nights until the normal sleep cycle is restored.

2.5 ILL-HEALTH EFFECTS CAUSED BY WORKING THE NIGHTSHIFT

Working the nightshift can harm both the body and brain because the normal biological clock is meant to sleep at night and be awake in the day. However, working the nightshift disrupts this natural rhythm. Tiring nightshift work can have negative mental and physical effects. When working the nightshift, the pineal gland, which is one of the important glands linked to other glands and organs in the human body, will not be able to produce melatonin properly. Research (Stevens, 2006) found that artificial light reduces the amount of melatonin, which should be high at night, and impairs the sleep pattern of nightshift workers. Melatonin is the hormone that makes you feel sleepy at night and alert during the day. As a result, nightshift workers will not gain good sleep. Sleep is important for the body's internal systems. When sleeping effectively, other bodily functions will work properly. However, without good sleep, nightshift workers will feel exhausted and become weak because there is not enough time for the body to maintain its functions. People who experience lack of sleep, are often irritable, moody, depressed, get angry quickly, have a low tolerance to solve problems, and are not able to think logically. Lack of good sleep will also affect workers' concentration, alertness, motivation, and memory. A weak body can also be easily attacked by germs and diseases. Thus, people working the nightshift who are not able to sleep effectively will risk developing ill-health effects and related medical disorders such as sleep disorders, chronic fatigue, stress, cancer, heart problems, stomach problems, as well as nervous system, menstrual, and metabolic disorders.

Nightshift Workers Risk Developing Sleep Disorders

Sleep disorders are conditions that prevent people from getting effective sleep and cause sleepiness and body dysfunction. People working the nightshift are more prone to sleep disorders, especially Circadian Rhythm Sleep Disorders.

Circadian Rhythm Sleep Disorders are related to the timing of sleep within the 24-hour day. These sleep disorders are influenced by the timing of the sleep period that is under an individual's control, like shiftwork or time zone changes when traveling aboard. The other disorders in this group are disorders of neurological mechanisms such as irregular sleep-wake patterns, Delayed-sleep Phase Syndrome, and Advanced Sleep Phase Syndrome. These sleep disorders signal that the body cannot recover as quickly from physical and mental demands.

1) Delayed-Sleep Phase Syndrome (DSPS): Sleep disorder that involves the inability to fall asleep and awaken according to the ordinary pattern. People with DSPS fall asleep very late, sometimes not before 2-3 a.m., and cannot wake up before 10-11 a.m.
2) Advanced Sleep Phase Syndrome (ASPS): Sleep disorder that involves difficulties staying awake in the evening but waking up early in the morning.
3) Time Zone Change (Jet Lag) Syndrome: Sleep disorder affecting people who travel across several time zones.
4) Shift Lag Syndrome (Shiftwork sleep disorder): Sleep disorder affecting people who work in shifts, especially on rotating and night shifts.

Insomnia, Sleep Apnea, and Narcolepsy are common sleep disorders people encounter.

Insomnia is a sleep disorder where people have difficulty falling asleep. This can be either short or long term insomnia. People who have insomnia wake up frequently during the night and have difficulties going back to sleep. They also may wake up early in the morning without feeling refreshed after sleeping.

Sleep Apnea is a sleep disorder caused by breathing interruption. During sleep time, not enough air flows from the mouth and nose to the lungs, even though patients try to breathe. When this happens, the amount of oxygen in the blood may drop. Each

pause in breathing typically lasts 10 to 20 seconds or more and repeats about 5 to 100 times an hour. Therefore, people who have sleep apnea often feel tired and fatigued when they wake up.

Narcolepsy is a disorder that causes people to have difficulty staying awake, and they may suddenly fall asleep during the day. This unusual sleep pattern can affect people at school, work, and in their social life. Falling asleep during activities like walking, driving, or cooking is also very dangerous.

Nightshift Workers Risk Developing Chronic Fatigue

Fatigue is the condition when body feels very exhausted. Fatigue happens when people have to work in a the stressful situation for a long period of time, without proper time off. People who have to sleep by day are more prone to stress, and often experience difficulties sleeping because their biological clock does not adjust. So, both quality and duration of sleep are affected, which can cause work accidents and health problems.

Nightshift Workers Risk Developing Stress

Obviously, nightshift workers do not have time to relax with friends and family or do other activities like other people do. Nightshift workers usually go home after work and go right to the bed with all stress and tension of work with them. In fact, it is very important for people working the nightshift to relax and get away from the stress of work before going to bed. Listening to music, eating healthy food, and doing relaxing activities before sleep will help reduce stress and tension.

Nightshift Workers Risk Developing Cancer

Recently, the International Agency for Research on Cancer has reported that working the nightshift increases cancer risk. In women workers, breast cancer tends to increase when working at night for many years, whereas in men workers, risk of prostate cancer is increased (Cheng, 2007). According to Stevens (Stevens, 2006), being exposed to bright light at night suppresses the production of melatonin and raises the amount of estrogen. In experiments on animals, disturbing their circadian rhythms led to melatonin suppression and increased the risk of breast cancer.

