DEDICATED TO HELPING BUSINESS ACHIEVE ITS HIGHEST GOALS.

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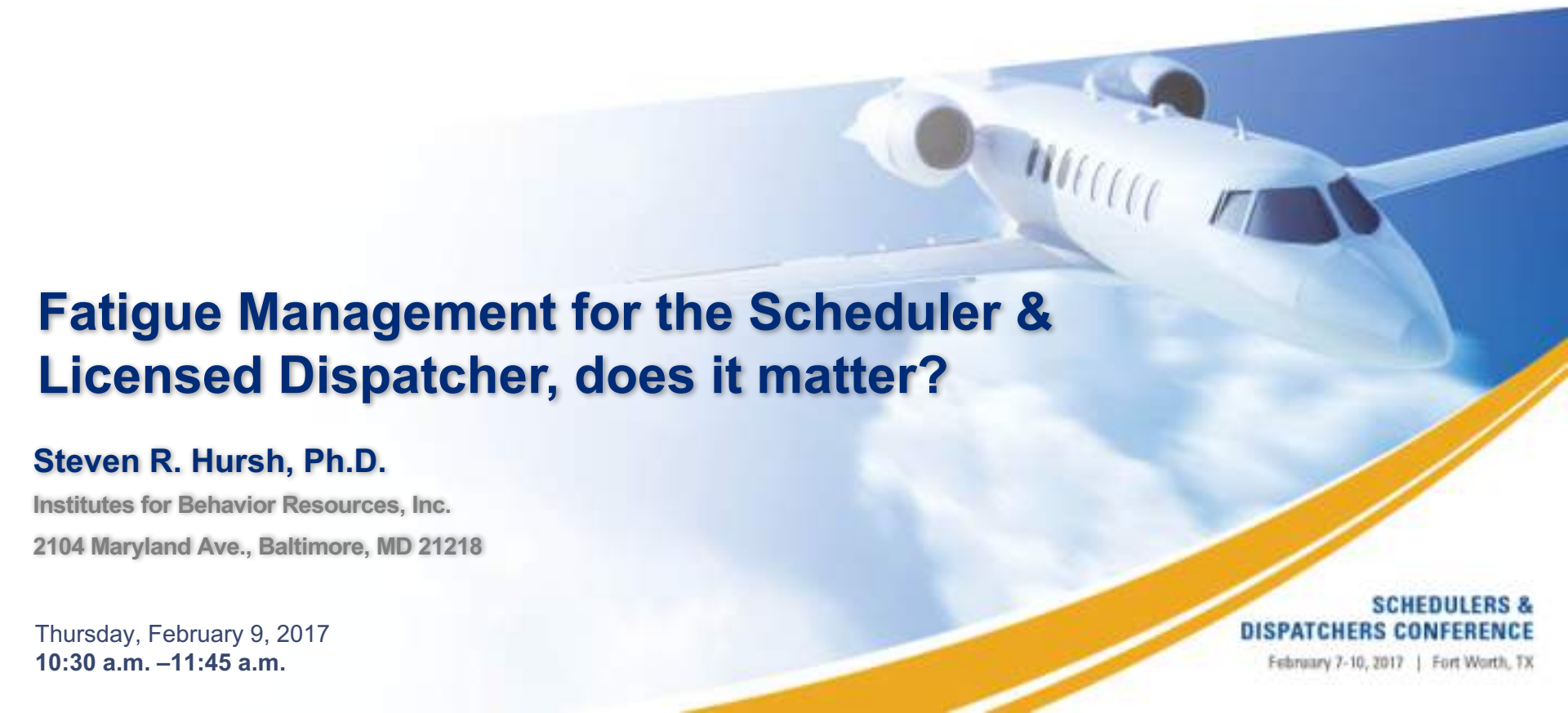

Fatigue Management for the Scheduler & Licensed Dispatcher, does it matter?

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Institutes for Behavior Resources, Inc.

2104 Maryland Ave., Baltimore, MD 21218

Thursday, February 9, 2017
10:30 a.m. –11:45 a.m.

SCHEDULERS & DISPATCHERS CONFERENCE

February 7-10, 2017 | Fort Worth, TX

Institutes for Behavior Resources, Inc.

WHO WE ARE

- Independent, nonprofit
- Research, services, and consulting
- Headquartered in Baltimore, MD

OUR MISSION

- To apply science to the improvement of human and social challenges.

