Sleep Deprivation and Impacts
South Metro’s Culture

• Overall, South Metro Values Public Trust, Equitable Treatment of All, Strong Community Ties, Integrity, Compassion and Professionalism.

But there’s more....

• We value the safety, health and wellness of all of our personnel so that they can go home each night to their families and have a healthy life after retirement.

We Invest in our People
How do we do this?

By identifying what’s harming our firefighters:

Cancer
• Cancer has become the leading cause of Line of Duty death in firefighters with 66 percent of the career firefighter line-of-duty deaths from 2002 to 2019 caused by cancer, according to data from the International Association of Fire Fighters (IAFF).

Cardiac
• The United States Fire Administration also names heart attacks and cardiac events as one of the leading causes of LODD for active-duty firefighters.

Suicide
• Research shows Post-Traumatic Stress Disorder (PTSD) and depression rates for firefighters can be five times higher than the civilian population. Just last year, more than twice as many firefighters died by suicide than died while on duty.
How SMFR is Responding

• Cancer – Contributing Factor is Exposure
  • What is SMFR Doing?
    • 2 Sets of Bunker Gear, Washing Gear Immediately, Laundry in Stations
    • Training with non-toxic burn materials, Exhaust Systems in Bays, Compartments on Apparatus

• Cardiac – Contributing Factor is High BMI, Obesity, etc.
  • What is SMFR Doing?
    • Physical fitness priority – equipment in stations
    • METs Testing

• Suicidal Ideation – Contributing Factor is PTSI, Depression, etc.
  • What is SMFR Doing?
    • Focus on Mental Health
    • Resource Availability

We Have an Amazing Wellness Bureau
Common Thread Through All of This?

- Cancer
- Cardiac
- Suicidal Ideation

Sleep Deprivation
Sleep Deprivation

- Decreased Cognitive Abilities
- Increased Stress Response

Systemic Performance Decrease

- Cognitive
- Neurological
- Heart
- Joints
- Metabolism
- Immunity
There are Many Studies on Sleep Deprivation
Impact of Chronic Sleep Debt

Physical
- Increase in illness/injury
- Increase in Body Weight
- Increase in Reaction Time
- Decrease in Motor Control

Emotional
- Increase in Negative Emotions
- Increase in Risk of Depression
- Decrease in Ability to Cope

Cognitive
- Decrease in Critical Thinking
- Decrease in Moral Judgement
- Decrease in Memory Formation
- Decrease in Information Processing
- Decrease in Accuracy of Performance Self-Appraisal
What is SMFR doing to Contribute to Minimizing Sleep Deprivation?

• Station Alerting Systems
  • Only rigs that are called for service are alerted in stations.
  • All SMFR Stations Have this Except Station 35 and Station 37

• Sleep Study
  • Partnering with Dr. Joel Billings, Assistant Professor, Department of Security and Emergency Services at Embry-Riddle Aeronautical University

What Else Can we Do?
Look at Shift Schedules

- SMFR Firefighters work 56 hours per week
- Shift Schedules are currently at a 48/96
- Data shows that this shift schedule (working 48 hours straight) has contributed to sleep deprivation
- SMFR Station Analysis
48/96 SLEEP STUDY ANALYSIS - 2010

Less than 6.5 hours of uninterrupted sleep between 2200 and 0600 for SUPPRESSION Units

Less than 7.5 hours of uninterrupted sleep between 2200 and 0600 for MEDIC Units
48/96 SLEEP STUDY ANALYSIS - April 15, 2018 - April 14, 2019

Less than 6.5 hours of uninterrupted sleep between 2200 and 0600 for SUPPRESSION Units
Less than 7.5 hours of uninterrupted sleep between 2200 and 0600 for MEDIC Units

PERCENTAGE

UNIT

< 10% 11 - 19% > 20%
How Can we Fix the Reds and Yellows?

- Look at Shift Schedule Change
- Moving from a 56 to 48-hr. Work Week
- Move Away from 48 hr. Shifts
Next Steps – What Now?

• Local 2086 and Staff Looking at Schedule Options
  • Possible reduction in work week
  • Define Funding Needs – personnel and/or other costs associated
• Quantify Plan and Impact and Present to Board for Recommendation
Thank you
Firefighter Accidents Are Linked to Sleep Problems

By Nicholas Bakalar  November 13, 2014 5:07 pm

More than 60 percent of deaths of firefighters are caused by heart attacks and traffic accidents. Sleep disorders may be an important contributing factor, a new study suggests.

Researchers screened a nationally representative sample of 7,000 firefighters in 66 fire departments for obstructive sleep disorder, insomnia, restless leg syndrome and shift work disorder. They interviewed the subjects and documented traffic accidents using police reports and detailed descriptions from subjects.

The study, published in The Journal of Clinical Sleep Medicine, found that about 37 percent of the firefighters screened positive for at least one sleep disorder, most for obstructive sleep apnea.

After controlling for sex, race, body mass index, smoking and other factors, the researchers found that compared with sound sleepers, those with a sleep disorder were about twice as likely to have a motor vehicle crash, to nod off while driving, and to have cardiovascular disease or diabetes. They were more than three times as likely to suffer from depression and anxiety.

The investigators acknowledge that some of their data depended on self-reports, which are not always reliable. Still, the lead author, Laura K. Barger, an associate
physiologist at Brigham and Women’s Hospital in Boston, said that screening for sleep disorders is important. “If you can get these people evaluated and treated when necessary,” she said, “you can improve the health of workers.”
Firefighter Shift Schedules Affect Sleep Quality
Joel Billings, MS and Will Focht, PhD

**Objective:** The aim of this study was to investigate the prevalence and severity of firefighter sleep quality across department shift schedules.

**Methods:** Sleep quality was assessed using a Pittsburgh Sleep Quality Index in a sample of 169 male career firefighters from six fire departments in three Southwestern US states. The three shift schedules studied were 24on/48off, 48on/96off, and Kelly. Results: Seventy-three percent of firefighters report poor sleep quality. The 24on/48off shift schedule is associated with the best sleep quality and Kelly is associated with the worst sleep quality. Firefighters working second jobs report significantly poorer sleep quality than those who do not. **Conclusions:** Shift schedules that disrupt normal circadian rhythms more result in poorer sleep quality, which can lead to less effective emergency response and increased risk to firefighter health and safety.

Sleep research has been conducted during the last 50 years in fields as diverse as medical services, transportation, military, and industry. Few studies, however, have investigated sleep quality in the fire service and none have looked at the relationship between shift schedules and sleep quality.

The emergence of inquiries concerning the relationship of sleep quality to firefighter performance and safety has elevated the importance of sleep research in the fire service. Investigators found that 59% of firefighters in a major US metropolitan city report sleep deprivation. Firefighters in Finland report sleep disturbances after working more than 50 hours in a week. In a study conducted in Tehran, 69.9% of firefighters report poor sleep quality compared with 37% of the general adult population. Finally, in a study of South Korean firefighters, 51.6% of shiftwork firefighters suffer poor sleep quality compared with 38.5% of nonshiftwork firefighters.

Acute health impairments from sleep deprivation include short-term memory loss, slower reaction time, reduced vigilance, and mood changes. Chronic effects include impairments to cardiovascular, immune, and gastrointestinal functions and contribute to obesity.

Sleep deprivation also increases the risk of workplace injury. Inadequate sleep has led to human errors that contribute to large occupational accidents such as the Three Mile Island Davis-Besse reactor, Chernobyl, and Bhopal. Workers experiencing excessive daytime sleepiness (EDS) exhibit a higher injury rate than those who are not experiencing EDS.

The urgency of comprehensive research on the effects of shift schedule design on sleep quality is obvious. Such schedules may be associated with an increased in health and fireground injury risks as well as decreases in mental and physical performance. Proper shift design requires accommodation to normal sleep patterns while on shift and include sufficient time between shifts to restore circadian sleep rhythm.

The purpose of this study is to investigate the effect of fire service shift schedules on sleep quality. This may be a result of frequent interruptions from emergency responses during the night that affects circadian rhythm.

**DISTURBANCE OF CIRCADIAN RHYTHM**

The National Sleep Foundation recommends seven to nine (average of eight) hours of sleep each night for most adults. Each sleep bout should include several consecutive and uninterrupted cycles of rapid eye movement (REM) and nonrapid eye movement (NREM) sleep. Deeper stages of NREM sleep, which takes about one hour to reach, are required to restore wakefulness and cognitive function. In the fire service, frequent interruptions from emergency response actions prevent firefighters from properly cycling through sleep stages of sufficient duration. Frequent disturbances and irregular sleeping patterns lead to sleep deprivation, increase firefighter stress, contribute to fatigue, and affect physiological function. (Although daytime naps may provide short-term benefits, they are not a substitute for long-duration sleeping.)

If normal cycles of wakefulness and sleep each day (circadian rhythm) are frequently interrupted, restoration of normal rhythm requires at least two days and as many as four days for more severe circadian dysrhythmia.

**Estimation of Circadian Dysrhythmia Associated With Shift Schedules**

Thousands of rotating and permanent shift schedules are used worldwide. The fire service is no exception. In the US, 150 fire department shift schedules have been reported. We believe that disturbances to normal sleep caused by emergency response calls can cause circadian dysrhythmia, and that the severity of the dysrhythmia is related to shift schedule.

For example, in a 24on/48off shift schedule (Table 1), the normal sleep cycle is disrupted for one day. As two days separate each work shift, we believe that the return to normal sleep patterns is possible such that no further circadian rhythm disturbance is accrued after the work shift is over. Therefore, the circadian dysrhythmia associated with this schedule remains at one day.

In a 48on/96off shift schedule (Table 2), the disturbance to circadian rhythm during the work shift is greater, totaling two days. However, as four days are provided between shifts, rhythm can return to normal and no further dysrhythmia occurs. We believe that it is appropriate to judge the circadian dysrhythmia associated with this schedule as two days.

In a Kelly schedule (24on/24off/24on/24off/24on/96off, Table 3), the disturbance is much greater. We can see that a firefighter goes five days before sufficient time off is provided to return to normal rhythm. Therefore, we conclude that the circadian dysrhythmia associated with this schedule is five days.

**RESEARCH DESIGN**

A focus group composed of a current fire chief and two retired fire chiefs provided expert advice on the selection of fire service shift schedules, design of a fire department sampling strategy, and construction of the interview questionnaire.

**Selection of Shift Schedules**

As our study is focused on sleep quality caused by sleep disturbances while on the job and restoration of circadian rhythm.

From the Fire and Emergency Management Administration Graduate Program, Department of Political Science, Oklahoma State University, Stillwater, Oklahoma.

The authors declare no conflicts of interest.

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DOI: 10.1097/JOM.0000000000000624
TABLE 1. 24on/48off Shift Schedule

<table>
<thead>
<tr>
<th>S</th>
<th>M</th>
<th>T</th>
<th>W</th>
<th>T</th>
<th>F</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>On</td>
<td>Off</td>
<td>Off</td>
<td>Off</td>
<td>On</td>
<td>Off</td>
<td>Off</td>
</tr>
<tr>
<td>Off</td>
<td>Off</td>
<td>On</td>
<td>Off</td>
<td>Off</td>
<td>On</td>
<td>Off</td>
</tr>
</tbody>
</table>

The 24on/48off schedule typically operates with three shifts, with all shifts starting at 7:00 a.m. on their work day, and departments choose to either pay Fair Labor Standards Act overtime or assign time off to avoid overtime depending on their designated work period.

TABLE 2. 48on/96off Shift Schedule

<table>
<thead>
<tr>
<th>S</th>
<th>M</th>
<th>T</th>
<th>W</th>
<th>T</th>
<th>F</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>On</td>
<td>On</td>
<td>Off</td>
<td>Off</td>
<td>Off</td>
<td>Off</td>
<td>On</td>
</tr>
<tr>
<td>Off</td>
<td>Off</td>
<td>Off</td>
<td>Off</td>
<td>Off</td>
<td>On</td>
<td>On</td>
</tr>
</tbody>
</table>

The 48on/96off schedule typically operates with three shifts, with all shifts starting at 7:00 a.m. on their work day, and departments choose to either pay Fair Labor Standards Act overtime or assign time off to avoid overtime depending on their designated work period.

