

Ergonomics

Rotational Shiftwork

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What is the definition of "rotational shiftwork"?

The term "rotational shiftwork" covers a wide variety of work schedules and implies that shifts rotate or change according to a set schedule. These shifts can be either continuous, running 24 hours per day, 7 days per week, or semi-continuous, running 2 or 3 shifts per day with or without weekends. Workers take turns working on all shifts that are part of a particular system.

The definition of rotational shiftwork in this document does not include fixed shifts like straight nights, straight afternoons or straight days. However, workers on fixed night shifts and workers on rotational shiftwork schedules have much in common due to the constantly changing schedules, night work and potential disruption to family and social lives.

The length of a shift can vary between 8 and 12 hours. Specific concerns about the extended workdays (10-12 hour shifts) are discussed in the [Extended Workday](#) OSH Answers document.

NOTE: In this document, instead of "rotational shiftwork" we will use, for simplicity, the term "shiftwork".

Why study the effects of shiftwork?

Shiftwork is a reality for many working people. Interest in the effects of shiftwork on people has developed because many experts have named rotating shifts for the "human error" connected with nuclear power plant incidents, air crashes, and other catastrophic incidents.

Alternating day, night and afternoon shifts are common in

- industrial work
- customs and immigration
- mines
- healthcare
- emergency response – police, fire, ambulance
- hospitality – hotels, food service
- transportation services – trucking, airlines

Shiftwork is also common in workplaces where technical processes cannot be interrupted without affecting the product and where expensive equipment is used more profitably when in constant operation. The overall prevalence of shiftwork is similar for women and men. However, there are gender differences in shift work patterns by sector of employment. Many more women than men work in the healthcare sector, while many more men than women work in manufacturing.

Many workers find that shiftwork disrupts their family and personal life and leads to health problems including chronic fatigue and gastrointestinal disorders. On the other hand, some workers prefer shiftwork because it usually allows for more free time.

Can shiftwork cause cancer?

A shift worker, particularly one who works nights, must function on a schedule that is not "natural". Constantly changing schedules can:

- upset one's circadian rhythm (24-hour body cycle),
- cause sleep deprivation and disorders of the gastrointestinal and cardiovascular systems,
- make existing disorders worse, and

- disrupt family and social life.

The International Agency for Research on Cancer (IARC) has classified night shift as "probably carcinogenic to humans" (Group 2A carcinogen). Group 2A means that this conclusion was based on "limited evidence of carcinogenicity in humans and sufficient evidence of carcinogenicity in experimental animals". IARC based its conclusion on studies on long-term night shift workers who have shown a higher risk of breast cancer than women who do not work at night. These studies have involved mainly nurses and flight attendants. The results are consistent with animal studies showing that constant light, dim light at night, or simulated chronic jet lag can increase tumour development.

The exact causes of this association are still not known. The results may be explained by the disruption of the physiological circadian rhythm (the daily or 24-hour cycle of human physical functions) that is caused by exposure to light at night. This exposure can alter sleep-activity patterns, suppress melatonin production, and dysregulate genes involved in tumour development. Among the many different patterns of shiftwork, those that include nightwork are most disruptive to the circadian rhythm.

(From: IARC 2020. IARC Monographs Volume 124: Night Shift Work)

What are the effects on circadian rhythms?

Many human physical functions follow a daily rhythm or a 24-hour cycle. These cycles are called circadian rhythms. The word circadian comes from the Latin "circa dies" which means "about a day." Sleeping, waking, digestion, secretion of adrenalin, body temperature, blood pressure, pulse and many other important aspects of body functions and human behaviour are regulated by this 24-hour cycle. These rhythmical processes are coordinated to allow for high activity during the day and low activity at night.

Normally, the body uses cues from its processes and from the environment such as clock time, social activities, the light/dark cycle, and meal times to keep the various rhythms on track. For example, body temperature is highest during the afternoon and early evening (6:00 p.m.) and lowest in the early morning (4:00 a.m. or just before sunrise). However, if the person is working at night, the body temperature does not have as much variation during a 24-hour period as it would normally. The temperature and other body rhythms get out of sync. These rhythms also get out of phase with the person's activity pattern. This disorientation can lead to feelings of fatigue and disorientation. "Jet lag" is a term often used to describe these feelings.

Some rhythms adapt in two to three days, while others change only after longer periods. People adapt to new schedules at different rates as do the different rhythms. Total reversal of circadian rhythms may never occur because most people go back to a "normal" day schedule on days off. Frequent changes in schedule and disruption to circadian rhythms can lead to chronic fatigue and other health problems.

What are the changes in sleep patterns?

Disruption of both the quality and quantity of normal sleep is inevitable in shiftwork particularly where night work is involved. Daytime sleep is seldom as deep or as refreshing as sleep at night. The problem is greater if there is not a quiet, dark, comfortable place to sleep. Even when disturbances are removed, a worker who returns home in the morning may still find sleep impossible or less refreshing. This difficulty occurs because the circadian rhythms are no longer synchronized. Being constantly tired is a typical complaint of shift workers.

