

Shiftwork and emergency medical practice

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ABSTRACT

Shiftwork has numerous negative effects on workers, but it is an essential component of the demanding 24/7 practice of emergency medicine. We conducted a systematic literature review to characterize the effects of shiftwork on physician health, well-being and practice, and to describe rational strategies to mitigate its impact on Canadian emergency physicians.

Key words: shiftwork, emergency medicine, physician health, circadian, schedules, sleep error

RÉSUMÉ

Les horaires de travail par quarts ont de nombreux effets négatifs sur les travailleurs, mais ils sont une composante essentielle de la pratique exigeante de la médecine d'urgence 24 heures sur 24, sept jours par semaine. Nous avons effectué une revue systématique de la littérature afin de caractériser les effets des horaires de travail par quarts sur la santé, le bien-être et la pratique des médecins et de décrire des stratégies rationnelles pour diminuer leur impact sur les médecins d'urgence canadiens.

Introduction

Emergency medicine (EM) is a unique specialty whose focus is upon providing a breadth of acute care whenever it is needed.¹⁻³ Because emergencies happen at any time of the day or night and require immediate expert care, shiftwork is an essential component of EM practice in Canada and around the world. Unfortunately, shiftwork has deleterious effects on individuals, organizations and communities. It is a serious concern for Canadian health care providers, a risk factor for many diseases,⁴⁻⁷ and one of the main reasons physicians leave emergency practice; consequently, it threatens the viability of EM as a medical specialty.⁸⁻¹² Our research question was, "What are the effects of shiftwork on emergency medical practice?" Our objectives were to summarize the literature describing the impact of shiftwork on physician health, well-being and prac-

tise, and to provide rational strategies to maximize shiftwork productivity and coping for physicians in Canada.

Methods

In performing this systematic literature review, we searched Ovid Medline (1966–2000) and Psyc Info (1984–2000) using the search terms "work schedule tolerance," "shiftwork," "shiftwork," "sleep deprivation," "personnel staffing and scheduling," "burnout," "workload," "job satisfaction," "emergency medical services," "emergency service, hospital," and "emergency medicine." References were excluded if they were not in English or had no abstract. We also searched the Web sites of the American College of Emergency Physicians (www.acep.org), the American Academy of Emergency Medicine (www.aem.org), and the Canadian Association of Emergency Physicians (www.caep.ca)

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for documents containing the words “shiftwork” or “shift work” and we searched the Internet for shiftwork information using the Google (www.google.com) meta-engine. In addition, we searched the University of Toronto electronic library resources site for relevant journals and references (www.utoronto.ca), and we hand-searched article bibliographies for additional references. Finally, we consulted experts in the fields of chronobiology and emergency physician (EP) wellness. The database search produced 32 references that met our inclusion criteria. Bibliographies added a further 65 relevant references, and information from 15 Web sites was incorporated. One author (J.R.F.) selected information sources, and both authors assembled these into predefined theme areas.

The context: Emergency medicine and shiftwork

Emergency departments (EDs) are chaotic, stressful environments. In Canada, they tend to be loud, variably equipped and lacking in resources and personnel. To serve their communities, they must be staffed 24 hours a day, 365 days a year. EPs have little control over their patient-mix; they deal with a wide range of challenging patients of all ages, they make many difficult decisions, often dealing with life or death, and they do so at a rapid pace. Emer-

gency medicine is both rewarding and demanding, and shiftwork is one of its critical challenges, impacting EP longevity and the well-being of the specialty itself.¹² EPs tend to have high rates of burnout, divorce, and attrition from EM practice.⁸⁻¹² Like many physician groups, they are an aging population.¹³ It is against this background of contemporary EM practice that knowledge of, and rational approaches to shiftwork must be considered.

Irregular hours are cited as a major reason for leaving EM practice,^{8,14} but working at different times of the day and working outside the classic daytime hours of 0800 to 1800^{7,15-17} is not always bad (Table 1). Shiftwork allows greater flexibility for some individuals, evening and night shifts allow more free daytime hours for personal or family reasons, and longer shifts may permit more time off between shifts. In addition, some jurisdictions provide incentives (financial and non-monetary) for working night shifts. However the “advantages” of shiftwork are tempered by some potentially harmful effects, outlined below.