TABLE 3. Kelly Shift Schedule

<table>
<thead>
<tr>
<th>S</th>
<th>M</th>
<th>T</th>
<th>W</th>
<th>Th</th>
<th>F</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>On</td>
<td>Off</td>
<td>On</td>
<td>Off</td>
<td>On</td>
<td>Off</td>
<td>Off</td>
</tr>
<tr>
<td>Off</td>
<td>Off</td>
<td>On</td>
<td>Off</td>
<td>On</td>
<td>Off</td>
<td>On</td>
</tr>
</tbody>
</table>

The Kelly schedule typically operates with three shifts, with all shifts starting at 7:00 a.m. on their work day, and departments choose to either pay Fair Labor Standards Act overtime or assign time off to avoid overtime depending on their designated work period. The Kelly schedule is also commonly referred to as the Blockley, Modified Detroit, and 3/4 schedule.

afterward, we decided to investigate only shift schedules that are at least 24 hours long. Although five 24-hour work schedules have been reported, the focus group advised that few departments in the Southwest US study region adopt 24on/24off and 24on/72off schedules. Therefore, the shift schedules examined in this study are the 24on/48off, 48on/96off, and Kelly shift schedules.

Selection of Fire Departments

The United States Fire Administration (USFA) divides fire departments into four categories: volunteer, mostly volunteer, mostly career, and career. As this research concerns firefighters who sleep at fire stations, only career departments that employ full-time firefighters were considered.

To minimize the effect of variables other than shift schedule, we decided to investigate departments in the Southwestern US with similar characteristics regarding the number of fire stations, annual call volume, number of firefighters, and shift start time. We selected two departments for each of the three shift schedules. These departments each had between four and six fire stations, 60 and 100 firefighters, 4000 and 5000 calls per year, and shifts starting at 7:00 a.m.

Selection of Respondents

Only full-time firefighters with at least one month of current continuous shift-work experience were recruited to participate in interviews held at their fire stations. This assured that the respondents worked the entire shift, responded to alarms for emergency response when these occurred, and had sufficient experience on the shift schedule to reliably report sleep quality.

Interview Protocol

At each fire station in a department, the lead investigator conducted group meetings with about five firefighters in each session. After discussing the purpose of the study, reviewing the interview protocol, and obtaining written consent, the investigator asked each respondent to complete a sleep quality questionnaire and a demographic characteristic questionnaire. Immediately after completion, each questionnaire was reviewed for errors and missing values, and corrections/additions were made as necessary. Each interview session lasted between 15 and 20 minutes. In all, 109 career firefighters completed questionnaires at 26 stations in the six departments. The interviews were conducted during a three-month period in early 2014.

HYPOTHESES AND VARIABLES

Hypotheses

The first hypothesis, H1, is that average firefighter sleep quality will be reported as poor regardless of shift schedule because all three schedules disrupt circadian rhythm. The null hypothesis, H0, is that sleep quality will be reported as good regardless of shift schedule.

Our second hypothesis, H2, is that sleep quality decreases with shift schedules that cause greater circadian dysrhythmia. The null hypothesis, H20, is that sleep quality does not decrease with shift schedules that increase circadian dysrhythmia.

Dependent Variable: Sleep Quality

The Pittsburgh Sleep Quality Index (PSQI) includes 19 questions that measure seven components of sleep quality: (1) subjective sleep quality, (2) sleep latency, (3) sleep duration, (4) habitual sleep efficiency, (5) sleep disturbances, (6) use of sleep medication, and (7) daytime dysfunction. The PSQI has been shown to be a valid and reliable testing measurement for sleep-related inferences. Its scales exhibit high internal consistency with a reliability coefficient (Cronbach's α) equal to 0.83. This measurement has been a popular choice in prior studies in the fire service and in numerous other occupational studies. Therefore, the combination of these scales into one sleep quality index is justified and appropriate to measure sleep quality.

Each component of the survey receives a value of 0, 1, 2, or 3. These values are then summed across the seven components to yield a global PSQI score, ranging from 0 (best sleep quality) to 21 (worst sleep quality). A global score of 5 or less is equated to good sleep quality; thus, any score greater than 5 is associated with poor sleep quality.

The PSQI was designed to measure average sleep quality over the previous month, assuming that respondents experience only one sleep bout per day. However, firefighters frequently experience several bouts of sleep in a 24-hour period due to emergency calls. We modified the calculation of sleep duration by summing the reported average sleep curation for each bout during a day over the previous month. It is unclear how past firefighter studies addressed the calculation of sleep duration over multiple bouts per day.

The global PSQI score was treated as both an ordinal variable and a dichotomous variable in our statistical analyses.

Primary Independent Variable: Shift Schedule

As described above, the focus group advised that only the 24on/48off, 48on/96off, and Kelly shift schedules are commonly used in the study region. Therefore, only these schedules were considered. Shift schedule was treated as a nominal variable in our statistical analyses.
**TABLE 4. Characteristics of Firefighter Respondents**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Distribution (All Schedules)</th>
<th>24on/48off Schedule</th>
<th>48on/96off Schedule</th>
<th>Kelly Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number working each shift schedule</td>
<td>109 (all male)</td>
<td>31 (28%)</td>
<td>38 (35%)</td>
<td>40 (37%)</td>
</tr>
<tr>
<td>Marital status</td>
<td>94 (86%)</td>
<td>27 (79%)</td>
<td>33 (87%)</td>
<td>34 (85%)</td>
</tr>
<tr>
<td>Children living at home</td>
<td>79 (72%)</td>
<td>22 (71%)</td>
<td>27 (71%)</td>
<td>30 (75%)</td>
</tr>
<tr>
<td>Working a second job</td>
<td>70 (64%)</td>
<td>17 (55%)</td>
<td>22 (58%)</td>
<td>31 (78%)</td>
</tr>
<tr>
<td>Reporting sleep related disorder</td>
<td>13 (12%)</td>
<td>2 (6%)</td>
<td>5 (13%)</td>
<td>6 (15%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Mean (All Firefighters)</th>
<th>24on/48off Schedule</th>
<th>48on/96off Schedule</th>
<th>Kelly Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (Range = 20–59)</td>
<td>38.0</td>
<td>40.8</td>
<td>35.9</td>
<td>38.0</td>
</tr>
<tr>
<td>Years of Service (Range = 1–34)</td>
<td>12.7</td>
<td>15.3</td>
<td>10.5</td>
<td>12.8</td>
</tr>
<tr>
<td>Average number of interruptions/</td>
<td>2.0</td>
<td>2.2</td>
<td>2.0</td>
<td>1.9</td>
</tr>
<tr>
<td>work night (Range = 0–5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Control Variables**

The focus group agreed with our selection of four demographic characteristics that can also affect sleep quality by interfering with restoration of circadian rhythm. These included one interval variable: years of service and three dichotomous variables: children living at home, working a second job, and existence of a diagnosed sleep-related disorder such as sleep apnea.

**RESULTS**

Table 4 summarizes demographic and sleep quality characteristics of the career firefighters interviewed for our study. All respondents are male and most are married, have children living at home, work a second job, and worked in the fire service an average of nearly 13 years. Nearly all firefighters report no sleep-related disorder and the average number of sleep interruptions per night is two.

Calculation of PSQI scores and statistical analyses were conducted using STATA software. Figure 1 illustrates the distribution of PSQI scores. Although these scores can range from 0 to 21, the highest score found was 15. The distribution of scores within this range approaches normality, though slightly skewed. Eighty (73%) of the 109 firefighters report poor sleep quality (PSQI global score greater than 5).

A one-sample mean-comparison analysis was performed to determine whether the mean global PSQI score for each shift schedule is significantly greater than 5 (the threshold of good sleep quality). The result of this analysis confirms that the mean PSQI score for each of the three shift schedules is significantly greater than 5 (Table 5), demonstrating that the average firefighter on all three shift schedules suffers from poor sleep quality.

To control for the effects of years of service, children living at home, working a second job, and affliction with a sleep disorder, we performed a logistic regression (Table 6). These results demonstrate that shift schedule, personal average number of night interruptions at work, and working a second job are the only demographic variables that adversely affect sleep quality.

Table 7 presents the mean PSQI global scores for each shift schedule, for each department and across both departments. Figure 2 illustrates that these scores increase with increasing circadian dysrhythmia estimates associated with each shift schedule. [Note that we did not include shift schedules with dysrhythmia estimates of three or four because such schedules would be rare, if they exist at all.]

To examine more carefully how sleep quality varies across shift schedules, we first used a Kruskal–Wallis test, which suggests that sleep quality weakly varies across the schedules [$\chi^2(2, 106)=4.451, \ P=0.108$. To explore this variance more closely, a post hoc comparison between the three pairs of shift schedules demonstrates that only two of the three comparisons are statistically different: the 24on/48off schedule versus Kelly and the 48on/96off schedule versus Kelly. The difference between the 24on/48off and 48on/96off schedule is not statistically significant (Table 8), which explains the relative weakness of the Kruskal–Wallis test result.

**FIGURE 1. Distribution of PSQI scores from 109 firefighters.**

**TABLE 5. Comparison of Sleep Quality Scores Across Shift Schedules**

<table>
<thead>
<tr>
<th>Shift Schedule</th>
<th>Number of Observations</th>
<th>Mean PSQI Score</th>
<th>Standard Error</th>
<th>Standard Deviation</th>
<th>$t$ Score</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>24on/48off</td>
<td>31</td>
<td>7.0</td>
<td>0.55</td>
<td>3.0</td>
<td>3.6</td>
<td>0.001</td>
</tr>
<tr>
<td>48on/96off</td>
<td>38</td>
<td>7.3</td>
<td>0.52</td>
<td>3.2</td>
<td>4.5</td>
<td>0.000</td>
</tr>
<tr>
<td>Kelly</td>
<td>40</td>
<td>8.3</td>
<td>0.45</td>
<td>2.8</td>
<td>7.2</td>
<td>0.000</td>
</tr>
</tbody>
</table>

PSQI, Pittsburgh Sleep Quality Index.
TABLE 6. Logistic Regression of Independent and Control Variables on Sleep Quality

<table>
<thead>
<tr>
<th>Variable</th>
<th>β</th>
<th>Standard Error</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shift schedule</td>
<td>0.73</td>
<td>0.34</td>
<td>0.03</td>
</tr>
<tr>
<td>Average number of interruptions/night</td>
<td>1.34</td>
<td>0.37</td>
<td>0.00</td>
</tr>
<tr>
<td>Reporting a sleep-related disorder</td>
<td>1.70</td>
<td>1.17</td>
<td>0.15</td>
</tr>
<tr>
<td>Working a second job</td>
<td>0.87</td>
<td>0.52</td>
<td>0.09</td>
</tr>
<tr>
<td>Children living at home</td>
<td>-0.55</td>
<td>0.61</td>
<td>0.93</td>
</tr>
<tr>
<td>Years of service</td>
<td>0.01</td>
<td>0.03</td>
<td>0.70</td>
</tr>
<tr>
<td>Constant</td>
<td>-3.62</td>
<td>1.34</td>
<td>0.01</td>
</tr>
</tbody>
</table>

N observations: 109
X² test: 30.81, 0.000

DISCUSSION

Hypothesis Testing

On the basis of a sample of 109 firefighters from the six fire departments, 80 of the 109 (73%) firefighters report poor sleep quality. Our finding of poor sleep quality compares favorably with the incidence of poor sleep quality in other studies (69.9% in Tehran study6 and 51.6% in the Republic of Korea study). Although no comparative investigation was conducted in this study, poor sleep quality has been reported in a different Tehran study7 (37% in the general population) and in the Republic of Korea study (38.5% of nonshiftwork firefighters), indicating that shiftwork firefighters suffer poorer sleep quality than comparative samples.

The mean PSQI global scores are significantly greater than 5 for each department and shift schedule. The strong statistical relationship (P = 0.000) between the number of sleep interruptions in a night and sleep quality is consistent with the claim that disruption of normal sleep stages contributes to poor sleep quality. Therefore, we reject the first null hypothesis, H0, lending support to our claim that fire department schedules that include work shifts equal to or greater than 24 hours contribute to poor sleep quality through interruptions of normal sleep likely caused by emergency calls during the night.

In comparing the sleep quality differences between pairs of shift schedules, we find that sleep quality associated with the 24on/48off and 48on/96off schedules is not significantly different. Although we had hypothesized that a significant difference would be found, our results did show a difference in the predicted direction. We speculate that our failure to find a statistically significant difference may be that firefighters on the 48on/96off shift schedule are able to obtain some sleep during their shift given its 48-hour length that mitigates circadian dysrhythmia (or these departments may manifest other unique features that are not captured in our study).