Nightshift Workers Risk Developing Heart Problems

Working at night also causes workers to overuse their body which is supposed to work in sleep mode, and forces their heart to work harder. The disruption to circadian rhythms also increases blood pressure and blood cholesterol levels, which increases the risk of hypertension and heart attacks. There are many factors that cause heart disease, like smoking cigarettes or stress. However, studies (Baxter, Raffle & Hunter, 2000; Levy & Wegman, 1995) show that lack of effective sleep when working the nightshift also increases the risk of heart problem and as well as other diseases related to heart problems, such as cardiovascular disorders, ischemic heart disease, and coronary artery disease.

Nightshift Workers Risk Developing Digestive Disorders

Digestive disorders are caused by dysfunctional digestive systems. Nightshift workers tend to consume bad food. They also eat less healthy foods like fish, vegetables and fruit. Significantly, nightshift workers do not provide enough time for the body to digest the food taken, as they usually go to bed a few minutes after taking some food. Also, the time which is best for digesting is used for sleep instead; thus, the digestive system is confused and works improperly. A dysfunctional digestive system increases the risk of other diseases related to the digestive disorders, such as stomach discomfort, frequent stomach aches, abdominal pains, dyspepsia, flatulence, heartburn, constipation, colitis, gastroenteritis, excessive gas as well as (duodenal ulcers, gastric ulcers, mouth ulcers, and peptic ulcers.) Many workers develop more serious disorders related to gastrointestinal disorders such as chronic gastritis, gastroduodenitis and peptic ulcers (Baxter, Raffle & Hunter, 2000; Carpentier & Cazamian, 1977; Levy & Wegman, 1995).

Nightshift Workers Risk Developing Neurological Disorders

Moreover, neurological disorders, such as chronic headaches, migraines, chronic anxiety and depression, and epilepsy are often associated with a disruption of the sleep-wake cycle and lack of sleep (Baxter, Raffle & Hunter, 2000; Carpentier & Cazamian, 1977).

Nightshift Workers Risk Developing Menstrual Disorders

The disruption of circadian rhythms also disturbs women's menstrual cycles and causes other problems for women's health such as increased menstrual pain and higher rates of spontaneous abortion (Baxter, Raffle & Hunter, 2000).

2.6 APPROACHES TO LOOKING AFTER ONE'S SELF WHEN WORKING THE NIGHTSHIFT

Working the nightshift can alter sleep patterns. While working the nightshift, it is important to make sure nightshift workers are getting effective sleep. This not only makes the workers feel more energized, but it also protects their health from long term ill-health effects. Following sleep hygiene and food hygiene suggestions will help nightshift workers cope when they have to work the nightshift.

Sleep Hygiene

The first thing that you must do to gain effective sleep is to schedule your sleep time and sleep at the same time every day. Be sure not to sleep in or stay up late on weekends. When working the nightshift, try to get bright light as much as possible. A full-spectrum of bright light will help regulate the sleep-wake cycle, because when exposed to bright light during the night, the body will figure that it is daytime. And it is important not to be exposed to sunlight before going to bed, as sunlight is stronger than the artificial light and your body will think that it is daytime. You should sleep in a dark, cool room or sleep with eye pads in order to make the body think that it is the nighttime when going to bed. Your body will set a new sleep-wake pattern. During the night or before going to work, if possible, take a 30 or 45-minute nap; it will help the body to recharge energy and maintain normal body functions. With refreshed body, you will be able to sleep more effectively than going to bed with an exhausted body (Moore-Ede & LeVert, 1998; Postawski, 2004).

Also, try not to watch TV before going to bed, remember that you should not do anything on the bed except sleep so that the body will not get confused. If you stay in the bed for 30 minutes without sleeping, get out of bed and do other activities, like reading or sweeping the room. However, avoid watching TV or using the computer. Doing exercise daily will improve sleep hygiene, which helps you fall asleep quickly

and sleep deeply. Furthermore, daily exercise will also make you healthy. Doing meditation is also great because it will reduce tension and increase the level of melatonin during your sleep time. Try to work in only one permanent shift, if your company allows doing so, because switching between the dayshift and nightshift will make it hard for your biological clock to regulate the sleep-wake pattern.

Food Hygiene

Consuming healthy foods and maintaining regular eating patterns with well-balanced meals will help keep all internal circadian rhythms, including sleep-wake patterns, function normally. Also, avoid eating foods that are high in fat; instead, eat foods that are easy to digest, such as fresh vegetables and fruits, lean meat, fish, chicken, bean, dairy products, grains, pasta, and breads (Moore-Ede & LeVert, 1998). This will reduce the work of the digestive system. It will also decrease the risk of developing heartburn, ulcers, and other gastrointestinal disorders.

Foods that contain high amount of tryptophan, the precursor substance of melatonin, such as warm milk, cheese, dates, figs, bananas, soybeans, pumpkin seeds, almonds, peanuts, peanut butter, corn, oats, rice, barley, ginger, tomatoes, tofu, turkey, chicken liver, tuna, spirulina, and yogurt, will help you sleep deeper (Moore-Ede & LeVert, 1998; RealAge, 2008; สุพัตรา สุภาพ, 2008). On the other hand, try to avoid drinking and smoking and reduce the amount of caffeine intake. Alcohol and sleeping pills may help you fall asleep easily, but you will not gain effective sleep (Moore-Ede & LeVert 1998). Try to drink lots of water instead. To help the digestive system work more effectively while working at night, try to eat lightly throughout the night and have a moderate breakfast. Do not go to bed immediately after eating, and provide enough time for the digestion. Tryptophanic foods take about an hour to reach the brain so you have to plan time for proper digestion as well.