Known effects of shiftwork

Researchers have found that about 25% of the North American population are shiftworkers, and that an estimated 20% of people cannot tolerate shiftwork.^{5,6,18} Shift systems have been studied in many industries, including

Table 1. Selected shiftwork and sleep definitions

Shiftwork	Method of staffing in which different employees work at different times during the day, including times outside the classic 800–1800 hours. The “shift” is the unit of work time scheduled per day.
Fixed shift schedule	A method of scheduling shiftwork in which the individual always works the same hours each day.
Rotating shift schedule	A method of scheduling shiftwork in which the individual periodically changes the shift worked.
Shift rotation rate	A measure of the number of consecutive days an individual works before changing shifts.
Forward rotation	A change in shift to one later in the day, or clockwise, also known as a “delay shift.” The most circadian-friendly method.
Backward rotation	A change in shift to one earlier in the day, or counter-clockwise, also known as an “advance shift.” The least circadian-friendly method.
Circadian rhythms	Periodic patterns of physiologic systems (from Latin, “about a day”). In humans, these rhythms have a natural 25-hour cycle, but external cues keep them synchronized to a 24-hour period.
<i>Zeitgebers</i>	Environmental time-cues that modulate circadian rhythms, such as the light/dark cycle (from German, “time-givers”). Without these cues, human rhythms migrate to a 25-hour schedule.
Dysynchrony syndrome	A constellation of effects and symptoms due to a disharmony of circadian rhythms induced by conflicting <i>zeitgebers</i> (such as a work phase shift). It manifests as sleep loss, malaise, GI symptoms, irritability and reduced performance.
Jet lag	A circadian dysynchrony syndrome resulting from transmeridian travel.
Partial vs. complete sleep loss	Shiftwork disrupts sleep, leading to partial sleep loss daily, and a cumulative sleep debt. Complete sleep loss involves skipping one entire sleep period, as in staying up all night.
Shiftwork syndrome	A dysynchrony syndrome due to chronic shiftwork. It is characterized by a constellation of problems including chronic fatigue, GI symptoms, alcohol or drug abuse, higher rates of accidents, mood disturbances, and interpersonal relationship disturbances.
Anchor sleep	Anchor sleep is one method of maintaining sleep hygiene patterns. It involves sleeping a portion of each day’s sleep at about the same time (e.g., 4 hours every morning), no matter the shift schedule.

medicine, and much of the information generated is relevant to this discussion. The extensive literature on shiftwork describes both immediate and long-term negative effects,^{19,20} which vary from person to person and depend on many internal and external factors (Table 2).^{7,12,16,21} The pathophysiology of shiftwork, sleep, performance and health are considered below and summarized in Table 3.

Impact on sleep

Circadian physiology involves natural periodic variations in vital signs, digestion, hormones, feelings, behaviours

and, especially, sleep.^{6,15,22} The suprachiasmatic nucleus of the hypothalamus, our body's natural clock, regulates these cycles in response to many internal and external cues. Exogenous cues are called *zeitgebers*, the German word for "time givers."^{15,19,23} Powerful *zeitgebers* include social activities, food, exercise, clocks and light/day cycles, which are mediated by optical input to the suprachiasmatic nucleus.^{12,15,20} Unfortunately, working at different times of the day de-synchronizes our cues and cycles, alters our physiology and changes the way we feel. Shiftwork therefore disrupts natural circadian rhythms and interferes pro-

Table 2. Factors known to affect individual ability to cope with shiftwork

Individual factors

Age (especially <40), Gender, Chronotype (morning or evening-type), Genotype, Health status, Sleep needs, Individual adaptability, Attitudes toward work, Nutrition

Shift schedule

Direction, Rate of change, Flexibility, Degree of input, Length of shifts, Number of evening shifts, Time off, Holidays

Job requirements

Work load, Task types, Stress, Repetition, Challenges, Union rules

Environment

Light/dark cycles, Stressors, Transportation, Housing

Social factors

Family life, Social supports, Daily routines, Social group attitudes to shiftwork