Nevertheless, differences in sleep quality between Kelly and the other two shift schedules show that the greater the dysrhythmia, the poorer the sleep quality. We believe these results allow us to tentatively reject the null hypothesis, H2, lending support to our primary hypothesis that sleep quality decreases as circadian dysrhythmia associated with shift schedules increases.

Second Jobs

Currently, no extant peer-reviewed literature explores how second jobs influence firefighters’ overall well-being. An earlier study suggested that 25% to 50% of firefighters have second jobs but did not report how these percentages were estimated.16 In a sample of 458 firefighters from departments in the Midwestern United States, 245 (53.3%) of firefighters were engaged in additional paid work outside the fire department.23 Another study found that 156 out of 379 firefighters (41.2%) work a second job and that this was a predictor of poor sleep quality.25 Our study finds that 70 of the 109 (64%) of firefighters work in jobs outside of the fire department. Our results suggest that working second jobs during time off between work shifts may further adversely affect sleep quality (r = 0.24, P < 0.01; β = 0.87, P = 0.09). Thus, it is reasonable to surmise that those who work a second job are more likely to have poorer sleep quality than those who do not because they do not have sufficient

TABLE 7. PSQI Scores, by Shift Schedule

<table>
<thead>
<tr>
<th>Shift Schedule (Dysrhythmia Estimate)</th>
<th>Statistic</th>
<th>Department One</th>
<th>Department Two</th>
<th>Both Departments</th>
</tr>
</thead>
<tbody>
<tr>
<td>24on/48off (1 day)</td>
<td>No. of observations</td>
<td>16</td>
<td>15</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Mean PSQI Global Score</td>
<td>6.8</td>
<td>7.2</td>
<td>7.0</td>
</tr>
<tr>
<td></td>
<td>Standard deviation</td>
<td>2.3</td>
<td>3.7</td>
<td>3.0</td>
</tr>
<tr>
<td>48on/96off (2 days)</td>
<td>No. of observations</td>
<td>18</td>
<td>20</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>Mean PSQI Global Score</td>
<td>7.0</td>
<td>7.6</td>
<td>7.3</td>
</tr>
<tr>
<td></td>
<td>Standard deviation</td>
<td>2.7</td>
<td>3.6</td>
<td>3.2</td>
</tr>
<tr>
<td>Kelly (5 days)</td>
<td>No. of observations</td>
<td>23</td>
<td>17</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Mean PSQI Global Score</td>
<td>8.2</td>
<td>8.4</td>
<td>8.3</td>
</tr>
<tr>
<td></td>
<td>Standard deviation</td>
<td>2.2</td>
<td>3.6</td>
<td>2.8</td>
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TABLE 8. Analysis of Difference in PSQI Scores Between Shift Schedules

<table>
<thead>
<tr>
<th>Shift Schedule</th>
<th>χ² with Ties</th>
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<tr>
<td>24on/48off vs 48on/96off</td>
<td>0.115</td>
<td>0.734</td>
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<tr>
<td>24on/48off vs Kelly</td>
<td>3.967</td>
<td>0.046</td>
</tr>
<tr>
<td>48on/96off vs Kelly</td>
<td>2.979</td>
<td>0.084</td>
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</table>

time to restore normal circadian rhythms. We intend to investigate the influence of working second jobs more carefully in a follow-up study.

CONCLUSIONS

As the human body requires sleep tied to normal circadian rhythms, disruption of sleep patterns disturbs rhythm and therefore contributes to poor sleep quality. Poor sleep quality can lead to less effective emergency response, increased risk to firefighter health and safety, and affect services delivered to communities. Although the fire service cannot prevent interruptions during the night, departments can consider revising their shift schedules to decrease circadian dysrhythmia.

ACKNOWLEDGMENTS

We would like to extend our gratitude to the 109 firefighters, six associated fire departments, and fire chiefs Chris Neal, Ed Kirtley, and Jarett Metheny, without whose expert advice this study would not have been possible.

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Sleep: A Missing Link to Cancer Prevention

BY DENA ALI

The increased toxicity of the modern fireground makes cancer one of the greatest threats to firefighter health today. Although this claim has been supported by numerous studies, many of them have conflicting findings because there is no standard method to harvest data. For example, a large-scale study of 30,000 firefighters from 1860-2009 conducted by the National Institute for Occupational Safety and Health reported a nine percent increase in cancer deaths for firefighters. Yet, another interpretation of the same study found just a small to moderate increase for certain cancers stemming primarily from the digestive, respiratory, and urinary systems. Notably, this study found a two-fold increase in malignant mesothelioma from asbestos exposure.

Conclusions from these types of studies suggest the need for future research to control for such variables as gender, race, number/type of calls, and use of respiratory protection. However, studies like these have also been limited in what they tell us about techniques for cancer prevention. We're directing efforts at limiting exposure by keeping firefighters, gear, apparatus, and stations clean. But are we missing other critical pieces of the prevention puzzle?

Effects of the Immune System

What if there was a simple way to strengthen your immune system so that your body's natural killer cells could attack malignant (cancerous) tumor cells? There is an embattled system to boost these cancer-fighting cells, but to work, the system requires obtaining sufficient sleep—seven to nine hours a night. Preventing cancer by limiting exposure to toxins but failing to get proper sleep is akin to attempting to lose weight by exercise but failing to eat healthy.

In a landmark study on the impact of sleep and cancer-fighting immune cells, Dr. Michael Irwin discovered that just one night of insufficient sleep (four hours compared to eight) eliminated 70 percent of these cells circulating in the immune system. To further demonstrate the negative effects of insufficient sleep on the immune system, a large European study of almost 25,000 people found that sleeping six hours or less was associated with a 40 percent increased risk of developing cancer compared to those who slept seven hours or more.

It's not just the cancer-fighting cells that poor sleep renders ineffective; studies of vaccines have found that insufficient sleep can also render the body too weak to produce an effective immune response. One study found that individuals who had their sleep restricted for just a week prior to getting a flu shot produced less than 50 percent of the immune reaction compared to the group that had adequate sleep.

Sleep Health

First responders are well known for their poor sleep habits, and it doesn't take too long to hear the adage, "I'll sleep when I'm dead" tossed around. Sadly, if that's a motto you live by, you may have the opportunity sooner than you'd prefer. "Like water from a burst pipe in our home, the effects of sleep deprivation will seep into every nook and cranny of biology, down into your cells, and even alter your DNA." Simply put, the less time you sleep, the less time you will live. In his research, sleep scientist Dr. Matthew Walker found that insufficient sleep was a slow form of euthanasia. Despite growing evidence for this, there is often an attitude of invulnerability in firehouses that suggests that those who need more sleep are weak or lazy.

Although it is easy for firefighters to attribute their sleep deprivation to their uncontrollable work schedules, many firefighters neglect sleep during their off time as well. For example, it's common during shift change to talk about plans for the day; those plans usually surround second jobs or child care. Rarely will you hear anybody admit to needing to "go home and take a nap" because sleep's necessity is rarely discussed in the fire service. The Toomeys argue that the first step to improving sleep in the fire service is to admit that there is in fact a problem rather than avoiding the issue and convincing each other that sleep is unnecessary.

It came as no surprise when a 2016 national study of 7,000 firefighters conducted across 66 fire departments found that 37 percent of firefighters were at risk of sleep disorders. Eighty-one percent of that cohort had not yet been diagnosed. This study included educational sessions, sleep disorder screening, free treatment, and outcome measures. Despite the free treatment, only 10.3 percent of those who screened positive for the risk took advantage of it. The study also found that implementing a program on sleep disorders could significantly reduce the percentage of firefighters who filed an injury report. They reported that this department of 1,200 active firefighters could save approximately $2.1 million dollars annually in lost time from...
disability and sick hours with the implementation of a sleep health program. (6)

However, if firefighters who screened positive for risk are unwilling to pursue free treatment, how can we expect all members to proactively be screened for risk? The only way is through exposing the damaging effects of poor sleep by educating members on their biological need for sleep. Agency leaders must invest in their members by placing priority on exposing the dangers of inadequate sleep.

The fire service must normalize the need for sleep in the same way it has normalized the use of self-contained breathing apparatus. This starts by recognizing that the leading causes of the diseases that are crippling health care systems and the fire service such as heart disease, obesity, depression, suicide, diabetes, and cancer have causal links to poor sleep.

In shift workers, increased incidences of cardiovascular disorders, peptic ulcers, and reproductive dysfunction are well known, and all are attributed to shift disorders. (6) Shift work is strongly linked with cancer and is now classified as a “probable carcinogen” by the World Health Organization. (6) Sadly, although sleep disorders are common, costly, and treatable, many remain undiagnosed and untreated.

In 2013, the American Medical Association issued a warning report that attributed certain cancers, obesity, diabetes, and psychiatric disorders with disruption of circadian rhythm. (3) Electric light emitted from phones, televisions, and interior lights effectively suppresses melatonin and leads to circadian confusion. Working frequent extended shifts and long workweeks leads to sleep deficiency and misalignment of circadian phase. In addition to metabolic disorders, poor sleep contributes to all major psychiatric conditions including depression, post-traumatic stress disorder (PTSD), anxiety, and suicide. Abnormalities of rapid eye movement sleep are considered specific to major depressive disorder (MDD) and connect with work depression. (6) Compared to all disorders associated with suicide, MDD confers the greatest risk. (4) Although lifetime rates of major depressive disorder are 17 percent, the suicide rate among people with MDD is 20 times higher than a person without it. When compared to people who sleep for six to eight hours a day, the suicide rate is 3.5 times higher in those who sleep fewer than four hours a day. (5)

Connection to Cancer

However, of all the illnesses associated with poor sleep, learning about its connection to cancer was the most frightening. Epidemiological studies on shift work discovered that sleep disruption increases your odds of developing numerous forms of cancer, including breast cancer, prostate cancer, and colon cancer. (3) In fact, because of the increased evidence connecting sleep disruption with cancer, Denmark became the first country to pay workers compensation to a woman who had developed breast cancer after years of night work shift work. A recent European study of almost 26,000 people found that sleeping fewer than six hours was associated with a 40 percent increased risk of developing cancer compared to those sleeping for seven hours or more. (3)

The connection between insufficient sleep and cancer has to do with sleep’s connection to the inflammatory response. Lack of sleep forces the sympathetic nervous system into overdrive and thereby causes an inflammatory response from the immune system. In the short term, inflammation is necessary to help your body fight disease; however, it increases the risk for several chronic diseases. The longer sleep insufficiency lasts, the longer your body remains in some degree of the fight-or-flight state. This can last for years with those who have untreated sleep disorders or excessive work hours or who simply choose to neglect their sleep.

According to Dr. Walker, “Like a car engine that is revved to a shrieking extreme for sustained periods of time, your sympathetic nervous system is flooded into perpetual overdrive by lack of sleep. The consequential strain that is placed on your body by the persistent force of this sympathetic activation will leak out in all manner of health issues, just like the failed pistons, gaskets, seals, and gnashing gears of an abused car engine.” (3)

Cancers use the inflammatory response to their advantage by luring inflammatory factors into the tumor mass to initiate the growth of blood vessels that feed it with more oxygen and nutrients. Tumors use the inflammatory response to help further damage and mutate the DNA of their cells, increasing the tumor’s strength.

Because of this, lack of sleep is causally associated with metastasis, allowing the cancer to spread to other parts of the body. Once cancer metastasizes, intervention becomes more complicated, and death rates increase. However, if metastasis can be delayed, localized cancers are more easily eradicated.

This metastatic relationship was studied at the University of Chicago by Dr. David Gozal, who injected mice with malignant cells and tracked tumor progression. In the study, half the mice were allowed to sleep normally while the other half had their sleep partially disrupted to reduce their sleep quality. As a result, the sleep-deprived mice experienced a 300 percent increase in the speed and size of cancer growth compared to the rested group.

