

Shift Work and Working Long Hours: Risks and Risk Reduction

by Nellie J. Brown

As a kid, I used to watch an animated TV show about the future called, The Jetsons. I remember hearing George Jetson, husband/father/breadwinner, complaining that: "These three-hour work days are murder." Obviously, this vision of the future is still a ways off.

Long Hours: Was It Always This Way? ¹⁻⁷

Only about 30 percent of employed Americans (age 18 and over) work the common notion of a standard work week: during the daytime, 35 to 40 hours a week, five days a week, Mondays through Fridays. With the tightly packed schedule of shifts, shift workers work 400 more hours a year than those who work only 40 daytime hours. Why do people work non-standard hours? For over half of these people, it is a requirement of the job. Some parents use these schedules as a way to arrange for childcare. For others, it enables time for school, provides better pay, offers less contact with the supervisor, or is simply quieter, less crowded or less distracting.

Certainly, today's 40-hour work week seems short compared with the 70- to 80-hour work week of the 19th century Industrial Revolution, but work time before 1800 was very different. Prior to industrialization, most people did not work very long hours – the tempo of life was slow and the pace of work relaxed. Pre-capitalist society did not have a culture of consumption and accumulation. There was less interest in, and opportunity for, earning or saving money. Goods for purchase were not so available and there was no middle class with the extra money to buy them. Consciousness of time was different – punctuality and time-saving concepts were virtually nonexistent or held less economic value. Also, the pace of work was slower because, unless you were wealthy, food consumption was insufficient to fuel a continuous or rapid labor pace.

In medieval times, official (religious) holidays in Europe took up about one-third of the year. With the advent of the textile industry in the 14th century employers wanted to keep machinery operating continuously. The Puritans launched a holy crusade against holidays, demanding that only one day a week be set aside for rest. By the 19th century, laborers were working six days per week with only Good Friday and Christmas as official days off. Then, following a 100-year struggle, the trade union movement achieved success for shorter work hours. After World War II, however, American's working hours began to rise.

What about Shift Work? ¹⁻⁷

There are a few cases of shift work from ancient times. Certainly the military have had night duty. In ancient Rome, all deliveries were made during the night hours to relieve the congestion in the streets. For many centuries, bakers of bread worked through the second half of the night. Shift work was used during World War I in munitions and other factories. But, shift work became common in America following World War II when increasing competition and rising costs made it difficult for many industries to justify operating factories only 40 hours per week – at less than one-quarter of capacity. Then, there are police, firefighters, medical and emergency services that work 24/7. To meet the needs of these night workers, many service industries stay open at all hours as well.



Working long hours and our internal clocks influence how we perform at work.

Disrupting Body's Internal Clock ^{3, 5, 8-27}

Our circadian (around the day) rhythm is a blending of internal and external cues so that a well-balanced, synchronized human will sleep at night and be active during the day. External cues are our perception of time of day – light/dark (day/night), and our awareness of meals, traffic noise and observations of what the rest of society is doing. Internal cycles – hormonal activity, heart rate, body temperature, blood pressure, potassium excretion, nerve impulses, eating, sleeping and other internal functions (respiration rate, cell mitosis, enzyme activity, gene expression, behavioral output such as short-term memory function and reaction time) – have their own separate high and low activity periods throughout the 24-hour day. Our brain and body blend these internal rhythms to be in sync with the external world. For example, we perceive that it is dark outside and it's the wee hours of the morning by the clock. Our body temperature drops to its lowest point around 3:00 to 4:00 a.m., then rises slowly again at about 5:00 to 6:00 a.m. – this affects performance, activity and alertness as they reach this low point and is the most difficult time to stay awake and alert.

Our systems can adjust without difficulty to small, gradual changes – such as seasonal changes in day length. But the abruptness of changing shifts causes our bodies to become temporarily and severely disorganized. In work shift arrangements which keep people in a constant state of imbalance, it is impossible for the rhythms to get resynchronized for the numerous body functions involved. Shift work is sometimes taken on by the "survivors" of these schedules, or by people who may be so chronically sleep-deprived that they no longer realize what it is like to feel good.

Once disrupted, the body tries to adapt by resynchronizing all the affected functions. But, different systems take different amounts of time to reach the new rhythm – the longest is about three weeks for

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liver function and bone repair to catch up with the rest of the body. If the cycle is disrupted again within the three-week period, the body needs to adjust again.

Shift workers who sleep during the day do so with the noise of traffic, planes, lawn mowers, children playing, and other daytime noise, as well as warmer temperatures and the light of day. These delay or interrupt sleep – so people sleep fewer hours. Brain waves show that REM, or dream sleep, and what is termed Phase 2 of basic sleep are severely affected and, thus, daytime sleeping is not as beneficial. People tend not to wake up refreshed, and sleep deprivation occurs.