WHAT WE DO:

Support evidence-based safety-related policy

- **Fatigue, performance and safety**
- Behavioral economics
- Substance abuse treatment
- Space exploration and teamwork

Objectives

- By the end of this course you will:
  - learn how fatigue can affect your performance
  - become familiar with the factors that increase your risk of being impaired by fatigue
  - understand how your sleep affects your health and performance
  - discover what you can do to manage your sleep to limit the risk of fatigue

QUIZ

Overview

I. Basic fatigue facts

II. Sleep

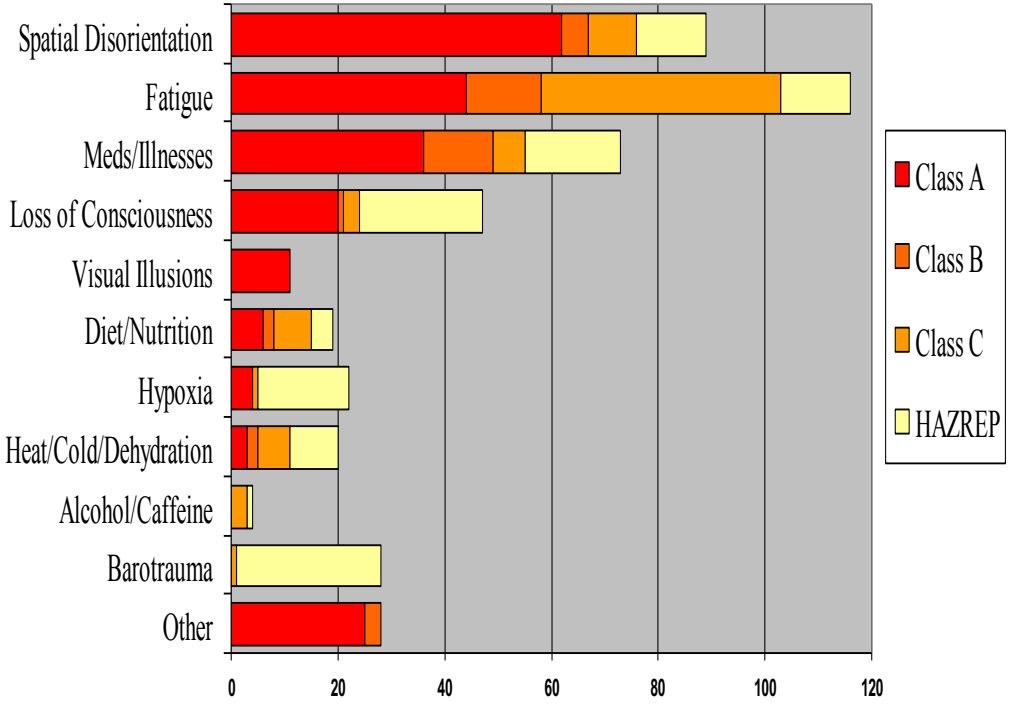
III. The Circadian Clock

IV. Ways to Manage Fatigue

V. Fatigue Management Challenges and Solutions

BASIC FATIGUE FACTS

Aeromedical Causal Factors
Reported in Mishaps & HAZREPS



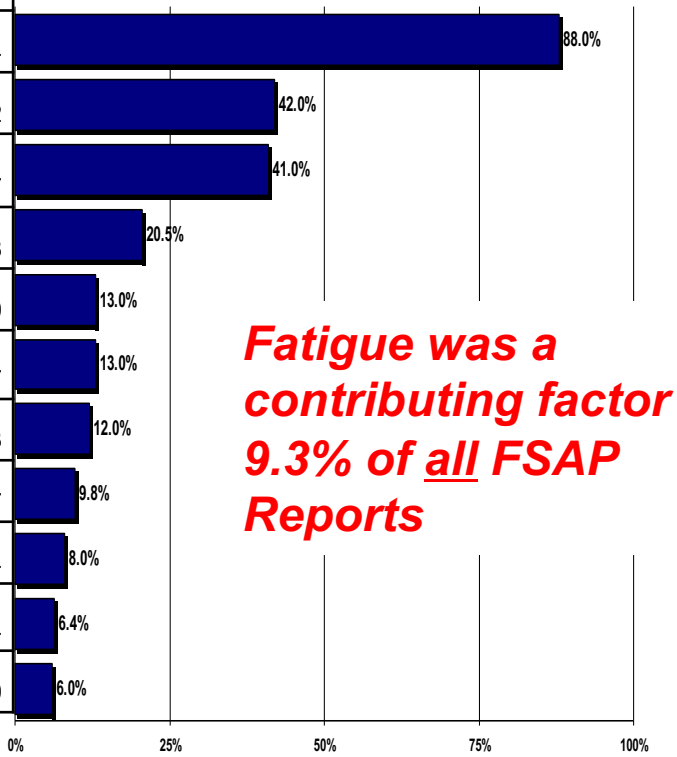
CAPT N. Davenport; NAVSAFECEN data from CAPT John Lee & Mr. John Scott; FY's 1990-2004

Reported Events & Fatigue Causal Factors

Commercial Carrier LOSA Reports, Jan 04 – Dec 06 (414 out of 2386)

Almost all reported procedural errors were attributed to fatigue!

	# Fatigue	# All FSAP
Procedural Error	109	124
Unstable Approach	43	102
Lined up Wrong Rwy	7	17
Land w/o Clearance	16	78
Altitude Deviation	142	1070
Speed Deviation	22	167
Runway Incursion	4	33
Navigation Deviation	50	487
SOP Error	7	84
Communication Deviation	6	94
Surface Incident	8	130



Fatigue was a contributing factor to 9.3% of all FSAP Reports

What is Fatigue?

