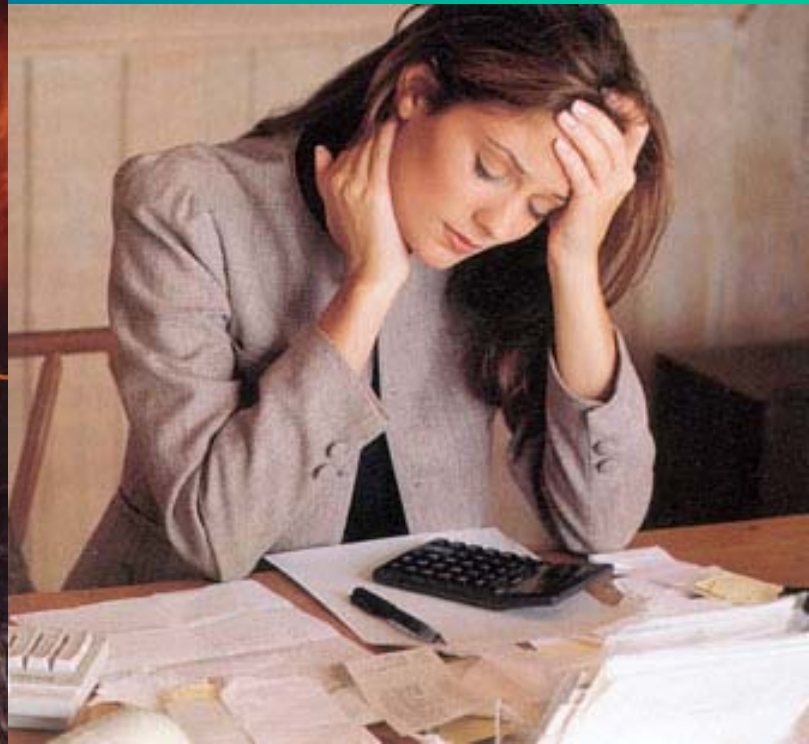


FATIGUE AWARENESS

USDA Forest Service



Introduction

- ❖ This presentation is designed to serve two groups: all agency employees, and those involved in wildland fire suppression. The material can be used for self-study or as a class presentation. Additional information concerning fatigue is listed at the end of the presentation.

MTDC

Contents

- ❖ Part One—All agency employees
- ❖ Part Two—Fire managers, supervisors, firefighters, and support personnel
- ❖ Goals are to understand:
 - Causes of fatigue
 - Factors that influence fatigue
 - Effects of fatigue
 - Signs and symptoms
 - Operational Strategies
 - Fatigue Countermeasures