We need sleep. The body secretes growth hormone and repairs tissue. Our brains are more active electrically when we are asleep than when we are awake as the brain is engaged in activities that are not possible when conscious. It consolidates memories and learning from the previous day and prunes unimportant connections between neurons. This prevents brain overload so that we can continually take in and store new information. Most adults need about eight hours of sleep, though the typical range is six to 10 hours. For a person who needs eight hours and obtains six hours, sleep is deprived by two hours. If this occurs over four nights, then a sleep debt of eight hours has occurred. The common phenomenon of sleeping late on days off to compensate for sleep debt accumulated during the week is the result. Usually, recuperation involves obtaining deeper sleep over one to two nights, and sometimes sleeping longer. However, the compensated sleep, in reality, amounts to much less than the actual lost sleep time.

Adverse Effects of Long Shift Work on Health: 3,5, 8-27,40-44,94-98

Light is the strongest environmental time cue, producing both acute physiological changes and effects on circadian rhythms. Repeated changes in light-dark cycles, such as shift work, can induce a wide range of health disorders.

- Altered gene expression
- Cardiovascular problems including coronary heart disease
- Increase in the risk factor of obesity
- Reduced plasma antioxidant capacity
- Infections
- Digestive problems
- Fertility problems
- Depression
- Diabetes, disturbed glucose regulation, altered metabolic response and rate-limiting enzymes (further affected by meals at non-standard times)
- Cancers, including breast cancer

Long-term consequences of weekly shift changes studied in animals indicated a 20 percent shorter life span.

It has been proposed that possibly these adverse effects on health could be minimized by seeking out and hiring people with an “ability” to tolerate shift work. Can it be predicted who is best suited for shift work? About 10 to 20 percent of the population seem to be “morning types” (larks) and “evening types” (owls). Morning types have a small swing between their body temperature maximum and minimum and seem to have more trouble adjusting to shift work than those with a relatively large swing, the evening types. About 20 percent of shift workers never seem to adapt to shift work. Questionnaires do not appear to be sensitive or specific enough to select applicants or employees for shift work. Older workers around ages 40 to 50 years, after decades of rotating shift work, may suddenly exhibit intolerance, especially problems in obtaining restful

sleep, insomnia, persisting fatigue, altered behavior (increase in irritability and excitability, malaise and lowered performance), dyspepsia, epigastric pain, and peptic ulcers. Studies have indicated that alertness and cognitive performance decline with the increasing number of years working shifts, up to 20 years. These can affect creativity, productivity, decision-making, and critical thinking. These abilities appeared to return to normal four years after moving from shift work to normal work schedules – suggesting reversibility. However, even within a particular age group, the longer the experience with shift work, the poorer the sleep measures become – this is not simply a function of the increased age of the worker. Therefore, even if we try to predict who could tolerate shift work, eventually the stress may still catch up with people.

Consequences: Risks, Errors and Accidents 2, 3, 17, 36-58

Operating Machinery: Driving or operating machinery or equipment is a serious problem for sleep-deprived employees working shifts or long hours. When deprived of sleep, the human brain can shift spontaneously and in an uncontrolled fashion from wakefulness to sleep to meet its need. The sleepier the person, the more rapidly and frequently this occurs. Spontaneous sleep episodes can last only seconds (micro-sleeps), or for extended periods lasting for minutes. These can occur while a person is standing, operating machinery, or driving a vehicle. In terms of performance, a person who has been 24 hours without sleep is equivalent to a drunk with a blood alcohol level of 0.10 percent.

Chemicals: For workplace inhalation of chemicals, the basic assumption of the occupational exposure limit-setting process by OSHA, the ACGIH (American Conference of Governmental Industrial Hygienists), and others is that workers work a traditional eight-hour shift, five days a week. The National Institute for Occupational Safety and Health (NIOSH) uses a 10-hour day for its recommended exposure limits in order to build in a safety factor for people working some overtime. However, for compressed work weeks involving 10 or 12-hour days or for extended overtimes (often mandatory), people would have longer continuous chemical exposure. This creates the potential for taking in a greater body burden of chemicals or particulates, with correspondingly less time off for detoxification and excretion to occur. For a few chemicals, such as lead, if an employee is exposed for more than eight hours in any work day, the OSHA permissible exposure limit is reduced according to a formula which incorporates the actual hours worked. Where this issue is not considered in regulations, OSHA does have recommended formulas for use during unusual work schedules.