Political factors

Economic conditions, Shiftwork policies, Political ideologies

Table 3. Potential negative effects of shiftwork

Problem	Individual level	Organizational (Hospital/ED/Group) level	Professional level
Medical	Fatigue & sleep loss Decreased alertness Coronary artery disease Motor vehicle collision Other trauma Peptic ulcer disease Other GI symptoms Decreased immunity Infertility Exacerbate diabetes mellitus Exacerbate epilepsy Increased smoking Poor diet	Absenteeism Accidents Errors Decreased productivity	Recruitment & retention problems Burnout & attrition from specialty
Psychological	Irritability Depression & negative moods Substance abuse Decreased motivation & burnout Diminished memory Communication problems	Poor group dynamics Relationship difficulties Decreased patient satisfaction	Burnout & attrition from specialty Decreased public perception
Social	Isolation Family challenges Lesser sex life Divorce	Isolation Lesser teamwork	Decreased public perception

*Adapted from the Centre for Sleep Research. Understanding Shiftwork. UNISA, Australia, p. 45. www.unisa.edu.au/sleep/main/tcsr_home.html

foundly with sleep. The pathophysiology of these “phase shifts” is compounded by the fact that our rhythms all adjust at different rates.²⁴ This circadian dysynchrony manifests as poor sleep and chronic fatigue.^{7,9,12,16,24,25}

Most shiftworkers have sleep problems.^{15,26} Night shiftworkers sleep, on average, 25% to 33% less than day or evening shiftworkers and have poorer quality sleep.^{9,20,26–28} Daytime interruptions (like phone calls) and a loss of Stage 2 and REM (rapid eye movement) sleep lead to chronic and cumulative sleep debt.^{7,9,15,20,29} While conventional wisdom held that many consecutive night shifts would re-synchronize circadian rhythms and allow workers to adapt, researchers have demonstrated that this is generally untrue.^{7,24,30,31} This is why “fixed” shifts and slow-rotating schedules have fallen out of use.^{16,31} For similar reasons, shiftwork differs from jet lag and from occasional overnight call, where a phase-shifter quickly re-synchronizes his or her circadian rhythms.^{12,32,33} This form of chronic sleep deprivation causes a sleep-disorder known as “shiftwork syndrome.”^{7,34} The effects described are more pronounced in people over age 40 and in women, who often tend to their children and do family chores after their shifts.^{7,16,17,35–37} Shiftwork-induced sleep disturbance ultimately leads to other health problems.

Impact on performance

In addition to sleep deprivation, circadian dysynchrony hampers cognitive and performance abilities. Experts previously viewed work-related fatigue as a linear construct that increased with more “time on task,” but this model has given way to a more sophisticated one, where fatigue is related to time on task and time of day.^{4,38} Our ability to accomplish certain kinds of tasks, such as memory-intensive work, peaks at different times of the day (e.g., reaction time is said to be maximal in the evening).^{7,15,17,30,39,40} Alterations in performance and vigilance means that shiftworkers are more prone to accidents and errors.^{6,41,42}

The literature in this area is large and complex, but there is a clear pattern of serious errors associated with night shiftwork.^{7,18,30,31,42–44} The most infamous examples include the Challenger spacecraft explosion, the Bhopal chemical disaster, the Exxon Valdez oil spill, Three Mile Island, and the Chernobyl reactor meltdown.^{9,44–47} Single-vehicle accidents are 200% more frequent when the driver is a night shiftworker,^{44,48} and in EM night shiftworkers in particular.⁴⁹ Nursing studies have also implicated shiftwork fatigue as a cause of motor vehicle accidents.^{50,51} Furthermore, anesthesia studies have documented the impact of night work and fatigue on medical error, and have advocated more humane shift systems.^{52,53} Several researchers

have attempted to measure the impact of night work on EP performance. Most notable are the works of Smith-Coggins and coworkers, who evaluated the ability of EPs at Stanford University Medical Center to carry out tasks such as EKG interpretation and intubation during different shifts.^{28,54} These investigators showed that performance clearly declines with night shiftwork and fatigue, and that EPs must be both careful practitioners and strong advocates for optimal working conditions to prevent medical errors.^{12,28,43–45,55}

Impact on psychological and social health

Disruptions in circadian rhythms lead to mood changes, irritability, feelings of stress and fatigue, and relationship difficulties. In the longer term, shiftwork is associated with higher rates of substance abuse, depression, divorce, suicide, burnout, and leaving EM altogether.^{6,9,14,56–60}