Postmortem studies of the mice found that the tumors were far more aggressive in the sleep-deficient animals. Their cancer had metastasized by spreading to surrounding organs, tissues, and bones. Gozal’s work in the years after this experiment found that immune cells are the root cause of the cancerous influence resulting from sleep loss. Sleep loss diminishes the ability of immune cells to combat...
cancer while supporting the cancer growth of alternative cells, M2 cells. (3) With this discovery, Gozal realized that poor sleep increases the risk of cancer development and, if cancer is established, provides a healthy environment for its rapid and more rampant growth. (3)

Walker likes not getting sufficient sleep when fighting cancer to pouring gasoline on an already aggressive fire. (3) If we are serious about preventing cancer among first responders, we must prioritize changing the way we view sleep. Agency leadership must also prioritize finding ways to increase the quality of sleep among its members by encouraging them to be evaluated for sleep disorders; this evaluation should include educational sessions that will encourage better sleep hygiene practices and treatment.

**Sleep Education and Stages**

Our indifference toward sleep is directly related to our historic failure to explain and understand sleep's purpose. Today, science has advanced sufficiently to the point where we understand that sleep is the single most effective thing we can do to reset our brain and body health each day. (3) Sleep serves our brains by enriching our ability to learn, memorize, make decisions, and process events. In fact, dreaming has been found to serve as virtual reality space that mollifies painful memories. In essence, dreaming is built-in therapy necessary for trauma processing and the prevention of PTSD.

Sleep further serves to recalibrate the body by releasing toxic waste and anabolic hormones, tissue repair, and a process of resetting nerve cells in the brain, all of which assist with regulating our blood pressure, sugar levels, and immune system. Without necessary sleep, hormone levels alter drastically. Among first responders with poor sleep, testosterone and cortisol levels have commonly been found to be dangerously out of range.

Through advances in science and technology, we now understand that our bodies are designed to experience four stages of sleep each night. These stages progress through approximately four or five 90-minute cycles that rotate between a nonrapid eye movement (NREM) state and a rapid eye movement (REM) state. The first two cycles are primarily dominated by NREM deep sleep, while the last two cycles consist primarily of REM sleep. Both stages of sleep serve different roles for the body and mind. NREM is necessary for mental and physical recovery, while REM is necessary for cognition and processing of memories.

If you naturally sleep an average of seven to nine hours a night, you are more than likely allowing your body to complete the four necessary stages of sleep. People who stay up too late rob their bodies of NREM sleep; those who wake up early rob their bodies of REM sleep.

Those who suffer from sleep disorders such as sleep apnea and insomnia are deficient in these stages and thereby suffer from chronic sleep deprivation. This condition results in fatigue that manifests itself in many mental and physical ailments.

Walker recommends a few simple ways to evaluate if you are getting sufficient sleep. Number one is if you didn’t set an alarm clock, would you sleep past that time? If so, your body needs more sleep than what you are allowing it, and you should consider an earlier bedtime. Also, during the day, do you find yourself rereading the same sentence multiple times (fatigued brain)? Finally, do you sometimes forget what color the last few traffic lights were (distraction)? If you regularly sleep seven to nine hours and still experience these symptoms, you should consider being evaluated for a sleep disorder that may be interrupting your sleep. If you experience these symptoms because you don’t sleep sufficiently, consider finding ways to get more sleep. Additionally, if you are using sleeping pills or alcohol as a sleep aid, understand that these substances work as a sedative and inhibit true restorative sleep. They inhibit the REM stage of sleep, which prevents the brain’s natural ability to recalibrate, regulate emotions, and process memories.

**The use of alcohol and sleeping pills has been found to contribute to early mortality, emotional dysregulation, and PTSD.**

Individuals and company- and agency-level members can take many actions to improve their sleep. At the individual level, work on consistent bedtimes and rid sleeping areas of any distractions. When your body recognizes you are in bed solely to sleep, you fall asleep easier. Other suggestions include the following:

- Limit the use of electronic devices in the hour before going to bed.
- Drop your body temperature by two degrees, which allows you to fall asleep easier. Find ways to reduce the temperature in your bedroom.
- Exercise daily, which motivates the body to sleep better. However, try not to exercise within three hours of sleep.
- Stop using the “snooze” button on your clock. If you snooze for 30 minutes, you have robbed your body of approximately 25 percent of REM sleep. (REM sleep dominates the end of the last two sleep cycles.)
- If you toss and turn, unable to calm your mind while attempting to sleep, there are ways to calm your mind. First, hide any time-keeping

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**Firefighters must be encouraged to place priority on their sleep, and their employers must become educated on methods to encourage sleep hygiene techniques while reducing the number of interruptions their members experience when not responding to emergencies.**
Wellness Supplement

devices to reduce stress. Practice mindfulness by doing a simple breathing exercise. One of the simplest is the Navy SEALs' breathing technique where you inhale for four seconds, hold your breath for four seconds, exhale for four seconds, and hold your breath for four seconds. By focusing on your breath, you start to calm the mind. This technique also reduces your respiratory rate and activates the parasympathetic nervous system. Using the sleep stories included in the calm and Headspace apps are extremely helpful.

- If you are still unable to fall asleep, get out of bed and go to another room. Keep the light dim and engage in a calming activity (not television).

- Take naps! Dr. Allison Brager, sleep scientist for the Department of Defense, recommends napping for 20 to 30 minutes. A trick she has shared includes consuming a dose of caffeine right before lying down for a nap. Because caffeine takes 30 minutes to kick in, you should immediately feel its effects when you wake up. Take a 30-minute nap after lunch or in the early evening. If you work on a busy company and may be up most of the night, doing this allows you to complete one full cycle of sleep, thereby becoming more alert during the overnight hours.

- Limit taking over-the-counter sleeping pills.

- Eliminate alcohol within four hours of bedtime.

- Establish a consistent nighttime routine that is free of light and low in mental and physical intensity.

- Eliminate caffeine intake after lunchtime. Caffeine has an average half-life of five to seven hours. This means if you have a cup of coffee with the crew at 7 p.m., you may still have half the caffeine in your system at 1 a.m.

- Encourage members to practice sleep hygiene techniques. One of the greatest things a company officer can do for his crew is recognize the need for sleep and encourage his members to change their habits, including nap taking, quiet dorms, and being awakened only for your company's response.

- Eliminate telephone use, television watching, and other electronic devices in dorm areas. When your body recognizes an area is only for sleep, it is able to fall asleep more quickly.

- Keep dorm temperatures approximately 2°F to 3°F cooler than other areas of the firehouse.

- Sleep in private dorms that are free of distractions and the sound of snoring.

- Use dim lighting in the dorm.

- Replace trip lights with a calmer red light.

- In multicompartment stations, awaken only the crew being dispatched for a call.

- Focus on finding a schedule that allows more recovery time after shifts. The current 56-hour workweek is not optimal. One study found that one to two nights of recovery sleep are required to recuperate from deficits caused by a 24-hour shift.

- If you suffer from insomnia, search for a therapist trained in cognitive behavior therapy for insomnia.

- If you rarely feel refreshed after sleeping; be evaluated for a sleep disorder.

- Tart cherry juice is a natural sleep aid and an anti-inflammatory. You can purchase concentrated versions at your local grocery store.

- For more tips, go to https://sleepfoundation.org.

- Firefighters are at increased risk for cancer and many other metabolic and psychological disorders. Each of these has been found to be causally connected with insufficient sleep. Firefighters are notoriously for their disrupted sleep and indifference toward the need for sleep. Now that we have learned that sleep is a biological necessity and its absence is a slow form of euthanasia, we must change the way we view the need for sleep.

- Firefighters must be encouraged to place priority on their sleep, and their employers must become educated in methods to encourage sleep hygiene techniques while reducing the number of interruptions their members experience when not responding to emergencies.

Finally, for the fire service to understand the true culprit behind cancer and also make strides at prevention, we must place emphasis on controlling not only demographics and exposures but also personal health factors to include sleep and nutrition.

REFERENCES


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Managing Sleep, Health & Safety

Heart attacks and motor vehicle crashes are the two leading causes of death in firefighters. Sleep deficiency—whether instigated by short sleep duration, circadian misalignment associated with working overnight shifts, or a sleep disorder—increases the risk of these two adverse health and safety outcomes.

These and other negative consequences of sleep loss are of major concern, with more than half of firefighters reporting sleep disturbances.

Sleep deficiencies: a national snapshot

There are several aspects of firefighting that make obtaining sufficient quantity and quality of sleep particularly challenging for firefighters. First, firefighting requires 24-hour coverage, 7 days per week, 365 days each year, and most firefighters work 24-hour shifts. The number of alarms sounded each shift and policies restricting on-duty daytime sleep may limit sleep duration on duty. Even when permitted, daytime sleep following night work is more difficult due to light streaming through windows, noise at the fire station, and the circadian clock’s push for wakefulness during the day. Further, the circadian disruption inherent in shift work has been associated with an increased cancer risk. Finally, firefighters often live together while on duty at the fire station, often sleeping in the same room. Therefore, when one firefighter or paramedic is awakened for or returns from duty, makes noise or snores loudly, the sleep of others may be disturbed.

A nationwide survey of nearly 7,000 firefighters in 66 fire departments across the country found that 37 percent of firefighters were at high risk for a common sleep disorder. More than one out of four firefighters (28 percent) screened positive for obstructive sleep apnea (OSA), which is commonly associated with loud snoring. Nearly one in 10 (9 percent) screened positive for insomnia, with another 6 percent screening positive for shift work disorder and 6 percent for restless leg syndrome.

Those firefighters who screened positive for a sleep disorder had twice the risk of a motor vehicle crash, near-crash or falling asleep while driving. They were also more than twice as likely to have cardiovascular disease, almost twice as likely to have diabetes, and more than three times as likely to have depression or anxiety. Common sleep disorders are easily treated, but alarmingly, 83 percent of firefighters who screened positive for a sleep disorder were undiagnosed and untreated.

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Sleep Matters Initiative

Fatigue education and awareness training programs are already required in commercial aviation, and similar programs have been instituted successfully for railroad workers, truck drivers and nurses. In an effort to improve the health and safety of firefighters, the Sleep Matters Initiative at Brigham Health in Boston, MA, offers a sleep health education and sleep disorders screening program tailored for firefighters. The program includes presentations on the basics of sleep and circadian rhythms, strategic use of caffeine, napping and other fatigue countermasures, descriptions and screening for common sleep disorders, and sleep health monitoring.

In a randomized trial of a sleep health education and sleep disorders screening program in the Columbus, OH, Fire Department, firefighters assigned to stations that received such a program reported 46 percent fewer disability days than those assigned to control stations. Firefighters who received the education were also 24 percent less likely to report an injury than firefighters who did not receive the training. In a department of approximately 1,200 active firefighters, such a reduction in disability day usage translates into an estimated annual savings of $2.1 million, not including the medical costs and human suffering associated with injury and disability.

Further, considering the differences among fire departments—number of firefighters, the number of trainers, the experience in implementing wellness programs, and technology available in firehouses—we compared three different methods of administering the sleep health and education program using three different methods:

- **Expert-led.** The research team presented the sleep health education and sleep disorders screening program in-person.
- **Train-the-Trainer.** Fire department trainers attended a two-day course taught by the research team and then teach the program in their department.
- **Online.** The program was provided via website.

In each method, firefighters listened to the educational program and then were screened for common sleep disorders. Those who scored at risk for one or more sleep disorders were notified either by mail or online, and encouraged to seek additional evaluation from a board certified sleep specialist in their area (sleepeducation.org/find-a-facility).

Eight fire departments enrolled in this part of the study: two Expert-led departments, two Train-the-Trainer departments and four Online departments. Although all groups showed improvement in the knowledge of sleep-related topics following the education, the Expert-led group had the highest improvement rate. Firefighters in the Expert-led departments were also twice as likely to seek clinical evaluation if identified as at risk for a sleep disorder.

In all groups, the majority of firefighters rated the program as important, and indicated that the information was useful and that they would recommend the program to other fire departments. At the conclusion of the study, 42 percent of firefight-

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Implementing sleep health education and sleep disorders screening in fire departments could lead to a decrease in crashes, injuries, accidents, lost job work time and poor health outcomes in firefighters, and provide major cost savings for fire departments.

**Implementation strategies**

As a progressive, data-driven fire department, Orange County, FL, Fire Rescue (OCFR) regularly participates in high-level research efforts that impact the profession. **Operation Stay Alert**—developed by sleep scientists at Brigham Health and Harvard Medical School in Boston, and supported by a FEMA Assistance to Firefighters (AFG) grant—was poised to add a body of knowledge about an important topic that would benefit firefighters nationwide.