Heat and Cold: Heat stress and cold stress are other workplace conditions to consider in relation to shift work, compressed work weeks and double shifts. Heat stress, by itself, has been known to produce sleep deprivation. Also, it is necessary to look at the interaction of heat stress with other workplace stressors.

Lifting: Ergonomic studies of standardized, prolonged lifting in daytime workers indicate that the ability to lift declines over time, even with normal breaks in an eight-hour day. For a 12-hour day, the weight decreases further by 12–22 percent per lift. Studies of eight-hour shifts indicate that, although the speed of work on the nightshift was slightly slower than on days, the energy expenditure was 10 percent higher. It would be expected that 12-hour shifts would magnify these effects. Thus, separate standards of lifting capacity and other tasks for night shifts probably should be established.

Security: For employees coming and going at night, security

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becomes an important consideration. With fewer potential witnesses around at night, employees could be seen as easier victims. High risks for violence include building entrances and parking areas, as well as work in the field or making deliveries. Night time construction work for buildings or roads may have the added risk of worker visibility.

EMFs: Electromagnetic fields (EMFs) adversely affect circadian rhythm as well. Power line fields affect circadian rhythms but only if the field is turned on and off. Very strong static magnetic fields can interfere with circadian rhythm, including hormone levels and body temperature regulation.

Social: Sleep deprivation and its mood swings and fatigue can affect relationships with family and friends who may not understand the shift worker's physiological upsets, edginess, tiredness, moodiness, or depression. A spouse may begin to feel ignored and disliked. Shift work can lead to a higher rate of separation or divorce. Children may begin to feel as though they have an occasional second parent who doesn't care about them enough to be around more often. Shift workers tend to form close bonds and friendships among themselves as a way to lessen the pain of isolation.^{6,68-71}

What can be done to minimize these consequences? Read the following items with effective proposals for both the employer and employee to apply.

What the Employer Can Do:

Schedules and Work Organization^{5, 19, 37, 46, 50, 51, 64, 84-86}

Set regular, predictable work schedules that benefit the work/family balance. Making the workplace more "family-friendly" by increasing workplace flexibility gives employees more autonomy in meeting family needs such as child care. Sometimes, family members may work nonstandard schedules deliberately in order to deal with family issues. Often, workers with children like 12-hour shifts and compressed work weeks because they minimize the number of days requiring paid childcare and allow more time with children. Creative approaches to roster workers may help with retention of employees. Schedule shifts on a yearly basis so workers can plan their lives.

To minimize the adverse effects of electromagnetic fields (EMFs) on circadian rhythm, avoid shift work schedules which cause loss of awareness of day-night cycles.

Enforce maximum allowable work hours per week.

Forward shift rotations only: Move with the clock, not backwards against the clock. Overall, the slower the rotation the better; whereas, some forms of weekly shift rotation or rotation in the wrong direction may be difficult or impossible to cope with for the employee. Does the job need to be done 24 hours a day? Tailoring shift schedules to subgroups within an organization, rather than for an entire organization, may work best.

Avoid Accidents: Due to the potential for increased errors in moving from an eight-hour to a 12-hour shift, consider avoiding tasks requiring error-free activity toward the end of a 12-hour shift. Similarly, avoid such tasks in the 3:00 – 6:00 a.m. period. For physiologically-demanding work, rest breaks provide recovery from muscular fatigue. For jobs involving vigilance, a break of five to 10 minutes every half to one hour may be needed to maintain a high level of alertness and decision-making.

Training and Education^{37, 50, 64, 86}

Workers need to know what to expect and how the body may respond to shift work. Invite family members to attend. (Trainees

in my workshops often remark: "I wish my wife were here to hear your training.") Cover these basics:

- Circadian rhythms
- Symptoms of fatigue and sleep deprivation; and risk factors for safety and health
- Work hours/shift work issues
- Coping and counter measures

Workplace Lighting^{13, 18, 19, 37, 50, 90-94}

During evening and night work shifts, full daylight-spectrum bright light promotes the re-setting of the body's sleep and wake cycles, but *filter out wavelengths <480nm*, as these have the most serious effects on melatonin, cortisol, peripheral clock gene expression, body temperature regulation, alertness, mood, errors, and breast cancer risk.

Workplace Departments and Policies^{19, 37, 50, 51, 67, 88-89}

Have Human Resources, Personnel, Benefits, and other services available for those working unusual hours, to avoid disrupting their sleeping routine. Schedule workplace trainings on work shifts; and, avoid holding employees after their shifts or bringing them in early to avoid disrupting their sleep schedule (as well as child care).

Food and Drink^{18, 19, 37, 39, 50, 51, 64, 65}

Make healthy food choices available, including in vending machines. Have adequate and appropriate liquids available to deal with heat stress and cold stress.