What are the gastrointestinal disorders associated with shiftwork?

Gastrointestinal and digestive problems such as indigestion, heartburn, stomach ache and loss of appetite are more common among rotating shiftworkers and night workers than among day workers. It is less clear if more severe conditions such as peptic ulcers are more common in shiftworkers. The irregular work, sleep and eating schedules make it difficult to properly care for ulcers.

Given the irregularity in type and timing of meals, it is not surprising that the night worker is more likely to have a poorer diet. At night, the loss of appetite often leads to increased snacking on "junk" food rather than eating a full, well-balanced meal. Feelings of fatigue may encourage the consumption of beverages with caffeine (coffee, cola) to help the worker stay awake.

What are the cardiovascular disorders associated with shiftworkers?

Shiftwork is not certainly associated with cardiovascular disease. However, heart rate and blood pressure have been shown to follow a circadian rhythm. Lifestyle can directly affect an individual's health. Therefore, it is very important that a shiftworker follows exercise programs to maintain an adequate level of fitness. It is also very important not to smoke, have good dietary habits and participate in leisure activities.

A study of Swedish men with a history of heart attack showed they were significantly more likely to have been shiftworkers than those men without a history of a heart attack. Another study showed that the modification of shift rotation schedules by changing the direction of rotation of shifts to a forward direction (for example, days -> afternoons -> nights) can significantly decrease the levels of several coronary risk factors, e.g., triglycerides, glucose, and urinary excretion of catecholamines (chemicals like adrenalin that occur naturally in the body).

Are there concerns about pregnancy?

The Center for Disease Prevention and Control (CDC) states that working at night and working long hours have been related to menstrual disorders, miscarriages, and preterm birth.

Circadian rhythms also regulate the menstrual cycle and pregnancy hormones. However, it is unknown what causes most cases of menstrual disorders, miscarriages or preterm birth, or are they able to state the amount of night shifts or how many hours per week are safest to work during pregnancy.

Can shiftwork aggravate existing conditions?

Workers who require prescription drugs to control certain disorders should be aware that disruption of the circadian rhythm can interfere with the medical treatment of some diseases. Check with your family physician if you take medication while working shifts. Your pharmacist may also be able to give you some additional information.

What are the effects on family and social life?

Compared with people who work straight days, shiftworkers report more interference to their family lives, especially the time available to spend with spouses and children. This fact is very important since the amount and quality of social interaction are related to physical and mental health. Individuals who cannot establish regular routines in their daily activities have more difficulties when planning for family responsibilities and coping with physical and mental fatigue than non-shiftworkers. Participation in clubs, sports, and other organized activities is very difficult since these activities are usually geared to the normal day schedule. The lack of regular social contact can lead to feelings of loneliness and isolation. In addition, quality childcare facilities aimed at meeting the needs of shiftworkers are almost nonexistent.

What are the safety concerns associated with working shifts?

The Institute for Work and Health (IWH) reports that there is strong evidence that night, evening, rotating and irregular shifts are associated with an increased risk of occupational injury. This risk is associated with worker [fatigue](#), and less supervision and co-worker support during non-daytime shifts.

One study reported that night shift had the most incidents, followed by afternoon shifts (least incidents in the morning shift). The risk of an incident was 20% more during the first to second hour of a night shift, as well as a small rise between 3 and 4 am. More incidents are reported on the 4th successive night shift than on the first night shift.

What are some strategies for improvement?

The best solution to the issues of shiftwork would be to eliminate it, but this is not often a practical possibility. Shiftwork will continue to be a reality for a percentage of Canadian workers.

There are two basic levels where improvements can be made:

- The organizational level - primarily through the design of shift schedules, education and better facilities.
- The individual level - helping workers to get better sleep, a healthier diet, and the reduction of stress.

What are some organizational approaches?

There are several approaches the organization can take to help reduce the effects of shiftwork. There are also several important considerations for organizations.

Shift Schedule Design: Optimizing the design of the shift schedule is the most effective way of reducing health and safety problems. Satisfaction with a particular shift system is the result of a complicated balancing act that is the best compromise for personal, psychological, social and medical concerns.

- **Length of the rotation period** (the number of days on any one shift before switching to the next shift). The optimum length of the rotation period has been disputed.
 - The most common system has a rotation period of one week, with five to seven consecutive night shifts. However, since it generally takes at least seven days for adjustment of the circadian rhythms, it is argued that just as adjustment starts to occur, it is time to rotate to the next shift. Some schedule designers feel that a longer shift rotation should be arranged so that the worker spends from two weeks to one month on the same shift. This time that would allow circadian rhythms to adjust. A problem occurs when the worker reverts to a "normal" day/night schedule on days off, thus, possibly cancelling any adaptation. Also, longer periods of social isolation may result.
 - Others suggest a rapid shift rotation where different shifts are worked every two to three days. This system may reduce disruption to body rhythms because the readjustment of circadian rhythms is minimized. It also provides time for some social interaction each week.
 - In the end, individual differences and preferences, play the most important role.
- **Direction of rotation of shifts.** It is recommended that shifts rotate forward from day to afternoon to night because circadian rhythms adjust better when moving ahead than back.