The department was selected to participate in the **Train-the-Trainer model**, in which the Brigham Health/Harvard team trained its firefighter safety staff members, who then taught classes to the rest of the firefighters in the department.

Training focused on educating OCFR participants about the risks of sleep deprivation and sleep disorders in firefighters, and how to manage them more effectively. This included topics ranging from sleep hygiene, post-shift recovery sleep, and intake of medication.

OCFR had a high degree of participation, driven by the assurance of strict confidentiality. Initially, firefighters were concerned that issues identified could impact their career if released to management. There was also concern as to whether findings would be a catalyst to alter the highly preferred 24-hour shift schedule. However, no identifiable personal information was given to the management team; only de-identified aggregate data was summarized in reports. This anonymity reinforced to participants the department’s commitment to both their health and their privacy.

With the help of the Sleep Matters Initiative team at Brigham Health and Harvard Medical School, OCFR peer fitness trainers have become subject-matter experts.
experts, and having that asset moving forward proved to be a key benefit of using the Train-the-Trainer model.

Furthermore, the department unexpectedly found a study within the study that provided an additional benefit. The partnership with the Brigham Health/Harvard team provided a clearer understanding of the limitations and benefits of each available training delivery model. Following the study, OCFR adopted all three methods of training models, and regularly discusses the options when coordinating its own training efforts.

For example, Expert-led classes are provided for live-fire exercises and other critical, high-risk skills. In the Expert-led model, full-time training officers and credentialed adjunct instructors personally lead training evolutions. Crews attending Expert-led training are taken offline, where they can focus on the training material without interruption. Although this training model can be more costly, it is important to consider when clear, consistent messaging and trainer expertise is critical to life safety.

The Train-the-Trainer model is used for efforts such as instruction on the operation of new equipment and ongoing skill maintenance and reinforcement. In this method, a group of battalion chiefs, captains, or firefighters can be trained prior to delivering the training to crews at the station level. This model allows instructors to train in-service crews without taking units offline. Although crews are available to respond to emergency calls during Train-the-Trainer-delivered classes, these interruptions in drills can hamper training efforts.

For time-sensitive topics in which the department needs to reach all 1,300 employees rapidly, such as for notification of policy updates or prerequisite training required prior to expert-led efforts, Online training is often used. With this model, information can be quickly disseminated, and verification of training completion obtained through the department’s Learning Management System. However, distractions can affect the retention of information provided during online training.

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Another key implementation following the Brigham Health/Harvard study is within the department’s Safety & Wellness Program. The program now incorporates the role of cardiac health and other sleep-related topics into its wellness educational programs. Beginning with recruit school, the department’s wellness coordinator educates recruits about the importance of sleep and fatigue management. Ongoing education by the Safety & Wellness program promotes to all firefighters how to use their time off between shifts to recover effectively.

Following the study, Orange County Fire Rescue adopted many principles of fatigue risk management and expanded the fatigue policy in its standard operating procedures (SOPs) and collective bargaining agreement. Rules include limitations on overtime and mandatory rest periods before and after work shifts.

**Lessons learned: practical application of the study**

OCFR identified several actionable steps that could be implemented for the improved health of its members:

- It is the department’s goal to effectively train, reinforce and support the principles of sleep hygiene.
- The department has implemented a state-of-the-art station alerting system so only responding crews are affected by station tones and lighting. Each bunk is programmed by unit responding. For example, if the rescue crew gets a call and the engine isn’t required to respond, the engine crew is not disturbed by station tones.
- During extended operations, incident action plans (IAPs) are broken into operational periods of front-line crews, and incident commanders are rotated out for rest.
- Individual bunk rooms outfitted with blackout shades and sound-attenuating walls should be used instead of group sleeping areas. OCFR has created division walls between bunks as buffers in existing stations. All future fire station designs provide for individual sleep rooms.
- Compensatory daytime sleep is encouraged between calls for service at the fire department. NASA has demonstrated in commercial aviation that cockpit napping is one of the best ways to improve performance from top-of-descent to landing.
- Continuous positive airway pressure (CPAP) systems, a treatment that uses mild air pressure to keep airways open, are regularly used at the stations by those who suffer from sleep apnea to improve health and safety for affected firefighters, and to reduce snoring and thereby minimize sleep disruption to other firefighters.

**Crews have been instructed in a CRM approach to vehicle operation in which all crewmembers assist the driver in staying alert and watching for unseen hazards while driving.**

- Research showed low-dose caffeine over a longer period of time is the most effective manner of maintaining alertness during extended bouts of wakefulness. The department includes caffeine education, including instruction on the risks of the overdose of caffeine, during annual fitness assessments, multi-company drills and live-fire burn training. Vitals are taken prior to physical training, and firefighters who exceed the maximum blood pressure levels are ineligible to participate.
- The department continually promotes self-awareness and supervisory responsibility in recognizing indicators of fatigue. A formal rehab process and Rehab Unit are in place for field personnel. These include rotation of crews for fatigue as well as providing proper nutrition, hydration, vital checks and cooling mechanisms on fire scenes, during extreme heat and for extended operations.
- Crews have been instructed in a crew resource management (CRM) approach to vehicle operation in which all crewmembers assist the driver in staying alert and watching for unseen hazards while driving.

**Final thoughts**

Despite firefighters’ expectations to the contrary, they are not superhuman and do require quality sleep to perform optimally. Chronic sleep deficiency can increase the risk of a variety of serious health disorders, making fatigue management every bit as critical to firefighter wellness as using breathing apparatus, eye protection and gloves.

In an industry that demands long work shifts in which firefighters provide service both day and night, interruption of normal sleep habits is inevitable. However, much can be done through sleep health education, screening for common sleep disorders, individual awareness, management philosophy and operational procedures to mitigate the effects of sleep deficiency. The goal, after all, is to both survive and thrive for a 30-year career.

To learn more about the Sleep Matters Initiative, visit BrighamandWomens.org/SleepMatters.

**References**


The Dangers of Sleep Deprivation

Sleep deprivation may be the most significant threat to EMS and firefighter health and safety in the future.

How many of us have endured sleep deprivation? If we’re honest, that number may be close to 100 percent because we have all had those nights where the calls came in one after another. Follow that with a day of off-duty events, and it’s easy to see how we can’t get caught up on rest.

As a retired career firefighter, all I can say is thank God for “rumble strips” on the side of the highway, as there were numerous times when I made my way home after a sleepless shift and drifted off the road, only to be rattled back awake by those strips. Toward the end of my career, I found it difficult to physically and mentally handle the effects of sleep deprivation. In fact, on-duty sleep deprivation was perhaps the biggest reason I opted for retirement. Because of my experience, I began to research the effects of sleep deprivation.

Most of us get enough sleep at home in our own beds, but as time goes on, fewer and fewer first responders are getting the restorative sleep that is needed to sustain us. The problem is that emergency services personnel are becoming more sleep-deprived because of getting less sleep while on duty for a variety of reasons, such as ever-increasing call volume, decreased staffing, and automatic- and mutual-aid

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call volume. These current conditions mean that EMS personnel and firefighters are frequently running on empty in terms of quality and quantity of sleep.

This may seem like business as usual, as most in this field know that sleepless nights will be in their future—but how many sleepless nights, and, at what cost? Additionally, as responders age, what associated complications may appear as a result of sleep deprivation? To this end, this article will examine the potential complications where both short-term and long-term sleep deprivation can manifest in regards to health and safety issues. We'll also discuss some short-term solutions and some successful long-term strategies to better manage sleep deprivation.

Sleep basics, cycles and hypnograms
By definition, sleep is "a naturally occurring, reversible, periodic and recurring state in which consciousness and muscular activity is temporarily suspended or diminished, and outside stimuli is reduced." Most people need a certain amount of sleep to function adequately, and the quantity varies substantially. The range usually falls within 4 to 9 hours with 7 or 8 hours of sleep per day being the norm. Quality of sleep is another consideration, as uninterrupted sleep is important in order for our brains to conduct its restorative functions.

Research has found that most people undergo four of five sleep cycles when they sleep. Each cycle contains varying amounts of rapid eye movement (REM) and non-rapid eye movement stages. After falling asleep, the brain will enter the first cycle that is approximately 90 minutes in length, and it includes three stages of non-REM sleep, with the third stage being the deep sleep, or slow-wave stage. After a sleep cycle, instead of waking up, the brain may enter a period of REM sleep, where dreams occur and the brain undergoes restorative functions. This cycle repeats another three or four times provided the sleep period is not interrupted. As the total sleep period unfolds, stage 3 sleep decreases, and REM sleep increases each cycle.

Hypnograms can measure the sleep cycles and the associated time that the brain is in each stage through brain wave monitoring. Knowledge of these sleep cycles provides the understanding that if a cycle is broken by being awakened, such as an emergency tone during the night, the sleep needed by the responder will not be as restorative as it could be. Numerous successive nights of being awakened during sleep can lead to physical and mental exhaustion.

Sleep deprivation and health
According to sleep researcher Susan L. Koen, PhD, president of Round-the-Clock Systems, sleep deprivation is defined as, "Insufficient deep sleep or restorative sleep for the brain, causes cognitive or brain fatigue that can result in slowed reaction time, decreased vigilance and impairment in complex reasoning skills." Abundant research indicates that poor and inadequate sleep can be problematic from a health standpoint. Sleep deprivation is linked to numerous human ailments, as outlined below. Further, there are several studies concerning sleep deprivation and emergency workers, and implications that long-term or chronic loss of sleep can have severe health manifestations.

Here we'll review the current studies and literature that show the effects of sleep deprivation on the general population, along with EMS and fire response personnel, as it relates to key health issues.

Cardiovascular disease
According to the Journal of Clinical Sleep Medicine, more than 60 percent of firefighter deaths are caused by cardiovascular problems, and traffic accidents and sleep disorders may be a common denominator. Researchers found that firefighters with sleep disorders were more likely to have vehicle accidents and report cardiovascular problems compared with those who had a good night's sleep.

Per the National Institutes of Health - National Heart, Lung and Blood Institute, adequate sleep is needed in order to repair heart and blood vessels, and ongoing sleep deprivation decreases the body's ability to accomplish these repairs.

Cancer
The International Agency for Research on Cancer, an extension of the World Health Organization, has classified shift work as a probable carcinogen. Shift work, especially late-night shifts, are thought to disrupt the circadian rhythm in humans and associated melatonin production. Sleep deprivation may be a key component of this modern-day finding along with a decreased immune system defense.

Data from a study of more than 30,000 firefighters from 1950 to 2009 show that approximately 68 percent of firefighters contract cancer in their lifetime versus 22 percent for the general population. While it could be stated that firefighters are exposed to carcinogens more frequently than people who are not fighting fires, could it be that sleep deprivation exacerbates the onset of cancer?

Alzheimer's Disease
Neuroscientist Jeff Iliff was part of a research team at the University of Rochester Medical Center that discovered the brain has a unique waste management system and they called it the "glymphatic system." At night, when most people sleep, the brain is getting rid of its waste, including amyloid-beta, which is a brain protein associated with Alzheimer's disease. Because the brain only cleans itself of these wastes during sleep, long periods of being awake can lead to an excessive build-up of amyloid-beta between brain cells. It is hypothesized that this accumulation of amyloid beta along with sleep deprivation may be connected with the development of Alzheimer's disease.

Immune system malfunctions (obesity, diabetes and metabolic syndrome)
Adequate sleep helps maintain a balance of the body's hormones that regulate hunger. Sleep deprivation can lead to an increase of the hunger hormone ghrelin, which makes people crave carbohydrates and sugar, and a decrease of the hormone leptin that produces the feeling of being full. According to an article in the Harvard Business Review, adequate balance of these hormones is important to avoid weight gain and excessive weight gain can lead to obstructive sleep apnea.