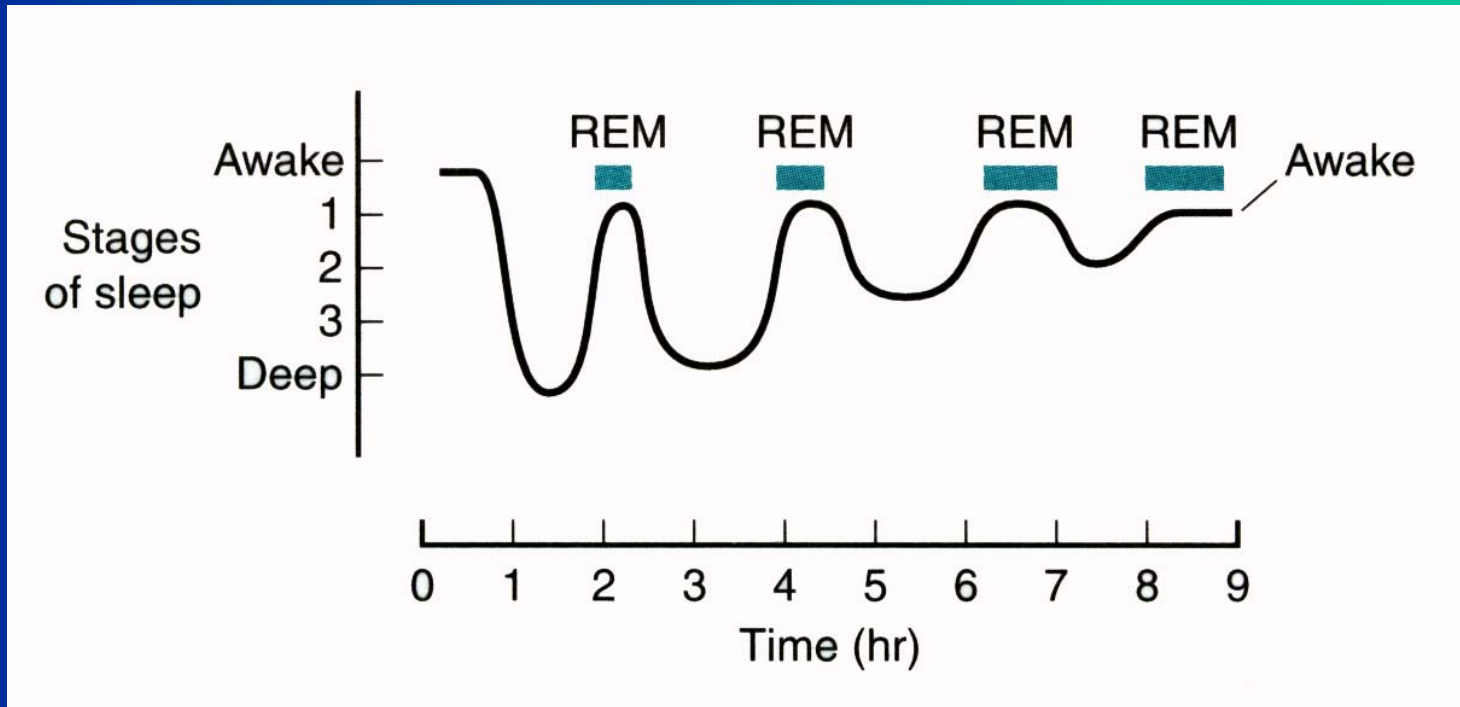
Systemic Causes of Fatigue

- ❖ Sleep Loss
- ❖ Disruption of Circadian rhythms
 - A number of biological variables exhibit a 24-hour periodicity or rhythm. They include: wakefulness, hormones, respiratory and heart rates, blood pressure.

Types of Sleep

- ❖ There are two types of sleep:
 - NREM (non-rapid eye movement) and
 - REM (rapid eye movement)
- ❖ They alternate through the night. Both are required for quality sleep.

The Stages of Sleep



Sleep Loss

- ❖ Sleep loss adds up and creates a sleep debt
- ❖ Sleep loss leads to increased sleepiness
- ❖ Sleep loss has consequences
- ❖ Repeated loss of REM sleep can lead to neurotic behavior

Consequences

- ❖ Worsening mood and communication skills
- ❖ Inability to focus
- ❖ Decreased mental and physical performance

Hours of Sleep

- ❖ When is the last time you had eight hours of sleep?
- ❖ On average everyone needs about eight hours of sleep!
 - Less than 7 or more than 9 hrs of sleep is associated with poorer health (vs 7-8 hrs sleep)
- ❖ *Short-term (few days) — you can get by with 6 hrs + naps*

Quality vs Quantity

- ❖ There are a number of factors that cause disrupted sleep:
 - Age—with age, sleep becomes less deep, more disrupted, and a total decrease in sleep occurs
 - Alcohol and caffeine
 - Medications
 - Environment (physical & emotional)
 - Sleep disorders (sleep apnea)

Components of Sleep

- ❖ Physiological sleepiness signals a physical need like hunger and thirst
- ❖ Subjective sleepiness is how you feel
 - This can be masked by environmental stimulation, physical activity, caffeine, etc.
- ❖ Estimating sleep requirements is difficult due to masking

Fatigue Accumulates



Factors that Affect Sleep

- ❖ Prior sleep and wakefulness
- ❖ Persons working over 16 hours on a regular shift will experience fatigue
- ❖ Most persons nearing 24 hours on a continuous shift will experience cognitive impairment
- ❖ **Note:** Regular moderate physical activity enhances the ability to fall asleep

Fatigue Awareness

- ❖ Critical management decisions (stress situations) will create a sleep debt, which increases the chance that fatigue will impair your abilities
- ❖ Disruption of the Circadian rhythm by working rather than sleeping between 10 p.m. and 6 a.m. increases the risk of fatigue

Sleep Deprivation

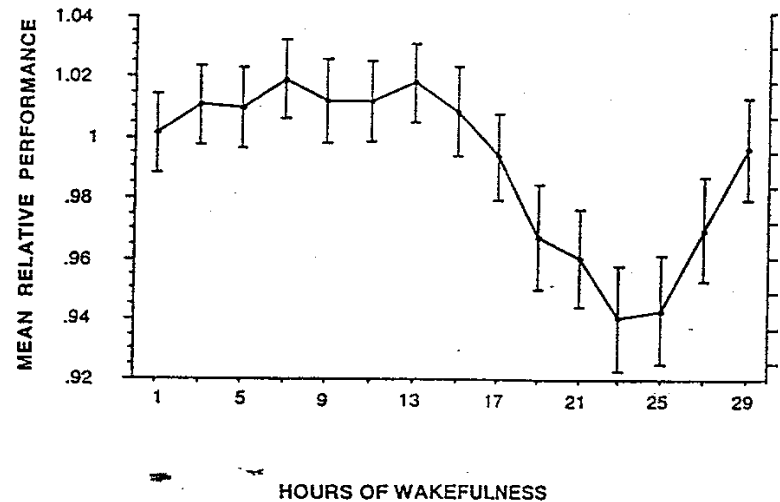
❖ Cognitive performance:

- Tracking task on computer
- No change for 12 hrs
- Drops from 12-24 hrs
- Rebounds 24-29 hrs!

