



Maximizing Firefighter Health and Safety: Advocating for the Implementation of a 24-Hour Shift Configuration

IAFF Local 1318 OH&S Committee

Introduction

In the unpredictable nature of their employment, Firefighters are regularly exposed to highly stressful, dangerous to life and health, and psychologically traumatic conditions. In ensuring public safety they endure unique challenges that demand not only physical but also mental resilience. The occupational hazards of a Firefighter are evident - operating in noxious environments often under extreme physical and mental burden in the face of injury or death. Amid these apparent dangers, less evident hazards pose substantial risks.

The shift configuration under which Firefighters operate contributes to their fitness for duty and plays a crucial role in their overall health and safety. Firefighters often contend with rotational shift schedules and irregular work hours resulting in heightened levels of fatigue, sleep deprivation, and disrupted circadian rhythms [7, 8, 10]. Numerous studies highlight the magnitude and association of circadian disruption with psychiatric illness and increased susceptibility to multiple diseases [4, 5, 6]. Simple administrative controls emphasizing positive health effects must be considered to mitigate unfavorable outcomes and yield broader benefits in the Fire Service.

There is a comprehensive case for the implementation of a 24-hour shift configuration for Firefighters that promotes better alignment with the body's natural cycles. Research supporting the adoption of a 24-hour shift analyzes the intricate relationship between circadian rhythm, shift configuration, and recovery mechanisms [1, 4, 5, 6, 7, 8, 9, 11, 12]. A shift configuration is not merely hours of work; it is an administrative control that can be employed in minimizing negative effects associated with Firefighting and in building resilience in Firefighters through effective recovery strategies. Fire Department administration has a vested interest in implementing policies that prioritize the mental and physical health of its members to support both short- and long-term health, performance, and organizational outcomes

Circadian Rhythm

The suprachiasmatic nucleus (SCN) is a region of the brain within the hypothalamus that works to establish and maintain the physiological cycle known as the circadian rhythm, a natural oscillation that repeats roughly every 24 hours [1]. The SCN is a central "master clock" that coordinates alignment between external synchronizing agents and circadian clocks in other brain regions as well as in peripheral tissues [1,3]. Circadian rhythms are inherent in human physiology and synchronize vital processes in individual cells, organs, and physiological systems [1, 2, 3].

Circadian "disruption" and/or "misalignment" are terms to describe a disturbance, dysregulation, or problem that negatively affects circadian function. It is evident that circadian disruption in humans results in broad and significant consequences for physical and mental health. Circadian disruption plays a major role in a wide range of pathology, ranging from impaired immune function and inflammation to increased risk for chronic disease [2, 5, 6]. Circadian rhythms also affect normal brain function and are strongly associated with mental health; disruption is linked to cognitive impairment, accelerated neurological decline, and psychiatric illness [4].

Animal-based evidence supports the link between circadian disruption and increased susceptibility to negative health outcomes ultimately leading to premature death [5]. The impact of disruption is observable in many areas of human health and underscores the importance of intervention in chronic misalignment between biological timing and behavior. Shift work, a prevalent cause of circadian disruption, is classified as a carcinogen by the World Health Organization [5]. A 24-hour shift configuration is shown to minimize circadian disruption and allow for the optimized recovery necessary to mitigate these short- and long-term adverse effects [7, 8, 9].

Shift Configuration

Initiating a shift without adequate recovery has profound consequences on performance. Cognitive effectiveness declines during consecutive night shifts, a stark reduction that highlights the urgency of addressing recovery periods to maintain optimal performance [7]. A 24-hour shift configuration breaks the sequence of consecutive night shifts that lead to cumulative fatigue and provides the requisite time for returning to the following shift at optimum capacity [7, 9].

For those on the traditional 10/14 shift, there is a notable desynchronization of the circadian rhythm [8, 10]. Firefighters remaining on the 10/14 shift continue to experience circadian desynchronization, emphasizing the need for a shift configuration that aligns more closely with physiological processes [8]. Transitioning to a 24-hour shift schedule reveals a restored circadian pattern, indicating the potential for positive circadian rhythm adaptation [7, 8].

The primary advantage of a 24-hour shift schedule lies in minimizing cumulative fatigue and disruptions of the sleep/wake cycle. With no consecutive nights worked, Firefighters reduce sleep debt, carry-over fatigue, and stress while gaining valuable recovery time [7, 9]. Efficient recovery time is not only essential for cognitive and physical restoration but also allows for the return to a physically and mentally resistant state that promotes short- and long-term health and safety in the line of duty [11, 12].