Sleep deprivation can lead to excess blood sugar levels and an increased risk of diabetes along with inadequate defense of common infections. Further, chronic
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Sleep restrictions increase not only levels of appetite but also stress hormones.4 

According to a study in the journal Sleep Medicine Review, extended poor quality and quantity of sleep can lead to an increase of metabolic syndrome with symptoms of elevated blood pressure and glucose levels. Further, the International Archives of Occupational and Environmental Health reported that sleep deprivation increases the stress hormone cortisol in firefighters.9

Cognitive impairment

Researchers Rucases and Miller found that sleep-deprived firefighters became more impulsive with their decision-making.11

Evidence exists that show periods of wakefulness of 18 hours straight can impair cognitive abilities that equate to blood alcohol levels of 0.05 percent. Plus, 24 hours of consecutive wakefulness can impair a person the same as 0.096 percent blood alcohol concentration (BAC) levels—the same as being legally intoxicated.12

Dr. Timothy Rochs authored an article for the journal Sleep in which he reported that sleep-deprived people endure diminished decision-making skills and took greater risks with tasks.13

Sleep deprivation and safety

Sleep deprivation of just 18 hours also affects responder safety by impairing judgment, decreasing reaction speed, and reduced short-term and long-term memory. Additionally, fewer hours of sleep over several days in a row magnifies these effects and produces cognitive impairment similar to a BAC of 0.1 percent, says Dr. Charles A. Czeisler, the Baldino Professor of Sleep Medicine at Harvard Medical School.4

For these reasons, Dr. Czeisler recommends that employees not work beyond 16 straight hours due to the loss of cognitive ability as the result of a need for sleep. Ideally, according to Czeisler, people should be allowed at least 11 consecutive hours of rest each day.

As reported above, researchers Rucases and Miller found that sleep-deprived firefighters became more impulsive with their decision-making, and they also found indications that more impulsive people have more accidents.11

The NFPA has found through data accumulated from fire response reports that firefighters have more than double the risk of injury while on fire emergencies from midnight to 8 a.m., compared to noon to 8 p.m. time periods. Factors that were cited for these statistics include lack of visibility, cold temperatures and lower alerterness of firefighters.14

In a March 2016 Firehouse Magazine EMS column, Chief Gary Ludwig outlined several catastrophes that were caused by sleep deprivation. Ludwig went on to describe how he experienced hallucinations while driving as a result of sleep deprivation.15

The road ahead

As was discussed previously, emergency services personnel are becoming more sleep-deprived because of ever-increasing call volume, decreased staffing and automatic- and mutual-aid call volume. It is a safe bet that every city has seen call volume increase over the last several years. EMS calls especially are skyrocketing due to an aging population that needs more medical care, people in need of medical care who use EMS as their healthcare service, and a recent surge in traffic-related deaths.

As an example, the Los Angeles Fire Department saw an increase of 8.8 percent for all emergency incidents, including an EMS call increase of 12.3 percent in 2014. The NFPA reported just over 5 million EMS calls in 1983 and nearly 20 million EMS calls in 2010—a four-fold increase in 25 years. The projection for EMS calls in 2020 is approximately 36 million calls nationwide. Based on this trend, emergency services managers will be hard-pressed to handle the medical service needs of tomorrow with extremely lean resources, and it appears that sleep deprivation of responders may be more of an issue than ever before. Perhaps it is premature to call it a crisis, but short of adding more staff, the threat of increased sleep deprivation looms large for our emergency response workforce.

As emergency response professionals, it behooves us to further examine the sleep-deprivation concerns of today, and also look at potential problem-solving mechanisms for immediate relief and future mitigation. With this in mind, there are several solutions and strategies to consider.

Sleep deprivation solutions

Dr. Czeisler from the Harvard Medical School recommends the following points for organizations to enhance sleep quality for their members:

- Develop sleep policies centered around maximum work periods.
- Develop educational programs for employees concerning sleep, health, and safety. Further, learn about the effects of caffeine, alcohol and other substances that interfere with sleep.
- Train managers to promote good sleep practices and ensure that well-rested people report to work.
- Keep dorms and bedrooms dark and quiet and free from electronic devices.
- Provide annual screening for sleep disorders to all employees.

Following are several short-term solutions for management of sleep deprivation issues:

- Allow personnel to nap, promoting the idea that some sleep is better than no sleep.
- Devise a policy that keeps dorms sacred places of sleep. Specifically, halts practices in which dorm rooms have TVs and electronic games set up, either in one large dorm area or in smaller cubicles, so that responders can get quality sleep free of unwanted noise and light.

And the following are several long-term strategies for management of sleep deprivation issues:

Again, allow personnel to nap! In order to best serve the public, responders need to be well rested, even if, at times, this may be at the sacrifice of fire inspections, public relations events and training activities. If the crew is tired or a busy evening is anticipated then the highest priority should be rest/sleep periods for emergency personnel. And, the sleep should be allowed in the dorm rooms with quality mattresses and pillows. Sleeping in La-Z-Boys or other upholstered chairs should be avoided due to poor body support and negative health consequences.

Consider changing shift start times to enable people longer sleep times while at their homes. Early shift changes mean
that responders are traveling very early to get to work. Arising early at home to get to work lengthens the day and sets up personnel for sleep deprivation later in the day. Setting the shift change back one hour from 7 a.m. to 8 a.m., for example, allows personnel one more hour in their own bed before they head off to work.

Focus on call volumes and strategize how to decrease unit call volume. Exchanging internal staff at 12-hour intervals can help to avoid the entire crew becoming sleep-deprived. A crew rotation concept prolongs employee careers. Additionally, some fire departments add extra medic units for anticipated higher call volume activities, such as sporting events, festivals and other special events. These shorter duration events usually require overtime personnel for staffing.

Examine culture and implement the concept that sleep is more important than we ever thought and it is acceptable to maximize sleep time on-duty. It was once considered taboo to sleep while on duty during the day. That mindset and culture needs to change in order to intelligently manage sleep deprivation. It was also considered macho to avoid sleep while on duty. This dynamic also needs to change.

Examine shift schedules that maximize off-duty time in order to erase sleep debt before coming back to work. From a sleep-deprivation viewpoint, it is better to have two days off after a 24-hour shift because responders can recover better after a sleepless night in the station. Compared to only one day off to recover responders return to work better prepared for duty after two days off.

An alternative that has become popular mainly in Western states is a 48/96-hour schedule. This schedule has responders working 48 hours or two days straight and then having 96 hours or four days off. Some departments have worked this schedule for over 20 years with no reported problems, and it has proven to be very popular with extremely high rates of employee satisfaction and morale. Proponents say that it allows more time at home with their families, less commuting time and costs, and many realized efficiencies in the stations.

As far as sleep deprivation on this schedule, many people comment that a 48-hour shift may cause short-term fatigue, but it is very effective at preventing long-term fatigue. Further, people seem to adjust and get used to the longer time on duty. Departments on this schedule also allow personnel to catch up on their sleep as needed.16

### 4 Habits of Healthy Lifestyles for Emergency Responders

![Image of a circular diagram with sections for Diet & Supplements, Exercise, Mental Health, Healthy Lifestyle, and Restorative Sleep.]

It has been recognized by many EMS and fire service organizations that the key to long living, reducing risk of health-related complications, and long-term healthy lifestyles includes eating smart, effective exercise, and stress management. But what about sleep quality and quantity? All of the above healthy lifestyle components are interrelated—and they would absolutely fall without good sleep! Consequently, the following is offered as a new healthy lifestyle model.

A great deal of information concerning this schedule is available at www.48-96.com and on Facebook at 48-96 Firefighter Work Schedule.

As far as the downsides to this schedule, one department offered data from the first two years that it used the 48/96 schedule, and they reported increases of discipline problems, sick leave, work-related injuries, motor vehicle accidents (MVAs) and turnout time. Most notable were significant increases in injuries and MVAs on the second day of the shift.17 The logical conclusion would be that sleep deprivation and general fatigue from on-duty rigor increased risk and costs for personnel on the 48/96 schedule.

One last consideration of the 48/96 schedule centers on the frequency of sleep disruptions. Dr. Koen defines two or more emergency calls between 10 p.m. and 6 a.m. as a scenario where sleep deprivation would most likely affect responders moderately at the end of their shift. Three or more calls in the same period would likely have responders enduring severe sleep deprivation. It is at this level of emergency calls that Dr. Koen recommends that these stations not consider the 48/96 schedule due to excessive sleep deprivation. She further states, "Having a second 24 hour-on-duty day, without sleep, could put firefighters at risk for some safety and performance challenges."18

### In sum

Sleep deprivation is a very real and current emergency services problem that must be managed if we are to ensure the health and safety of our personnel. Numerous studies and research efforts indicate that acute and chronic poor sleep quality and quantity significantly
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impacts people both physically and mentally. Sleep deprivation manifests itself in myriad ways and can affect decision-making skills, judgment, and coordination. The risks of sleep deprivation to the emergency services, such as EMS and firefighting, are clear: Sleep-deprived personnel are unsafe and may be subjected to higher risk for health complications. Policies and guidelines that focus on sleep quantity and quality, in an effort to avoid sleep deprivation for emergency response personnel, should be considered. These efforts should enable all of us to sleep better, both on duty and off.

References

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Sleep Deprivation - The other silent killer of First Responders — BEHIND THE SHIELD... Page 1 of 10
The tones scared the shit out of me. I had managed to enter a deep sleep that night after a busy day of calls and training. The dorm had been eerily quiet up to that point, in a firehouse that was normally getting hammered at night. The jarring voice of the dispatcher caused an adrenaline dump that catapulted my heart, feeling like it would burst through my chest. “Structure fire”, the two words that sent you from unconsciousness to fight mode in a fraction of a second. The station had a two story pole slide that was challenging, even with all of your faculties. At 2 am, thirty seconds after being ripped from sleep, it was basically a free fall to the bay floor below.

I threw my bunker gear on as the second repeat came over the loudspeaker. “Apartment complex, flames showing, multiple calls.” These magic words told us that this was not a false alarm. This time of night, most residents would be in their homes and fast asleep.

The chances of people being trapped by the flames was very high. I threw on my bunker gear and climbed into the doghouse of the tiller truck and signalled to the drive in front that I was ready. The plynovent rails screeched as the truck pulled out of the bay and separated itself from the yellow umbilicus. As we turned the corner, the familiar yellow glow filled the sky as a column of dark smoke rose through the night air. I navigated the back of the truck around parked cars and around sharp turns whilst trying to shake off the massive fatigue.

The structure in question was literally a block away from the station so it took less than two minutes to arrive on scene. Packs were thrown on backs, outriggers deployed and saws were fired up in the cool winter night. The aerial was surgically placed to the edge of the roof so we could climb to the top of the three story building. The fire was licking out of the windows below but had not compromised the roof yet. We cut our inspection hole and then sounded our way to the seat of the fire, cutting indicator holes as the lead firefighter pounded the roof with their hook. The saws began to scream as if in agony as they tore through the shingles and sunk into the plywood below. As the louver was pulled
back with the rubbish hook, the fire blew out, angry and impatient. The holes were extended to match the intensity of the fire below and finally sapped the strength from the raging inferno.

This isn’t a story of heroism or inhuman feats of strength or courage. It’s what firefighters do every day, around the world. Only five minutes prior, I had been in a dead sleep and now I was standing on a roof, fifty feet in the air, cutting with a chainsaw as fire licked all around me. A fire like this requires hours of hard manual labor, initially fighting the fire, then overhauling and trying to save the resident’s possessions in the process. Luckily on this particular fire there were no victims to find, no dead dogs to bring out to a heartbroken child. But still, people’s lives had been shattered.

As dawn broke, we wearily drove back to the station to begin the arduous process of cleaning tools, changing saw blades and fuelling the power tools. Our gear reeked of the toxic chemicals they absorbed during the fire, off gassing into our airways and skin. Gear needed to be cleaned and switched out to minimise the contact with the potentially life threatening carcinogens. Bodies are scrubbed in piping hot showers to remove the chemicals from the pores. Noses are blown to reveal a tissue full of black, noxious snot. Then, the message is given to dispatch that we are back in service to do this all over again.

The drive home from a night like this is the next challenge. Many fill themselves to the brim with tar like firehouse coffee to make it through the commute. Eyelids feel like a thousand pounds as you strain to maintain mental clarity. Windows are down, music is up and the occasional slap to the face are tools to maintain consciousness. You finally make it home safely and say a little thank you to your God or the Universe. You are met by the neighbour from hell who starts bitching at you about your rubbish bins not being put away at the correct time. The thoughts of knocking him out there in the middle of the street are overwhelming. You are spread so thin between mental and physical exhaustion, lack of sleep and the memories you carry from your worst calls. But you find the strength, unfold your fist and just walk away. “It must be nice having so much time off” you hear him mutter as you close the door behind you.
Sleep deprivation is an issue that is rarely if ever addressed in First Responders. In the fire department, we have become very good at protecting ourselves from the hazardous chemicals from fires and other incidents, yet we are still twice as likely to get certain cancers than civilians. When a brother or sister contracts a horrific disease, we look back to a certain incident and assume it was connected to that. The missing link, the part that is overlooked is the lack of sleep. A First Responder will lose sleep every night they work for their entire career. Whether it is a 12 hour night shift or a 24 at a Firehouse, the effects are the same. The sleep that is allowed on quieter nights is of poor quality as the anticipation of a call blocks the ability to fully switch off.