❖ Conclusion:

- Performance declines between 12 and 6 a.m. due to fatigue and Circadian rhythm.

Nature 1997



Circadian Rhythms

- ❖ Circadian rhythms (in brain) coordinate:
 - ✓ Sleep/wake periods
 - ✓ Body temperature
 - ✓ Hormones
 - ✓ Digestion
 - ✓ Cardiovascular responses
 - ✓ Performance

Fatigue Awareness

- ❖ Other physiological functions:
 - Disruption of the Circadian rhythm interrupts the synchronization of physiological functions, which further causes sleep loss (e.g. having to wake up in the middle of the sleep period to use the restroom)

Sleep Cycles

- ❖ The Circadian rhythm has two low activity or sleep cycles:
 - ✓ 2 to 5 a.m. and
 - ✓ 3 to 5 p.m.
- ❖ Studies show that traffic accidents caused by drivers falling asleep peak between 1 and 4 a.m., with a smaller peak between 1 and 4 p.m.

Night Shift



It takes weeks for the body to adjust to the night shift

Circadian Disruption

- ❖ Changing work shifts (e.g., night shift) and time cues (jet lag) result in:
 - Disturbed sleep
 - Increased sleepiness while awake
 - Degraded mental or physical condition
 - Worsened mood (emotional stress)
 - Gastrointestinal problems

Fatigue Factors

- ❖ Extended shifts or workdays can result in prolonged wakefulness, and fatigue from long or multiple shifts
- ❖ Restricted time for sleep (early wake-up before 6 a.m. or beginning rest period after 10 p.m.) results in sleep loss and cumulative sleep debt

Fatigue Factors

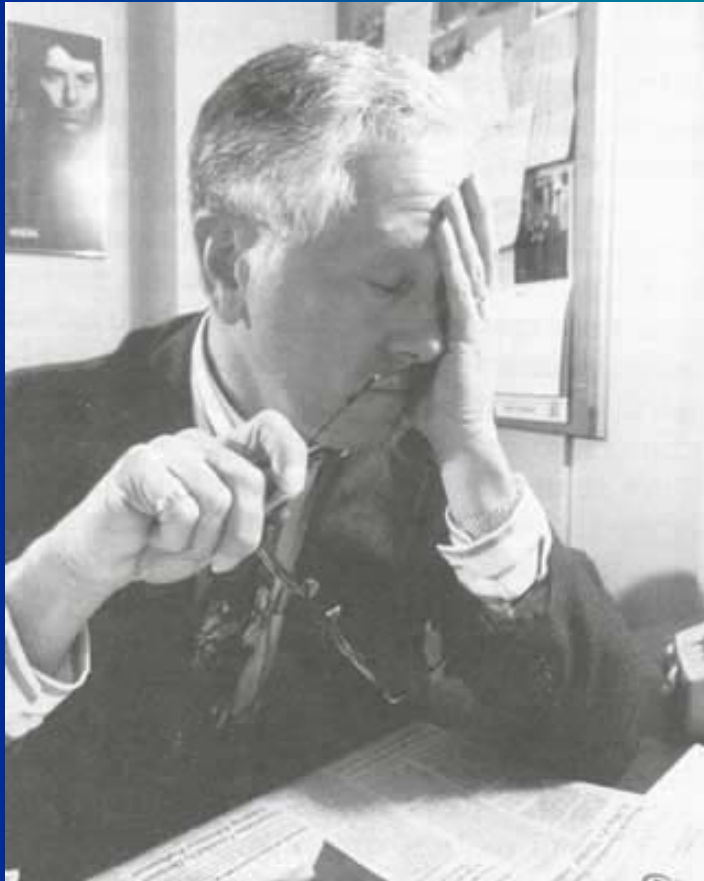
- ❖ Night shift (10 p.m. to 6 a.m.) or late afternoon shifts increase fatigue because of Circadian rhythm lows (2 to 5 a.m.) and the afternoon dip (3 to 5 pm.)
- ❖ Low activity, repetitive tasks, and monitoring roles increase fatigue; passiveness creates boredom and complacency, and boredom can unmask sleepiness

Fatigue Factors

- ❖ High intensity workloads (critical decision-making overload or work stress)
- ❖ Increased fatigue because of the high physical or cognitive workload
- ❖ Continuous workloads without breaks
- ❖ Physical environment also increases fatigue: temperature, humidity, altitude, air quality, noise and vibration

Fatigue

Decision-makers are more prone to the effects of fatigue than those doing hard physical work