Recovery

A significant portion of physical and mental illness is directly correlated to desynchronization in physiological processes of the 24-hour cycle [4, 5, 6]. Greater attention to the timing and duration of exposure and recovery is needed for firefighters living and working with shift configurations that necessitate disruption in circadian rhythms [7, 8, 16]. On the job exposures leave Firefighters far more likely to get sick or die than the average person. This reality identifies the need for a comprehensive recovery strategy that acknowledges the importance of recovery periods in relation to specific cumulative damage caused by different occupational exposures [9, 11, 12].

The importance of recovery time cannot be overstated. The shift-related consequences on cognitive effectiveness show a notable decline in performance and an accumulation of sleep debt over consecutive night shifts [7, 8]. However, the repercussions of circadian disruption extend far beyond immediate performance challenges. Outcomes associated with circadian disruption include a myriad of health issues, with increasing risk of autoimmune disorders, heart diseases, stroke, cancers, and mental illness [4, 5, 6]. Further protective mechanisms of the body are inhibited, leaving the body vulnerable with compromised immune function, disturbance in insulin action and release, systemic inflammation, and impaired detoxification pathways [6, 14, 16].

Resistance, both physiological and psychological, emerges as a crucial factor in navigating the challenges posed by demanding shift configurations and circadian disruptions [14, 19]. A key determinant in safeguarding Firefighters in the face of unique occupational challenges is the ability to resist the adverse impacts of the job through the protective role of recovery activities [11, 12, 13].

Conclusion

Shift configuration is a crucial aspect of a Firefighter's operational framework and educated implementation creates an opportunity to safeguard the well-being of Firefighters. The implementation of a 24-hour shift configuration for Firefighters is not merely a matter of adjusting hours of work but is a comprehensive strategy aimed at maximizing their health and safety while allowing them to perform at their best. A 24-hour shift configuration mitigates the pressing issue of cumulative fatigue and disrupted sleep patterns that Firefighters often experience in rotational shift schedules. The transition to a 24-hour schedule most importantly offers a positive adaptation of circadian rhythms, aligning more closely with physiological processes and promoting long-term health by optimizing recovery periods and acknowledging the role of circadian disruption in disease processes.

Worker claims data shows the leading cause of fatalities for Canadian Firefighters are cancer, traumatic injury, cardiovascular disease, respiratory disease, and mental health problems. Fire Department administrations have a moral obligation to implement measures that support the well-being of their members, and the adoption of a 24-hour shift configuration stands as a proactive and scientifically supported step in the right direction. It is time to recognize the significance of prioritizing the mental and physical health of our Firefighters and to implement a shift configuration that reflects commitment to their well-being.

By tailoring recovery periods to the specific cumulative effects caused by occupational exposures, Firefighters can maintain resistance against the health risks associated with their challenging profession. Shift configuration emerges as a crucial element in fostering resistance, allowing for optimal recovery, and mitigating the detrimental effects of circadian disruption on both physiological and psychological health. The 24-hour shift configuration extends beyond the administration of working hours; it is a strategic approach to prioritizing the health and safety of Firefighters through a simple yet effective administrative control.

References

Circadian Rhythm:

[1] Kelly Glazer Baron, PhD, MPH and Kathryn J Reid, PhD Circadian Misalignment and Health Int Rev Psychiatry. 2014 April ; 26(2): 139–154. doi:10.3109/09540261.2014.911149

“Circadian rhythms are coordinated by the SCN or “master clock”, however the molecular mechanism of the clock is present in every cell of the body. Circadian or clock genes (in humans- e.g. CLOCK, CRY, PER, BMAL) comprise an autoregulatory transcriptional - translational feedback loop which demonstrates a cycle every 24 hours. In addition to individual cells, rhythms are also generated among organs including the heart, stomach, liver, and pancreas. Circadian patterns are also present among physiological systems, including the cardiovascular and renal systems.”

[2] Lymphocyte Circadian Clocks Control Lymph Node Trafficking and Adaptive Immune Responses. Immunity. 2017 Jan 17;46(1):120-132. doi: 10.1016/j.immuni.2016.12.011. Epub 2017 Jan 10. PMID: 28087238; PMCID: PMC5263259

“Daily oscillations of lymphocyte count in blood have been described and cells of the adaptive immune system such as T and B cells, as well as dendritic cells, possess the components of the molecular clock machinery.”