- **Start and Finish Times.** Early morning shifts are associated with shorter sleep and greater fatigue. It is advisable to avoid shift start times as early as 5 or 6 a.m. The social customs and desires of the specific workforce should be considered as well as the availability of public transportation. The safety on the streets, in terms of crime and violence, is another consideration.
- **Length of rest between shifts.** It is recommended that a rest period of at least 24 hours occurs after each set of night shifts. The more consecutive nights worked, the more rest time should be allowed before the next rotation occurs.
- **Alternative forms of organizing work schedules.** For example, extended work days of ten or twelve hours have been used. It has the advantage of fewer consecutive night shifts and longer blocks of time off. However, the additional fatigue from long work hours may also have adverse effects. The physical and mental load of the task should be considered when selecting the length of a work shift. Exposure to chemical or physical agents should also be considered when selecting a shift system as well as ergonomic hazards.

Additional Considerations

- Provide time off at "socially advantageous" times like weekends whenever possible.
- Start a special shift system if production demands result in extended periods of overtime work.
- Inform shiftworkers of their work schedules well ahead of time so they and their families and friends can plan activities. Allow as much flexibility as possible for shift changes. Keep schedules as simple and predictable as possible.

Facilities: The provision of certain facilities can help the shiftworker cope better.

- Give attention to the work environment. For example, good lighting and ventilation are important on all shifts. Do not widely separate workstations so that workers at night can remain in contact with one another.
- Provide rest facilities where possible. Whenever a person must remain at work after a night shift to attend a meeting or a training session, providing rest facilities is advisable. When a night worker is "on call" and must remain in the building, it is advantageous for this person to be well rested rather than tired and bored.
- Provide healthy cafeteria services so a balanced diet can be maintained. The nutritional needs differ between day shifts and other shifts because of circadian rhythms. Provide educational and awareness materials on the benefits of eating a balanced meal.
- Consider offering facilities for social activities with the needs of the shiftworker in mind. Recreational opportunities are often minimal for workers on "non-day/night" shifts.

- Consider access to quality daycare for shiftworkers' children. Some strain on all family members would be alleviated.

Education: Educate employees on the potential health and safety effects of rotational shiftwork and what can be done to stop these effects. In particular, education in stress recognition and reduction techniques is helpful.

What can the individual do to manage shiftwork?

People who work shifts face many problems that others do not recognize. The difficulties stem from the change in eating, sleeping, and working patterns. The following guidelines can help people manage better.

Guidelines for Diet and Eating Patterns

- Maintain regular eating patterns as much as possible. Balanced, varied meals are very important. Keep family meal times the same even though the work routine constantly changes. Family meals may need to be altered in content to suit the shiftworker.
- Time meals carefully. Afternoon workers should have the main meal in the middle of the day instead of the middle of the work shift. Night workers should eat lightly throughout the shift and have a moderate breakfast. This way, they should not get too hungry while sleeping during the day, and digestive discomfort should be minimal.
- Pay careful attention to the type of food eaten. Drink lots of water and eat the recommended balance of vegetables, fruit, lean meat, poultry, fish, dairy products, grains, and bread. Eat crackers, nuts, and fruit instead of pop and candy bars during work breaks. Reduce the intake of salt, caffeine, and alcohol. Avoid greasy foods, particularly at night.
- Avoid excessive use of antacids, tranquilizers, and sleeping pills. It is healthier to watch what and when you eat, and use relaxation techniques to aid sleep.
- Relax during meals and allow time for digestion.

Sleep

- Sleep on a set schedule to help establish a routine and to make sleep during the day easier. Some people may prefer to get a full period of rest just before the next work shift (as it is with "normal day" work). Try different patterns of work and sleep to see which is best for you.

- Make sure that family and friends are aware of and considerate of the worker's sleep hours and needs. Make sure the shiftworker has a comfortable, dark, quiet place to sleep during the day. Air conditioning, a telephone answering machine or cell phones set to "do not disturb", and good blinds on windows are recommended.
- Make time for quiet relaxation before bed to help get better sleep. Learn how to relax using muscle relaxation, breathing techniques and so on. Use mental imagery to block out unpleasant thoughts. If you still do not fall asleep after an hour, read a book or listen to quiet music on the radio for a while. If sleep still does not come, reschedule sleeping hours for later. Limit commitments later in the day to allow for napping.

Other Important Considerations

- Pay attention to general physical fitness and good health habits.
- Find out about and understand the potential health and safety effects of shiftwork.
- Learn how to recognize and reduce stress through physical fitness, relaxation techniques and so on.
- Take leisure seriously.

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