Fatigue Factors

- ❖ Heavy workload (actual or perceived)
- ❖ Knowledge and use of fatigue countermeasures
- ❖ Time-of-day operations
- ❖ Physical environment (terrain, weather)
- ❖ Vigilance requirements

Effects of Fatigue

- ❖ Degraded cognitive functions (judgment, decision making)
- ❖ Decreased alertness (situational awareness, perception)
- ❖ Errors (missed radio calls, sloppiness, mis-understanding of orders)
- ❖ Impaired concentration
- ❖ Mood (complacency, irritability)
- ❖ Slowed reaction times
- ❖ Degraded skills

Fatigue & Immune Function

- ❖ Factors that reduce immune function & open door to upper respiratory illness:
 - Prolonged exertion/exhaustion
 - Stress (hormones reduce immune function)
 - Inadequate energy or nutrition
 - Smoke (including cigarettes)
 - Also: sleep deprivation, disruption of circadian rhythms, dehydration

Stress and Fatigue

- ❖ Stress increases cortisol and epinephrine (adrenalin)—preparing the body for fight or flight
- ❖ Do stress hormones erase fatigue?
 - Adrenalin provides a temporary reprieve from effects of fatigue, followed by a rapid physical and emotional decline

Emergency Response

- ❖ In an emergency, the effects of fatigue become critical, and may result in:
 - Spatial disorientation (proximity and location of hazards, escape routes, and safety zones)
 - Loss of vigilance (impairment of self-preservation behavior and situational awareness)
 - Workload monitoring (miscalculating task requirements)

Emergency Response

- ❖ Failure to consider consequences of actions (e.g. not developing a backup plan, or performing double checks)
- ❖ Increased multi-tasking (splitting attention)

Fatigue Awareness

**Accumulated
(chronic) fatigue
reduces alertness,
decreases
productivity, and
compromises
immune function**



Misconceptions

- ❖ Many believe that being well-trained, well-motivated, professional, or having previous experience with sleep deprivation prepares them to fight off the physiological consequences of sleep loss

WRONG

- People, especially sleepy people, can not reliably estimate their alertness and performance

Misconceptions

- ❖ There is one work/rest program that prevents fatigue in everyone

WRONG

- Sleep cycles and Circadian rhythms are complex, and subject to individual variations. Furthermore each operation, and a multitude of factors, present different and changing sleep demands.

Fatigue Signs and Symptoms

- ❖ Poor decision making
- ❖ Slowed reaction time
- ❖ Difficulty communicating
- ❖ Forgetfulness
- ❖ Fixation
- ❖ Lethargy
- ❖ Bad mood
- ❖ About to nod off

Strategies

- ❖ **Alertness strategies**—are preventive strategies used before or between shifts to reduce the effects of fatigue, sleep loss and circadian disruption.
- ❖ **Operational strategies**—are used during shifts to maintain performance. However these strategies do not address the underlying physiological mechanisms, but manage the effects of fatigue. These techniques mask the underlying physiological need for sleep.

Alertness Strategies

- ❖ Before the work shift, get the best possible sleep (ideally 7 to 8 hours)
- ❖ Use naps appropriately (e.g. use naps before and during the shift)
- ❖ Use up to two hours of naps during extended assignments. The rationale is that some sleep, even though interrupted, is better than none, and will decrease the sleep debt
- ❖ Up to 20 min or 90 min naps may work best

Operational Strategies



Operational Strategies

- ❖ Engage in active conversation with others (don't just listen)
- ❖ Do something physical such as stretching or moving around
- ❖ Engage in light to moderate activity (e.g., take a walk)

Operational Strategies

- ❖ Caffeine consumption—requires some knowledge and experience with the effects
 - Use caffeine to temporarily increase your alertness
 - Do not use caffeine when already alert or before bedtime
 - Be aware that it is a mild diuretic and stay hydrated
- ❖ Be sensible about nutrition—eat moderate portions, don't skip meals

Adrenalin Reprieve?

- ❖ Does adrenalin from excitement or danger overcome fatigue?

NO!

- ❖ Adrenalin produced during the body's fight or flight response allows a temporary reprieve—followed by a rapid and severe physical and emotional decline

Fatigue Awareness

❖ Safety vigilance:

- Avoid sleeping near hazardous areas
- Pull over and park vehicles in safe locations to take naps if feeling sleepy
- Don't push operations or make critical decisions by yourself if you are fatigued



Fatigue Countermeasures

- ❖ Improve your fitness and maintain regular physical activity
- ❖ Ensure appropriate rest before assignment or work shift
- ❖ Practice work cycling (hard/easy, long/short)
- ❖ Adjust your work to conditions (heat and humidity)

Fatigue Countermeasures

- ❖ Take rest breaks or naps (up to 20 min or 90 min)
- ❖ Change tasks and tools
- ❖ Take solid and liquid carbohydrate supplements to help maintain blood glucose, energy, alertness, and immune function

Conclusions

- ❖ Fatigue affects everyone
- ❖ Fatigue affects individuals differently
- ❖ Vigilance declines—we don't hear, see, think, or focus as well, and reactions are slowed
- ❖ People are incapable of making self-determinations of fatigue, therefore...