[3] Circadian control of brain glymphatic and lymphatic fluid flow. Nat Commun. 2020 Sep 2;11(1):4411. doi: 10.1038/s41467-020-18115-2. PMID: 32879313; PMCID: PMC7468152

“There are multiple circadian rhythms that may interact to promote rhythmic glymphatic function. Recent work hypothesized increased glymphatic clearance during the sleep phase, driving rhythmic fluid flow in the brain. Cortical neuronal activity as measured by EEG has strong circadian components in humans. The cardiovascular system as a whole is under tight circadian control, and arterial pulsatility is a key driving factor in transport of CSF along the penetrating arteries. Finally, immune system functionality is regulated by circadian timing, and we describe a clear interaction of CSF entry to the brain and lymphatic clearance of CSF.”

[4] Xie Yanling, Tang Qingming, Chen Guangjin, Xie Mengru, Yu Shaoling, Zhao Jijia, Chen Lili. New Insights Into the Circadian Rhythm and Its Related Diseases. Frontiers in Physiology 10 (2019) doi:10.3389/fphys.2019.00682

“The circadian clock system is a major regulatory factor for nearly all physiological activities and its disorder has severe consequences on human health. CR disruption is a common issue in modern society, and researches about people with jet lag or shift works have revealed that CR disruption can cause cognitive impairment, psychiatric illness, metabolic syndrome, dysplasia, and cancer.”

[5] Sletten TL, Cappuccio FP, Davidson AJ, Van Cauter E, Rajaratnam SMW, Scheer FAJL. Health consequences of circadian disruption. Sleep. 2020 Jan 13;43(1):zsz194. doi: 10.1093/sleep/zsz194. PMID: 31930347; PMCID: PMC7368337

“Circadian misalignment in shift work has also been linked to autoimmune disorders and impaired immune function. Other diseases that are associated with circadian misalignment and sleep disruption may be mediated by immunological mechanisms: heart disease, metabolic syndrome, stroke, and cancers all share inflammation as a risk factor or modifier. There is also animal-based evidence of environmental circadian misalignment causing disruption to innate and adaptive immune processes, increasing susceptibility to cancer, sepsis, intestinal inflammation, and early death. Shift work was classified by the World Health Organization as a probable carcinogen, and this classification was recently re-affirmed.”

[6] Leproult R, Holmbäck U, Van Cauter E. Circadian misalignment augments markers of insulin resistance and inflammation, independently of sleep loss. Diabetes. 2014 Jun;63(6):1860-9. doi: 10.2337/db13-1546. Epub 2014 Jan 23. PMID: 24458353; PMCID: PMC4030107

“These findings demonstrate that circadian misalignment can have adverse effects on insulin action and insulin release that are distinct from those imparted by sleep loss alone. Similarly, the levels of hsCRP, a marker of systemic inflammation and a predictor of cardiovascular disease risk, were increased after sleep restriction and to a greater extent in the participants who experienced circadian misalignment.”

Shift Configuration:

[7] Paul M, Miller J. Consideration of 5 Canadian Forces Fire Fighter Shift Schedules. 2005

“The main consequence of commencing a shift when not fully recovered is that performance will fall faster than in someone who is completely rested before commencing the same shift.”

“Cognitive effectiveness during the first to the third [consecutive] night shifts are 79%, 72%, and 68% respectively.”

“Cognitive effectiveness at the commencement of the 2nd 24-hour shift was 94% rather than 98% at the commencement of the 1st 24-hour shift.” “Days off between nocturnal alarms allowed a prediction of recovery between nights. Obviously, the sequence that produced cumulative fatigue was broken when the firefighter did not work on sequential night shifts or was not exposed to sequential nocturnal alarms.”

[8] Glazner L. MD Effect of Shiftwork on Health and Circadian Rhythm in 24-Hour Firefighters.