Shiftwork dates back to the watches of Roman sentries, but society remains day-centred, with most events and opportunities geared toward people who work “bankers’ hours.”¹⁵ Shiftwork is, therefore, socially isolating.^{16,18,61} During weekends, evenings and holidays, when friends and families gather, shiftworkers are often working. Irregular hours are challenging for workers, couples and families: shiftworkers tend to pursue independent hobbies,^{19,62} they have lower rates of participation in social and volunteer activities and they have higher divorce rates.^{39,63} Shiftworkers suffer by many social measures.^{9,15,19,30,62–65}

Impact on physical health

Shiftworkers have higher rates of alcoholism, drug abuse, smoking and caffeine intake.^{6,16,19,30,66} They also have higher rates of motor vehicle and occupational trauma,^{6,44} and are prone to a wide range of physical illnesses, including peptic ulcer disease and other gastrointestinal (GI) complaints, immune dysfunction, hypertension and infertility.^{4–9,17,30,58,67–69} In addition, shiftwork exacerbates diabetes, epilepsy and sleep disorders.^{7,15–18} Most notably, shiftworkers have been found to have increased rates of coronary artery disease and higher cardiac mortality.^{70–72} The risk of shiftwork has been equated to the risk of smoking one pack of cigarettes per day.¹⁴ Even after controlling for other risk factors and confounding variables, epidemiologic data show that coronary artery disease rates rise with exposure to shiftwork.⁷² Fortunately there are ways to mitigate these adverse health effects.

Optimizing shiftwork in EM

Given shiftwork’s potential to cause harm, it is important

for EPs to employ rational strategies to minimize ill effects. Table 2 summarizes many of the factors that affect the ability to tolerate shiftwork, and Table 4 outlines some of the principles and methods for modifying them.

Principle 1:
Optimize circadian-friendly schedules

Human circadian rhythms favour a forward-progressing sleep schedule,^{14,24} and research has shown that shiftworkers,^{7,22,73–76} including EPs,^{77,78} tolerate forward (clockwise) rotating shifts better than slow-rotating or fixed schedules, which condemn night shiftworkers to progressive sleep debt and associated safety risks. In addition, rapidly rotating schedules are preferred in order to avoid phase-shifting circadian rhythms to a nocturnal pattern.^{14–19,30,31,76,79–84} Individuals should work a minimum number of consecutive night shifts, optimally one or two, and nights should be followed by at least 24 hours off.^{9,15–18,25,84} To maximize recovery, some experts recommend that this should be 48 hours.³⁰ Time off should include some weekends and should allow for social activities.¹⁵ Ergonomic research suggests that optimal shift length depends on the nature of the work tasks.^{15,30} Given the complexity and stress of EM, experts recommend shorter shifts — preferably 8 hours — and this is increasingly the industry standard.^{9,32,84–88} Although 12-hour shifts allow for one-third more time off,^{9,32} they are associated with progressive fatigue and inferior patient care.^{14,86,89–93} In addition, end-of-shift handovers should be made the department practice, to facilitate EPs leaving at the end of a fatiguing shift. The more simple and predictable the scheduling template is, the greater the opportunity for worker planning and flexibility.^{15,30} Schedules meeting the above criteria improve job satisfaction and morale for EPs and other shiftworkers.^{14,16,46,75,79,94}

Principle 2:
Employ proper sleep hygiene

Useful strategies to increase the quality and quantity of sleep include optimizing sleep conditions, using “keeping patterns,” and obtaining “anchor sleep.” To optimize sleep conditions, find a comfortable bedroom, turn off phones and doorbells, use dark blinds and white noise, avoid caffeine, and educate family and friends about sleep needs.^{14,25,30} “Keeping patterns” are efforts to maintain sleep routines and rhythms. For example, a regular sleep routine helps one to unwind and prepare for sleep, and sleeping at the same time of day improves quality of sleep and maintains circadian synchrony.³⁰ “Anchor sleep,” another example of a keeping pattern, involves sleeping during a set pe-

riod each day — for example, 4 hours every morning, regardless of shift schedule.^{14,25,84,95,96} Proper sleep hygiene greatly enhances sleep quality.^{9,16,30,97}

Principle 3:
Modulate circadian rhythms

Researchers have demonstrated the power of using *zeitgebers* to modulate circadian phase-shifts.^{9,75} The most powerful of these is bright (>3000 lux) light, but there are no data to suggest this is a practical intervention for EPs.^{14,35,98} Melatonin, which is involved in the regulation of circadian