**Leadership needs to
manage fatigue!**

Fatigue Awareness: Part Two



Part Two—Fire

- ❖ For fire managers, supervisors, firefighters, and support personnel:
 - To understand the relationship between fatigue and long shifts, long assignments, and arduous work
 - Based on evidence from studies conducted in actual working conditions

Fatigue Research

- ❖ Fatigue occurs rapidly in simulated (make-work) studies
- ❖ Performance is better maintained in studies of actual or meaningful work
 - E.g., even with sleep and food deprivation, fit and motivated soldiers were able to sustain performance

(US Army Research Institute of Environmental Medicine, 2002)

Current Work



- ❖ Fireline studies
 - Fatigue
 - Sleep
 - Energy intake
 - Energy expenditure
 - Immune function
 - Mood

Fitness

❖ Does fitness influence fatigue?

Yes—fit workers
accomplish more work
with less fatigue.



Fitness and Fatigue

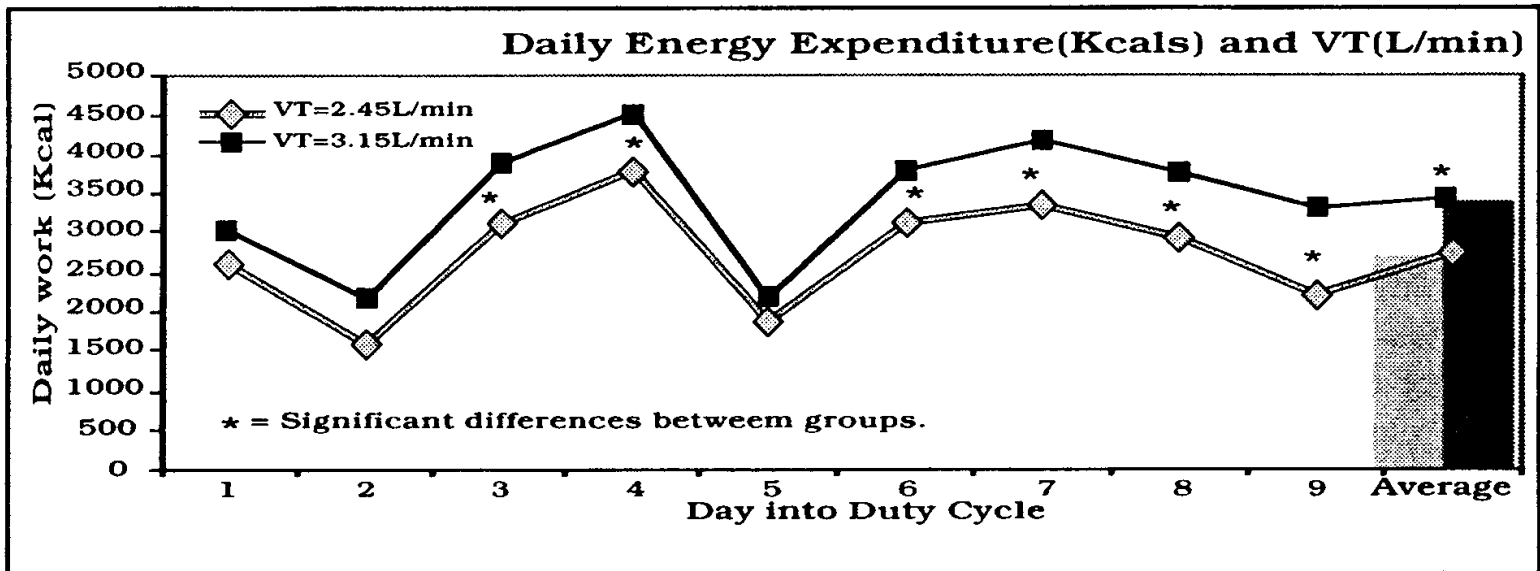


Figure 3—This graph shows the work (kilocalories per day) done by a hotshot crew over a 9-day period. The crew was divided into fitter and less fit groups. The fitter group did more work per day than the less fit group.

Energy

❖ Do nutrition and hydration influence fatigue?

Yes—fatigue is reduced and more work is done when energy needs are met.