Physical Exercise^{19, 37, 50, 64}

Improved physical condition can either increase tolerance of shift work or increase the rate of adjustment to shift work. Make it as easy as possible for people to make regular exercise a habit.

Promote physical exercise by:

- Having facilities available
- Offering discounts to gym, pool or exercise programs, or for assisting employees to purchase equipment for home use

Napping^{19,37,50,51,67,88,89}

Naps can compensate for fatigue and improve alertness or delay its decline. Use of a short nap (less than one hour) during the early morning hours of the first night shift can improve the ability to respond to visual signals during the second half of the night shift. Naps during the work shift can serve as a bridge over the night time low point in circadian alertness and arousal.

What the Employee Can Do:

Schedules^{5, 19, 37, 46, 50, 51, 64, 84-86}

Union/worker involvement:

- Design shift schedules: shift work designs are likely to be controversial among the membership and need to be resolved before approaching the employer so as to present a united front.
- Establish a right to transfer to daytime work without loss of pay and benefits for those who cannot tolerate working nights.
- Schedule doctor and dentist appointments that work for your schedule, rather than disrupting your sleep routine.

Relaxation Techniques^{19, 37, 50}

Don't knock it until you've tried it!

- Meditation
- Yoga – besides the physical exercise, the deep breathing exercises are relaxing before sleeping
- Progressive muscle relaxation – very helpful for drifting off to sleep

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Sleep Hygiene^{2, 19, 37, 50}

Maintain a regular sleep schedule for the duration of the week, **including days off** (otherwise you are simply disrupting your circadian rhythm in addition to what your shift changes do). Keep a regular meal schedule, as well. **Tell your family why these are necessary and need to be respected.** Invite family members to employer training on work hours and related issues.

Some sleep hygiene tips:

- Try to relax, unwind, and go through a regular bedtime routine before sleeping.
- Ensure adequate screening from noise and interruptions by keeping your room quiet; and insist that family and friends respect your sleep hours.
- Tune a radio between two stations to use background “white” noise.
- Use earplugs, unless you need to be on call or wake up for duty
- Keep your bedroom cool and pitch-dark. Use eye shades if necessary.
- Take a warm bath or shower before bed – increasing body temperature a couple of degrees shortens the time to fall asleep and promotes non-REM deep recuperative sleep.
- Warm your feet to induce rapid onset of sleep.
- Try to prepare for your sleep schedule on your days off before the shift changes.
- On your morning drive home after working all night, try wearing dark glasses so the daylight will not reset your biological clock and delay your sleep cycle.

Food and Drink^{18, 19, 37, 39, 50, 51, 64, 65}

Eating meals or snacks at the same time each day may help promote better digestion and offset the disruption of body systems caused by shift changes.

To stay awake, eat light to moderate amounts of protein

To produce drowsiness:

- Use high carbohydrate foods and avoid greasy foods that cause indigestion and disturb sleep.
- If hungry at bedtime, a light snack is preferable to a large meal.
- Avoid caffeine during the last half hour of your shift or near sleep time; caffeine is also a diuretic which could interrupt sleep. (Nicotine, either tobacco smoking or patch, has effects similar to caffeine and should be avoided within several hours before desired onset of sleep.)
- Avoid alcohol if you must sleep during the day. Alcohol can promote relaxation and help a person fall asleep, but produces easily disrupted lighter sleep because it suppresses REM sleep in first half of the night. The second half of the night can experience withdrawal effects and REM rebound causing awakening from intense dreaming activity with sweating and headaches.

Physical Exercise^{19, 37, 50, 64}

Improved physical condition can either increase tolerance to shift work or increase the rate of adjustment to shift work. This may be because physically-fit people tend to have a larger-amplitude circadian rhythm. Physical training appears to increase strength and produces more positive subjective reports in shift workers, including better mood and less fatigue.

Certainly, strenuous exercise can interfere with sleep. If this is the case for you, avoid strenuous exercise within six hours of going to bed. Maybe exercising when you wake up is a better choice.

Regular exercise may enhance the deep sleep which has been shown to be physically restorative.

Napping^{19, 37, 50, 51, 67, 88, 89}

Naps, to prevent anticipated fatigue and loss of alertness, appear to be effective. However, generally one cannot obtain extra sleep to “stock up” against an anticipated sleep debt in the future.

If napping before going to work, or if a nap is likely to be interrupted for a call to come to work, limit it to a maximum of 45 minutes. This minimizes the chances of entering deep sleep, as this waking from deep sleep can lead to grogginess and disorientation for several minutes.

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