Dr Kirk Parsley is a Navy SEAL who went to medical school to become the SEAL’s doctor. He was finding the same chronic medical conditions in his young uber athlete soldiers, who were exercising like maniacs and eating all of the right foods. It dawned on...
him that the one common denominator was lack of sleep. Whether going through Hell Week or just extended deployments, the men were coming back with blood work that was less than optimal. Dr Parsley began to focus on the men's sleep and saw an immediate change in their overall health. He began to delve deeper in this field and is now considered one of the authorities on Sleep Medicine in tactical athletes.

Unlike most professions, First Responders don't know what a call is going to entail until it happens. For firefighters it could be a fire, traffic collision, rope rescue, marine rescue or some other emergency that no one else is trained for. A police officer may be involved in a car chase, foot pursuit, fight or gun battle. The paramedic may roll up on an active shooting or explosion. The zero to a hundred nature of our professions takes a huge toll on the human body. This adrenal fatigue, the constant stress of expecting the worst case scenario to occur prevents the body from repairing and growing. The fight or flight response is a primitive mechanism that still keeps us safe today.

The problem is that the same mechanism can kill us if it never turns off. Stress keeps this sympathetic nervous system ticking over and doesn't allow the parasympathetic (feed and breed) to kick in and start repairing all of the damage from the previous day. This is further exacerbated by lack of sleep. Nighttime is when the body heals injury and grows muscle. In order to do this, the sympathetic nervous system has to be turned off to allow the parasympathetic system to begin the repair process. Dr Parsley states that by missing one night of sleep, your body's hormones become completely unbalanced. Testosterone is halved, blood sugar rises and you have the same neurological function as having a blood alcohol level of 0.08.

The other element that was often thought as fallacy is sleep debt. In his book "The Promise of Sleep", Dr William Dement details how sleep debt is in fact a very true phenomenon and it is unknown how long this debt spans. The other fact that he verified is that the average person needs either side of eight hours sleep, every night, to perform optimally. So this being said, just one night with no sleep immediately puts you 8 hrs in debt. Multiply this by a career of 20 to 30 years and you have a big problem. Naps can certainly help get some of this sleep back but is not a substitute for good REM sleep.
The immune system cannot function well in this deprived state, putting the First Responder at much greater risk to heart disease and cancer, the top two physiological killers in our profession. The brain is not spared from this destructive sleep behaviour. In fact it has been shown that sleep deprivation mimics traumatic brain injury. The same injury attributed to depression and suicide among soldiers, football players and combat athletes. I am convinced that this is one of the missing pieces in the treatment of PTSD.

So what is the answer? Certainly, playing with shift schedules is not the solution. The bottom line is that someone has to work at night to protect the citizens we serve. Someone has to climb that ladder to reach the trapped victim or arrest the violent husband before he hurts his estranged wife. The answer is twofold. Firstly, the First Responder’s work week needs to be reduced and yes, that includes more personnel but that’s the price of protecting a community. A 56 hour work week with no sleep is a recipe for disaster. Time needs to be given to recover from these shifts and catch up on the sleep debt. Naps need to be encouraged not banned. Would you want the person driving your child to hospital in an ambulance to be functioning like a drunk driver?

Secondly, as an individual, you need to practice good sleep hygiene at home. That means being strict with yourself about going to bed early. Black out your bedroom, as light is a cue for alertness and can stop deep sleep. Turn down the air. The optimal temperature is 67 degrees which may sound cold but again, this has been proven. The last point is to try and avoid alcohol in the evening as it will prevent the REM cycle, which is where the body repairs itself. We have an opportunity to make a huge difference in our own mental and physical health. Sleep deprivation is another area that must be brought to the forefront as its physical and mental effects are devastating.

Dr Kirk Parsley will be on the Behind The Shield Podcast later this month so make sure you listen.

Stay safe out there!

James

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Tired Medics Make Mistakes

As EMS budgets continue to tighten, an emerging trend is to increase the length of the shifts worked by EMS personnel. Although 24-hour shifts have been common, some departments are now going to 48-hour shifts. Those departments still offer overtime, and mandatory overtime due to staffing crises sometimes lengthens those shifts to 72 hours. Are longer shifts the answer to the budget crisis? Apparently not, if patient safety is a consideration. A number of studies show that employers should consider fatigue as a potential factor in both EMS vehicle crashes and clinical errors that may harm patients.

Statistics regarding errors made by sleep-deprived pilots and truck drivers have resulted in serious changes in the way both the airline and trucking industries function. One study looked at long-haul truck drivers who obtained less sleep than is required for alertness on the job and found that the greatest vulnerability to sleep or sleep-like states occurs during the late night and early morning. More recently, new studies have focused on medical residents, interns and nurses in an attempt to begin to turn the tide on the medical errors that are making headlines and reducing the public's confidence in the medical system. Seemingly oblivious to all of these studies and their applicability to our profession, EMS appears to be moving in the opposite direction: toward longer shifts.

According to the National Sleep Foundation, most adults need seven to nine hours of good-quality sleep each night. That means uninterrupted sleep—something that can never be guaranteed in a fire or EMS station. The physiology and effects of sleep deprivation have been well studied. In one study, even moderate sleep loss had a profound impact on attention during working-memory tasks, even when the subjects made a concerted effort to maintain wakefulness and performance.

The implications of fatigue on patient safety are well documented in the medical field. Among nurses, studies showed not only that overtime increased the odds of a reporting error, but also that the risks increased significantly when nurses worked shifts longer than 12 hours. In 2005, the Oklahoma Nurse’s Association House of Delegates resolved to disseminate this research and to ensure that nurses and administrators were aware of the clear relationship among work hours, fatigue and errors.

Studies done by the Centers for Disease Control and Prevention/National Institute for Occupational Safety and Health also demonstrated problems with shift work and long shifts. Sleep loss makes it easier to fall asleep at inappropriate times and can affect performance both on and off the job. After sleep loss, it is possible to have very brief periods of sleep that last only a few seconds. Although many people may not even realize they have completely lost attention for that period of time, such lapses can lead to serious injuries.

This study further detailed the long-term health effects of shift work, including disruption of social and family life and increased health risks including digestive problems and heart disease. In addition, the researchers note that several days of work followed by four- to seven-day “mini-vacations” is extremely fatiguing and should be done only if there is no other choice. This is precisely the kind of shift schedule now being used or proposed by many fire departments and EMS organizations.

People working long hours also demonstrate deteriorating performance on physiological tests and sustain more injuries. This pattern was shown across study findings, particularly with very long shifts and when 12-hour shifts were combined with workweeks of more than 40 hours. A number of studies focusing on the effects of extended shifts reported that work hours nine through 12 were associated with feelings of decreased alertness and increased fatigue, lower cognitive function, declines in vigilance on task measures and increased injuries.

Two studies examined physicians who worked very long shifts and reported deterioration on various measures of cognitive performance. A study done in Ireland in 1998 reported declines in two tests of alertness and concentration given to medical residents who had worked 32-hour call shifts. A New Zealand study of anesthesiologists linked long working hours to self-reported clinical errors. Another study done in New Mexico linked emergency physicians’ hazardous exposures to biological fluids with the time of day and duration into shift and found most exposures occurred during the first and the last two hours of work shifts.

More recently, studies showing alarming incidents of medical error by medical residents led to curtailing the number of hours resident physicians are allowed to work in the hospital. A prospective, randomized study compared the rates of serious medical errors
made by interns working a "traditional" shift schedule of extended (24-hour or more) work shifts every other shift (or an "every third night" call schedule) with those working an "intervention schedule" that eliminated the extended work shifts and reduced the number of hours worked per week. The frightening results: The interns made 35.9% more serious medical errors during the traditional schedule than during the intervention schedule. The study concluded that interns made substantially more serious medical errors when they worked frequent shifts of 24 hours or more than when they worked shorter shifts. The study further concluded that eliminating extended work shifts and reducing the numbers of hours interns work per week can reduce serious medical errors in the intensive care unit.

Another study recently published in the prestigious New England Journal of Medicine examined the relationship of extended work shifts and the risk of auto crashes among sleep-deprived interns and found an increased incidence after an extended work shift. In a prospective analysis, every extended work shift per month increased the risk of a motor vehicle crash by 9.1%. The study concluded that extended-duration work shifts (which are currently sanctioned by the Accreditation Council for Graduate Medical Education) posed safety hazards for interns during the drive to and from work.

Yet another study looked at changes in alertness and cognitive efficiency in people whose circadian rhythms are disrupted by shift work, and found that shift work causes short-term cognitive disturbances and a lowering of neuropsychological performance. The study focused on long-term effects of shift work on verbal memory and speed performances, finding that those who stopped shift work actually regained some of their cognitive abilities after four years.

A driver falling asleep at the wheel has resulted in more than one EMS crash. These accidents can be both costly and deadly—far more costly to the EMS organization than keeping shifts down to a reasonable number of hours. In 2001, a Virginia EMS driver fell asleep at the wheel, left the roadway and rolled the unit, with a patient on the stretcher and two paramedics in the back. Paramedic Neal Sherman sustained fatal head injuries after he struck his head on a shelf corner and was hit by an unsecured oxygen tank. The other paramedic sustained serious spinal cord injuries, and the patient suffered a heart attack during the rollover. The driver, who suffered a broken arm, was charged with and convicted of reckless driving, and civil lawsuits over this incident are still underway.

Some studies have addressed EMS issues directly. Operator fatigue has been recognized as a significant factor in many car accidents. EMS vehicle crashes are the main cause of injuries to EMSs and firefighters, with over 12,000 EMS accidents each year and one fatality per 100 accidents, or 120 fatalities each year. Vehicle accidents also cause the most lawsuits, and the highest litigation costs, to EMS providers. In 2003, 33 on-duty firefighters died while on their way to a call or returning from a call—nine more than died in actual firefighting activity. Studies have also shown that while the rate of ambulance accidents is higher in the urban setting, the severity of injury is higher in rural areas.

In addition, a Minnesota study found that when paramedic shifts were increased to 12 hours, there were more nontransports, and paramedics increasingly tried not to transport toward the end of their shifts. This study suggests that longer shifts result in tired paramedics who are prone to errors and to making poor decisions that may cost patients their lives.

What is the take-home message? With error reduction at the forefront of medical risk management activities, why do we ignore these numerous and important studies? It appears that budget concerns have begun to override concerns for patient safety, as well as the safety of EMS providers. Make no mistake: longer shifts mean health problems for providers, less job satisfaction, more medical errors and litigation, and more EMS vehicle accidents. So why are so many departments looking at longer shifts?

Editor's note: For more on this topic, see "A Hard Day's Night: The harmful effects of shift work," May JEMS.

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A HARD DAY'S NIGHT

The harmful effects of shift work

By Michael Brewer, MEd, EMT-P & Clyde Deschamp, PhD, EMT-P

Every EMS provider knows that emergencies don’t always occur conveniently within normal work hours. We’re required to respond at any time of the day or night and on weekends and holidays. As a result, EMS personnel must be on duty at all times. That requirement makes shift work an essential component of EMS practice.

Like in other professions, many EMS agencies use shift scheduling in order to meet the 24/7 demand for their services. Many pre-hospital personnel, therefore, find themselves working during non-conventional hours—times outside of the normal 8 a.m. to 6 p.m. workday range—and a variety of shift lengths, ranging from eight hours to extended shifts lasting more than 24 hours. In extreme cases, providers may work shifts lasting 72 or more hours.

Often, especially in the case of extended shifts, providers don’t get adequate rest while on duty but are still expected to perform at their best. Time off between shifts varies, but in some cases may not allow for adequate recovery. In both scenarios, the end result is fatigue and sleep debt, which together are known to have serious consequences.