Supplemental Energy

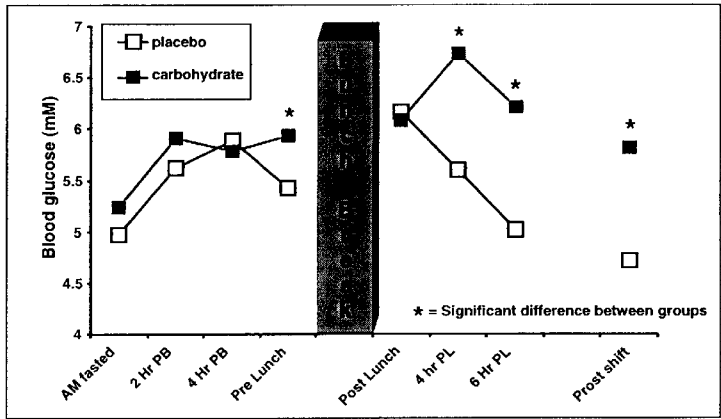


Figure 1—Changes in blood glucose during work performed after breakfast and lunch.

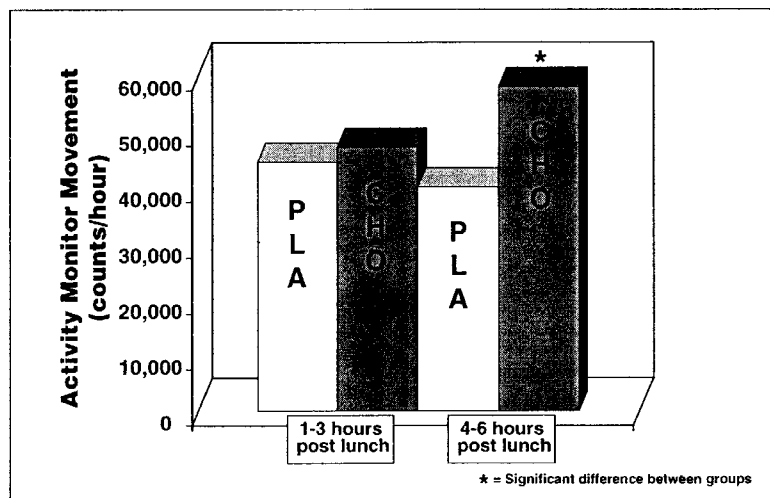


Figure 2—Average activity counts in the hours after lunch. PLA = placebo, CHO = carbohydrate drink.

Blood glucose is maintained with carbohydrate supplement

Energy expenditure is higher with supplement

Ruby & Gaskill 2002

Shift Length

❖ Does shift length influence fatigue?

Yes—fatigue accumulates
and immune function
declines during long shifts.