Table 4. Rational approaches to shiftwork

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|---|---|
| A. Optimize circadian-friendly schedules | <ul style="list-style-type: none"> • Forward rotating (clockwise with circadian rhythms) • Rapid changes • Minimize consecutive nights (1 or 2) • 24 to 48 hours off after nights • Allow social time, including some weekends • 8-hour shifts (absolute maximum 12 h) • Facilitate handovers • Institute regular, predictable template • Maintain flexibility |
| B. Employ proper sleep hygiene | <ul style="list-style-type: none"> • Use a sleep-friendly room: blinds, white noise, no phones, family aware • Maintain a regular sleep routine • Try anchor sleep • Avoid caffeine, alcohol or drugs |
| C. Modulate circadian rhythms | <ul style="list-style-type: none"> • Exercise • Consider bright light • Consider melatonin |
| D. Eat healthy | <ul style="list-style-type: none"> • Eat a balanced diet • Avoid junk food • Keep regular mealtimes |
| E. Promote a healthy life and work style | <ul style="list-style-type: none"> • Promote a personal healthy lifestyle • Educate friends and family about shiftwork issues • Educate colleagues about shiftwork issues • Reduce stress • Advocate for department improvements in working conditions • Advocate for shiftworker-friendly community services |
| F. Avoid pharmaceuticals | <ul style="list-style-type: none"> • Use caffeine in moderation, prn • Do not use sedatives or stimulants • Avoid alcohol before sleep |

processes and sleepiness, has received much attention;^{9,35,99,100} however, several randomized trials involving EPs have been unimpressive.¹⁰¹⁻¹⁰³ Exercise may be helpful, but, to date, no methods of modulating circadian rhythms have been shown useful for EPs.³⁰

**Principle 4:
Eat healthy**

Maintaining a balanced diet is an important component of good preventive health,^{7,14,16} and hurried consumption of junk food on night shifts undoubtedly compounds the ill effects of shiftwork. Some authorities recommend “physiologic eating” (i.e., eating at regular mealtimes in an attempt to anchor circadian GI rhythms, regardless of shift¹⁶). One recent fad, the “jet lag diet,” was proposed as a method of eating to modulate circadian rhythms, but this did not stand up to scientific scrutiny.¹⁰⁴⁻¹⁰⁶

**Principle 5:
Promote a healthy life and work style**

EPs should recognize the stress levels inherent in their departments and advocate for improvements wherever possible, since stress exacerbates the fatigue associated with shiftwork.^{30,32,107} EPs should adopt a personal healthy lifestyle, including regular physical exercise, relaxation and time for family and social activities. Whenever the opportunity arises, we should educate those around us about the nature of shiftwork and advocate for appropriate community services for shiftworkers.^{7,9,14,19,99}

**Principle 6:
Avoid pharmaceuticals**

Drugs have little role in coping with shiftwork. Some EPs use benzodiazepines and stimulants to cope with irregular hours.^{14,60,80} These substances are addictive, cause significant adverse effects and have not been shown to improve performance during off-hours shifts.^{14,30} Some physicians use alcohol to promote sleepiness, but alcohol interferes with sleep quality.^{9,30} Other relevant drugs are melatonin (discussed above), zaleplon and caffeine. Zaleplon is a new sleep aid that has shown promise for shiftworkers, but is currently not in use for this indication (H. Moldofsky, Centre for Sleep and Chronobiology, Faculty of Medicine, University of Toronto, Toronto, Ont.: personal communication, Dec. 15, 2000). Caffeine, by contrast, does have beneficial effects on alertness and performance when used in moderation.³⁰ Most sources recommend no caffeine during the final 4 hours of a shift, especially before sleep.^{14,30} Therefore, while caffeine may have a limited role, other drugs are not recommended.

Conclusion: the implications of shiftwork for emergency medicine

Shiftwork is a reality in emergency medicine. While it has some positive aspects, it leads to major health and wellness concerns for EPs and increases the stress of an already high-stress profession. EPs must be aware of the potential adverse effects and employ sound strategies to minimize them. They owe it to themselves, their families, their patients, their departments and to the specialty's future.

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