Working non-conventional hours isn’t always bad. For many, shift work allows for greater flexibility; evening and night shifts allow for more free daytime hours for personal or family time, and longer shifts may permit more time off between shifts. Also, many organizations offer some type of pay incentive to employees working shifts outside of normal work hours. Still, a shift worker’s ability to enjoy the “advantages” of shift work may be diminished if they’re not able to adapt to this type of work.

The ability to work non-conventional hours without experiencing problems is, in some cases, possible. A person’s ability to modify their body’s sleep/wake cycle, a process known as circadian
adaptation, is well documented, but is usually very slow and may take several days or weeks. Individuals who are able to adjust are usually those who work nonconventional hours on a permanent basis. The authors reporting the ability to adapt, however, make it very clear that the majority of individuals are not able to adjust their sleep/wake cycles and will almost always experience negative effects.

When adjustment to nonconventional work hours is slow or not possible at all, the individual may quickly begin suffering from fatigue. Such shift-work-induced fatigue (SWIF) is known to have negative effects at individual and organizational levels. Moreover, the effects of shift work alone are exacerbated by the hectic and demanding nature of EMS. Although little research has investigated the effects of shift work on EMS personnel specifically, much available data does describe the individual and organizational effects in similar professions—and the findings are not encouraging.

Implications for the individual
Researchers have found that about 25% of the North American population is composed of shift workers. It's estimated that 20% of that group can't tolerate shift work. Many individuals, however, continue to work shifts outside of "normal" work hours for reasons ranging from lack of other available shift times to the need for time off during daytime hours. Regardless of the reason, immediate and long-term negative effects are associated with shift work. It's well-documented that individuals who are not able to adjust to shift work are at increased risk for developing conditions that present a serious detrimental risk to their health and well-being, including problems with sleep, physical health, and social and mental well-being.

Sleep: A person's circadian physiology involves natural periodic variations in sleep, vital signs, digestion, hormones, feelings and behavior. Our bodies have a natural "clock," located in the hypothalamus, which is linked to other physiological mechanisms, such as the secretion of the hormones melatonin and cortisol. Together, these structures and biochemicals mediate the sleep/wake cycle and are known to respond to internal and external cues, including social activities, food, exercise and light/day cycles.

Rotating or alternating work shifts desynchronizes our cues and cycles, alters our physiology and changes the way we feel. In most individuals, shift work disrupts natural circadian rhythms and interferes profoundly with sleep. In those affected, this interference manifests as poor sleep and chronic fatigue. Documentation shows that most shift workers have sleep problems. In fact, night shift workers sleep, on average, 25–33% less than day or evening shift workers and have poorer sleep quality. A number of factors, including daytime distractions (e.g., phone calls, noise, sunlight and visitors) and lack of the deepest stage of sleep (known as rapid eye movement, or REM), lead to chronic and cumulative sleep debt. (Editor's note: For more on the stages of sleep and how your body responds to each, read From the Editor, "Dead Tired," February 2005 JEMS, available online at www.jems.com/jems/23-2/.) Conventional wisdom once held that a person's circadian rhythms could essentially be reset, but contemporary research has demonstrated that this is generally untrue.

It's now well known that individuals working fixed shifts during nonconventional hours may eventually suffer from a sleep disorder known as "shift work syndrome." The effects of this phenomenon are more pronounced in people older than 40 years of age and in women, who often tend to have their children and do family chores after their shifts.

Physical health: When the body lacks sufficient recovery periods, shift- work-induced sleep disturbances and the resulting SWIF often lead to physical and mental health problems. In addition to fatigue, shift workers have higher rates of alcoholism, drug abuse, smoking and caffeine intake. They also have higher rates of motor vehicle trauma and occupational trauma and are prone to a wide range of physical illnesses, including peptic ulcer disease and other gastrointestinal complaints, immune dysfunction, and infertility.

Shift work is also known to exacerbate diabetes, epilepsy and sleep disorders. Perhaps of most concern is the fact that shift work has been shown to increase rates of cardiovascular disease (CVD) and cardiac mortality. Even after controlling for other risk factors and confounding variables, data show that CVD rates rise with exposure to shift work. The risk of shift work has been equated to the risk of smoking one pack of cigarettes per day.

How can working nonconventional hours have such substantial effects on our health? One reason is that shift work is thought to induce increased secretion of stress hormones and cause changes in such factors as blood pressure, heart rate, coagulation, and lipid and glucose metabolism. These factors, in turn, are known to cause CVD. In a paper published in 1999, 17 studies on shift work and CVD were reviewed. In reviewing all of these studies, it was concluded that shift workers had a 40% excess risk for CVD compared with individuals who work during normal daylight hours.

Further, women seem to experience unique physical problems related to shift work, including abnormal hormone secretion, birth complications and interference with menstrual function. Several studies have been conducted that examined the effects of shift work on pregnant females working in the nursing profession. A report in the Journal of Clinical Nursing found
that secretion of the hormone prolactin is altered in nurses working nonconventional hours and may be related to their reported sleep disturbance and GI symptoms.26

Many studies have also shown significant relationships between shift work and birth complications, such as low birth weight, preterm birth and spontaneous abortion.26,31 Further, a group of researchers found a significant increase in changes in menstrual cycle function and a higher incidence of painful menstruation among female nurses working nights and rotating shifts. In their study, those reporting changes in menstrual function also reported significantly more sleep disturbances.32

**Social & mental health:** In addition to the many documented physical effects of fatigue induced by shift work, the literature is full of studies documenting associated mental and social effects. Like the physical effects discussed, the mental and social effects may also have significant consequences. Social problems can be attributed to shift work due to individuals missing the critical window for social activities that occur between 4 p.m. and 12 a.m.33 People working during these hours may experience adjustment problems in such areas as attitudes toward both home and work life.33,34 Research specific to the social effects of shift work on men show an increase in solitary activities because these activities are more flexible in terms of time and don’t conflict with working hours.

Disruptions in circadian rhythms lead to mood changes, such as irritability, feelings of stress and fatigue, and relationship difficulties.23 In the longer term, shift work has been associated with higher rates of substance abuse, depression, divorce, suicide, burnout and leaving an occupation altogether.26,35,36

Along with burnout, a study of nurses working nonconventional shifts found a greater incidence of depersonalization as a social effect of shift work. Depersonalization has been defined as “the tendency to cynically deindividuate patients and to treat them like objects.”26 The potential effects of depersonalization are serious, especially in an era of health care when the interpersonal aspects of patient care are paramount.

**Impact on the organization**

The vast majority of publications available on the effects of shift work focus on the physical and mental/social issues. The effects, however, are not isolated to individuals. As workers begin to experience the physical, mental and social effects of shift work, it’s only a matter of time before the organization as a whole becomes affected.

An organization is only as strong as the individuals that form its core. Most health professions, including EMS, are collectively known as helping occupations and, as a result, are dependent on competent and caring practitioners to provide services to patients. Research on physicians and nurses has shown a clear relationship between the effects of shift work—fatigue, sleep debt and physical ailments—and negative effects on organizational areas, including risk management and organizational effectiveness, both of which have direct effects on patient care.

**Risk management:** Fatigue from shift work is a well-documented workplace issue. EMS providers may be at risk from accidents or errors due to impaired judgment and cognitive function.36 Several studies have confirmed that shift work is associated with increased risk of traffic accidents among nurses, physicians and police officers.37,38

Blackout shades, eye masks, earplugs, a white noise machine and room temperature of 68–75° F also promote healthy sleep periods.
long work hours, sleep deprivation and circadian disruption has been recognized as a substantial cause of serious human errors. Human error due to fatigue has been implicated as the cause of transportation-related accidents, including plane crashes, train derailments and highway MVCs. It has also been implicated in large-scale disasters, such as the incident at Three Mile Island, the Chernobyl meltdown and the grounding of the Exxon Valdez. Although events of this magnitude have not occurred in EMS, the possibility of EMS errors and accidents is haunting.

Medical error has become a top priority in healthcare during the past decade, in part because of increased research and media coverage. As a result, healthcare organizations have attempted to implement policies and procedures aimed at reducing the incidence of medical error. The research literature for healthcare occupations, primarily for nurses and physicians, cites fatigue as a significant cause of medical error.

For example, an article in the New England Journal of Medicine reported that when it comes to the cause of medical errors, the public and physicians have agreed that fatigue of medical error in prehospital medicine as well.

Worker fatigue that results from shift work and nonconventional work hours is also known to compromise workplace safety and increase accidents. A study of the effects of shift work on firefighters found that most accidents occurred during night shifts, between the hours of 10 p.m. and 2 a.m. Other studies of a variety of occupations have shown slower and less accurate performance and an increased frequency of injuries during night and extended shifts.

One study in particular showed that sleep deprivation of 24 hours can result in dangerous performance levels equivalent to those of a blood alcohol level of 0.10%. The study also showed that low performance levels are reached sooner in older individuals. Overall, the study authors assert that environments involving “shiftwork should be viewed and managed as a hazardous place to work.”

Effects on driving: Fatigue as a result of working long or odd shifts is also known to have profound effects on an individual’s ability to drive. This fact should be of tremendous concern to those in EMS, because driving, often under hazardous conditions, is a key component of the services provided. In a study analyzing vehicle crashes among physician interns, researchers found that the odds of an intern being involved in an MVC after an extended work shift (<24 hours) were more than double the odds after a nonextended shift.

Researchers in the same study found that near-miss incidents were more than five times as likely to occur after an extended shift than after a nonextended shift. These findings further emphasize the fact that sleep deprivation degrades an individual’s performance and increases an organization’s liability for the person’s actions.

The effects of combining sleep deprivation and driving also have potentially profound legal implications for individuals and organizations.
The legal precedent has already been established in the United States and Great Britain for individuals found guilty of vehicular homicide in cases of driving while impaired by fatigue.49-50

Some states are in the process of amending reckless driving laws to include impairment by fatigue. Most notable, however, are two appellate courts in the United States that ruled that an employer’s responsibility for fatigue-related crashes can continue even after an employee has left work.51,52

Sleep-deprived staff members are at increased risk for making mistakes and becoming involved in accidents. Because the organization holds ultimate responsibility for the actions of its employees, this is clearly a risk management issue. As the link between rotating shifts and compromised performance continues to build, employers will almost certainly be forced to assume more responsibility for fatigue-related problems.

Organizational efficiency: The issue of workforce recruitment and retention has been cited as one of the top seven EMS problem areas.53 Irregular hours are cited as a major reason why employees leave many health occupations, including some that are similar to EMS (e.g., nursing and emergency medicine).44 According to one study, employees who achieve a match between their preferred and actual schedule are more likely to be satisfied with and remain at their jobs.54

Little has been written concerning the impact of nonconventional work hours on absenteeism and presenteeism. Presenteeism is the practice of coming to work and doing only what is absolutely necessary in order to maintain a job. This trend may be seen in employees who are too exhausted to contribute to the organization in a meaningful way. In EMS, it may manifest through limited interaction with patients and coworkers, poor documentation and a stagnant learning mode, all of which detract from overall organizational performance and efficiency.

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Conclusion
EMS plays an important role in our health-care system, and personnel must be available around the clock, making shift work a necessity. But shift work is known to lead to major health and wellness problems and has been a concern for shift workers in health-care professions for many years. Although little research has specifically focused on shift work and EMS, the findings in other health professions should emphasize shift work as a major concern for EMS personnel who must endure the challenges of a high-stress job. Because working conventional hours is often not an option, EMS personnel must be aware of the potential adverse effects of shift work and employ sound strategies to minimize them. (Editor's note: For practical tips on how to curb the effects of shift work, read "Effects of Shift Work, Sleep Deprivation & Stress," a sidebar to the "2004 JEMS Salary & Workplace Survey," October 2004 JEMS, available at www.jems.com/resources/surveys/.)

EMS administrators must also recognize the potential effects of shift work on the organization. In the current health-care environment in which administrators must take a proactive approach to preventing errors and accidents, the effects of SWIF cannot be ignored. Scheduling practices may warrant change in order to reduce fatigue while practitioners are on duty. Administrators must also recognize the impact that shift work has on the effectiveness of the organization in terms of staffing, employee retention and risk management.

Last, the effects of shift work on EMS personnel must become a subject of intense research in the field, as it has in other parts of the health-care spectrum. Only then will EMS as a profession understand what problems as a result of shift work are common or unique to the field and develop sound and safe ways of addressing them. In the interim, we must rely on the data produced by other health-care professions and learn from their research and experience.

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SHIFT WORK I