“Clearly, several impressions arise:

- 1) For most people who worked the 10/14 shift, there is desynchronization of the circadian rhythm. The amplitudes are flattened and there is no pattern.**
- 2) When fire fighters moved to the 24 hour shift, a circadian pattern became somewhat evident in several of the individuals.**
- 3) For those fire fighters who remained on the 10/14 shift, the desynchronization of the circadian rhythm remained.”**

[9] Glazner L. MD Letter addressed to Mr. Scott Marks President IAFF Local 3888. 2003

“In my opinion, the primary advantage of the proposed 24-hour schedule for the City of Toronto firefighters is the minimizing of negative effects of shiftwork on the 24-hour circadian rhythm of the body. It would greatly reduce the level of cumulative fatigue and disruptions of the sleep/wake cycle. As firefighters would not work consecutive nights, they would have a better opportunity to recover and rest at home in their own bed, before the start of their next workday; this would help in reducing the incidence of sleep debt accumulation, carry-over fatigue and stress.”

[10] Boivin DB, Boudreau P, Kosmadopoulos A. Disturbance of the Circadian System in Shift Work and Its Health Impact. J Biol Rhythms. 2022 Feb;37(1):3-28. doi: 10.1177/07487304211064218. Epub 2021 Dec 30. PMID: 34969316; PMCID: PMC8832572

“Simulated night-shift experiments and field-based studies with shift workers both indicate that the circadian system is resistant to adaptation from a day- to a night-oriented schedule, as determined by a lack of substantial phase shifts over multiple days in centrally controlled rhythms...”

“Reduced sleep quality and duration, and symptoms of insomnia are frequent in shift workers, especially those working nights, early morning, and rotating shifts. Typically, the daytime sleep periods of night-shift workers end prematurely after 4 to 6 h and workers are often unable to resume sleep afterward.”

Recovery:

[11] Zhao Y, Newman MC. Effects of exposure duration and recovery time during pulsed exposures. *Environ Toxicol Chem.* 2006 May;25(5):1298-304. doi: 10.1897/05-341r.1. PMID: 16704061

“Recovery time had a significant effect on the second-exposure mortality. Given enough time, [subject] could recover to a state similar to their original toxicant resistance state.”

[12] Zhao, Yuan, "Application of survival analysis methods to pulsed exposures: Exposure duration, latent mortality, recovery time, and the underlying theory of survival distribution models" (2005). Dissertations, Theses, and Masters Projects. William & Mary. Paper 1539616920

“The effects of both exposure duration and recovery time during pulsed exposures were tested in this study. No significant effect of exposure duration on latent mortality was found; Significant effect of recovery time on mortality during a second exposure was found for both toxicants.”

[13] Hruska B, Barduhn MS. Dynamic psychosocial risk and protective factors associated with mental health in Emergency Medical Service (EMS) personnel. *J Affect Disord.* 2021 Mar 1;282:9-17. doi: 10.1016/j.jad.2020.12.130. Epub 2020 Dec 28. PMID: 33387746

“While not widely explored among EMS personnel, some research indicates that providing workers with adequate time to recover following critical event exposure is both valued and associated with reduced psychological distress...”

[14] Liska DJ. The detoxification enzyme systems. *Altern Med Rev.* 1998 Jun;3(3):187-98. PMID: 9630736

“The scientific literature suggests an association between impaired detoxification and certain diseases, including cancer, Parkinson’s disease, fibromyalgia, and chronic fatigue/immune dysfunction syndrome. Data regarding these hepatic detoxification enzyme systems and the body’s mechanisms of regulating them suggests the ability to efficiently detoxify and remove xenobiotics can affect these and other chronic disease processes.”

[15] Huang T, Redline S. Cross-sectional and Prospective Associations of Actigraphy-Assessed Sleep Regularity With Metabolic Abnormalities: The Multi Ethnic Study of Atherosclerosis. *Diabetes Care.* 2019 Aug;42(8):1422-1429. doi: 10.2337/dc19-0596. Epub 2019 Jun 5. PMID: 31167888; PMCID: PMC6647049

“Increased variability in sleep duration and timing was associated with higher prevalence and incidence of metabolic abnormalities even after consideration of sleep duration and other lifestyle factors.”

[16] Colwell CS, Matveyenko AV. Timing is everything: implications for metabolic consequences of sleep restriction. *Diabetes.* 2014 Jun;63(6):1826-8. doi: 10.2337/db14-0283. PMID: 24853892; PMCID: PMC4392929

“As for metabolic parameters, mistimed sleep lacks the same restorative benefits of sleeping at an appropriate phase of the circadian cycle. (Leprout et al.) suggests that greater attention should be placed on the timing and not just the duration of our sleep.”