14 Hour Shift

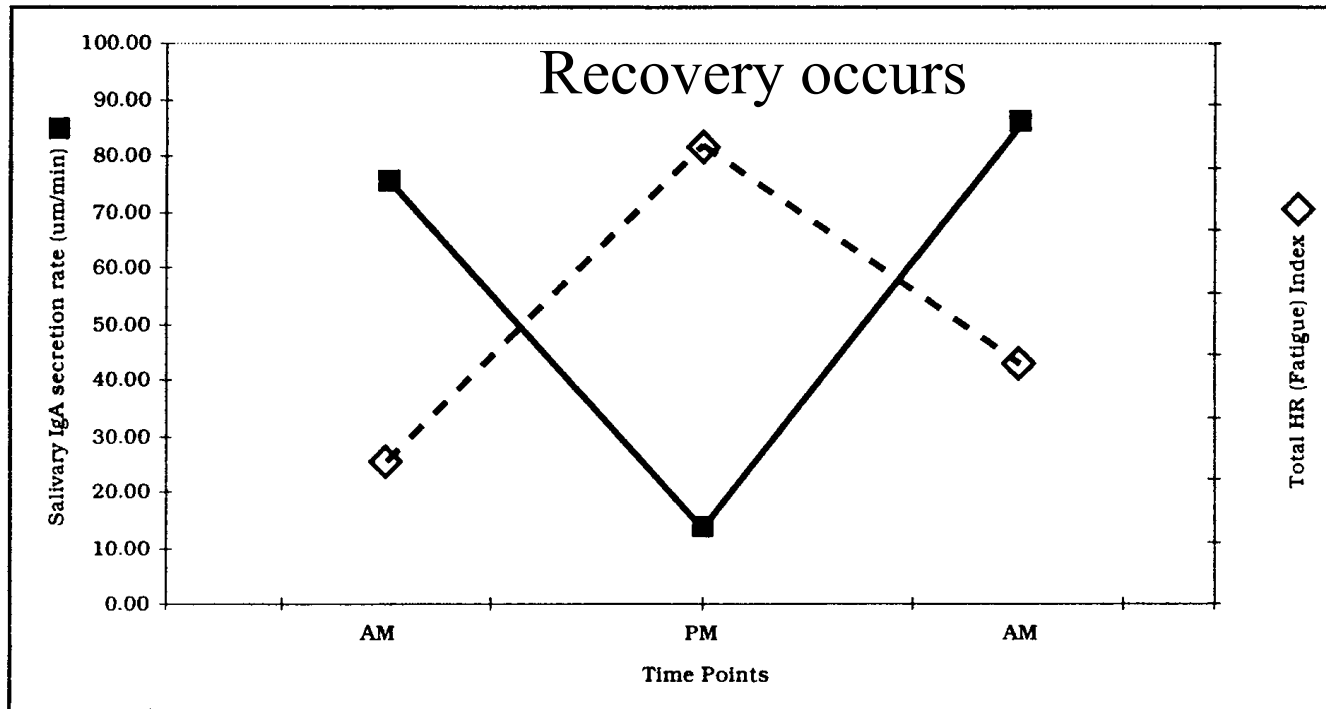


Figure 1—Changes in salivary IgA in response to a single work shift of 13.9 ± 0.7 hours ($n = 6$). The summary data for the fatigue index are also shown (heart rate response to a 1-minute step test). These data indicate adequate recovery after the single work shift.

21 Hour Shift

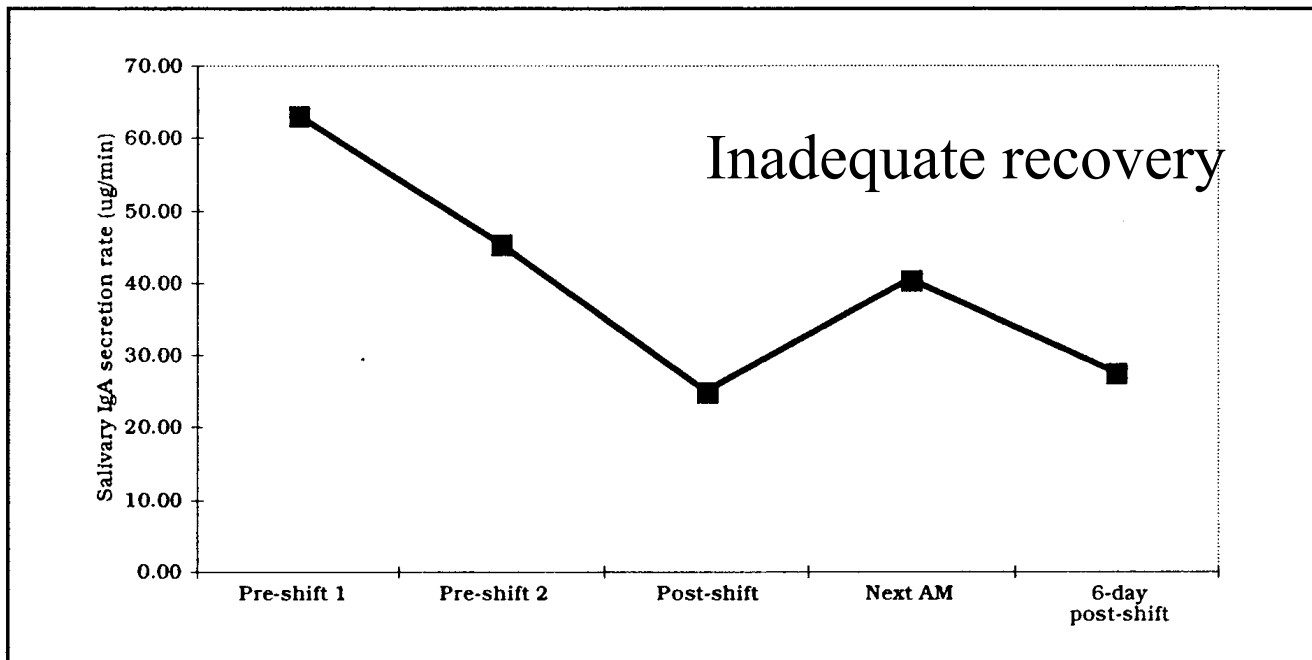


Figure 2—Changes in salivary IgA secretion rate in response to a single work shift of 21.4 ± 0.3 hours ($n = 11$) followed by 5 days of 14 ± 0.7 -hour shifts. Although subjects demonstrate an acute recovery response, sIgA secretion rate is still suppressed 6 days after the 21-hour shift in comparison to the rate after a 14-hour work shift.

Fatigue accumulates

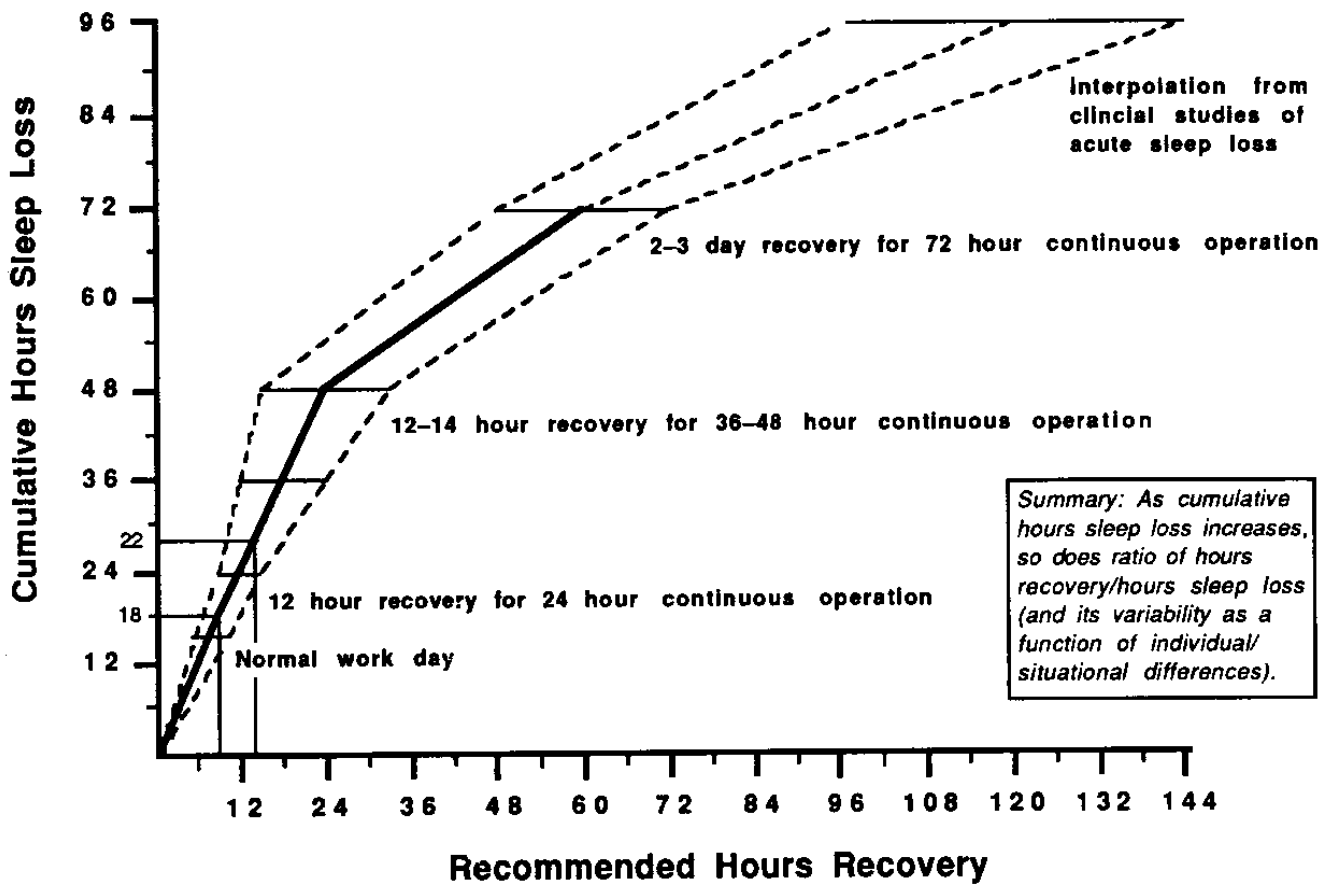
Work/Rest

❖ Do rest and sleep influence fatigue?

Yes—adequate rest/sleep help avoid chronic fatigue.



2:1 Work/Rest Ratio



Work/Rest Ratio

❖ Current policy:

- 1 hr rest for every 2 hrs work
- Ideally no more than 14 hr shift
- Over 16 hrs—must justify and document shift length, and implement countermeasures

Assignment Length

- ❖ Current policy:
 - 14 day assignments
 - Extensions up to 5 days—approvals are required
 - Back to back assignments require approvals and 2 days rest

Conclusions

- ❖ As fatigue progresses, vigilance declines—we don't hear, see, think, or focus as well, reactions slow
- ❖ Individuals and crews differ in their ability to perform during extended operations
- ❖ People are incapable of making self-determinations of fatigue, therefore...

The margin of safety needs to increase as fatigue progresses

Conclusions

- ❖ The 2:1 work/rest ratio helps to avoid accumulative fatigue (12-14 hr shifts)
- ❖ Nutrition and hydration supplements help maintain energy, cognitive function, work output, and immune function



Conclusions

- ❖ Individuals and crews differ in their ability to perform during extended operations, therefore...

Leadership must monitor and manage employee fatigue

- Recognize signs of fatigue
- Implement fatigue countermeasures
- Mandate rest when necessary

More Information?

See our web site at:

<http://www.fs.fed.us/eng/t-d.php>

➤ Look for:
Wildland Firefighter Health
And Safety Reports and
related topics (Work Capacity,
Work, Rest, Fatigue, Feeding
the Wildland Firefighter, etc.)