- Feeling of weariness, tiredness, or lack of energy associated with prolonged work and/or prolonged wakefulness
- Fatigue is a complex state characterized by a lack of alertness and reduced mental and physical performance, often accompanied by drowsiness
- **Fatigue is more than sleepiness and its effects are more than falling asleep**

DOT Human Factors Coordinating Committee, 1998

Symptoms of fatigue

General Symptom	At work, could result in…
Decreased alertness	→ Delay in reacting to challenge
Decreased attention to environment (vigilance); Reduced “situational awareness”	→ Missed cue → Overlooked safety hazard
Poor assessment of risk; Failure to appreciate consequences action	→ Ignored safety hazard
Reduced performance	→ Difficulty maintaining performance standard → Longer reaction times
Low motivation to perform “optional” activities	→ Inaccurate paperwork → Incomplete safety checks
Irritability	→ Difficult/Ineffective co-worker interaction
Impaired judgment; Impaired logical reasoning	→ Spatial disorientation
Feelings of drowsiness	→ Heavy eyelids → Unavoidable urge to sleep

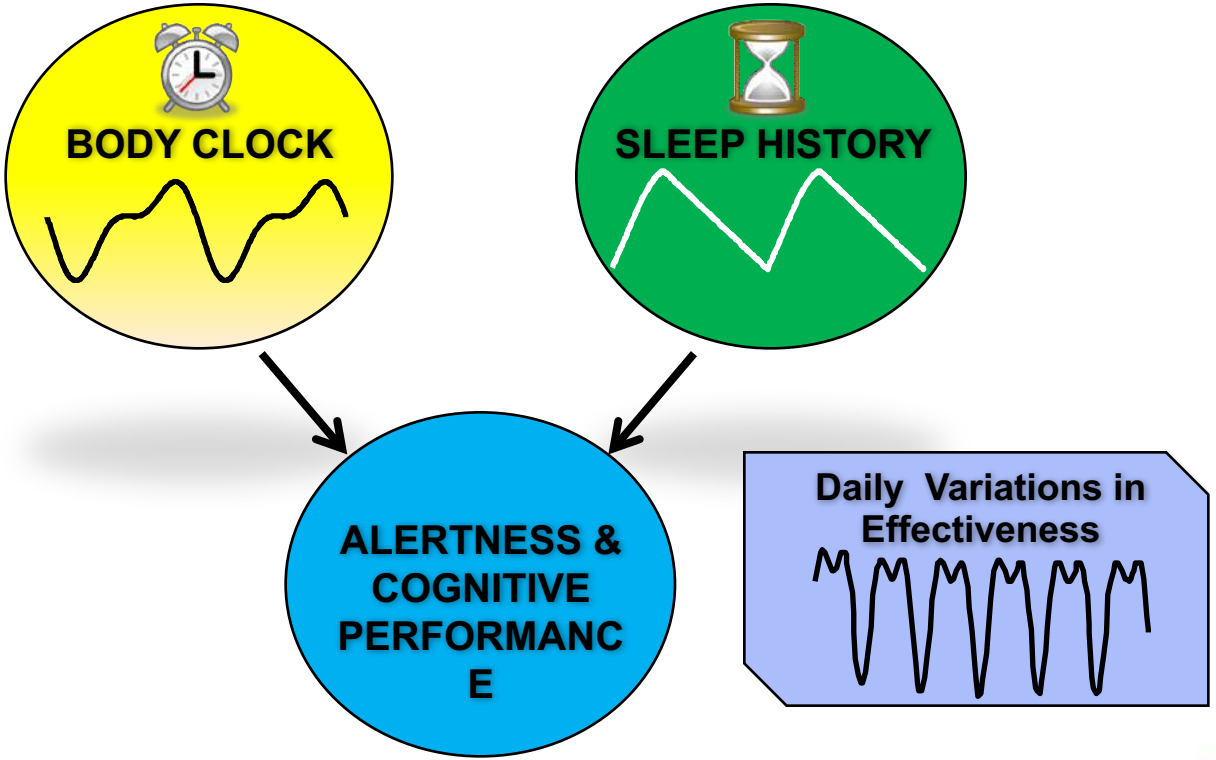
Fatigue is Insidious

NBAA

- No practical real-time fatigue detector
- Most people underestimate ***how fatigued they are*** and ***how impaired they are*** by fatigue
- We don't adapt to working fatigued

*Fatigue must be **managed**:*
limit the factors that contribute to fatigue in order to sustain alertness and performance

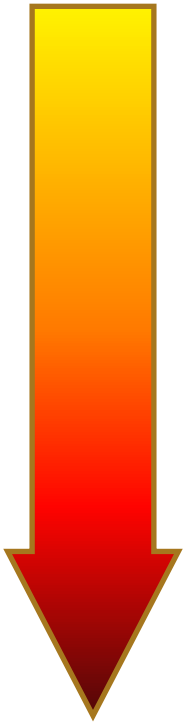
Fatigue or Loss of Alertness is Biology



SLEEP

Sleep Deprivation

Awake for one continuous period



16 hours awake
– length of a typical waking day

24 hours awake
– hand-eye coordination comparable to blood alcohol concentration of 0.1%;
– driving performance comparable to driving at 0.08%

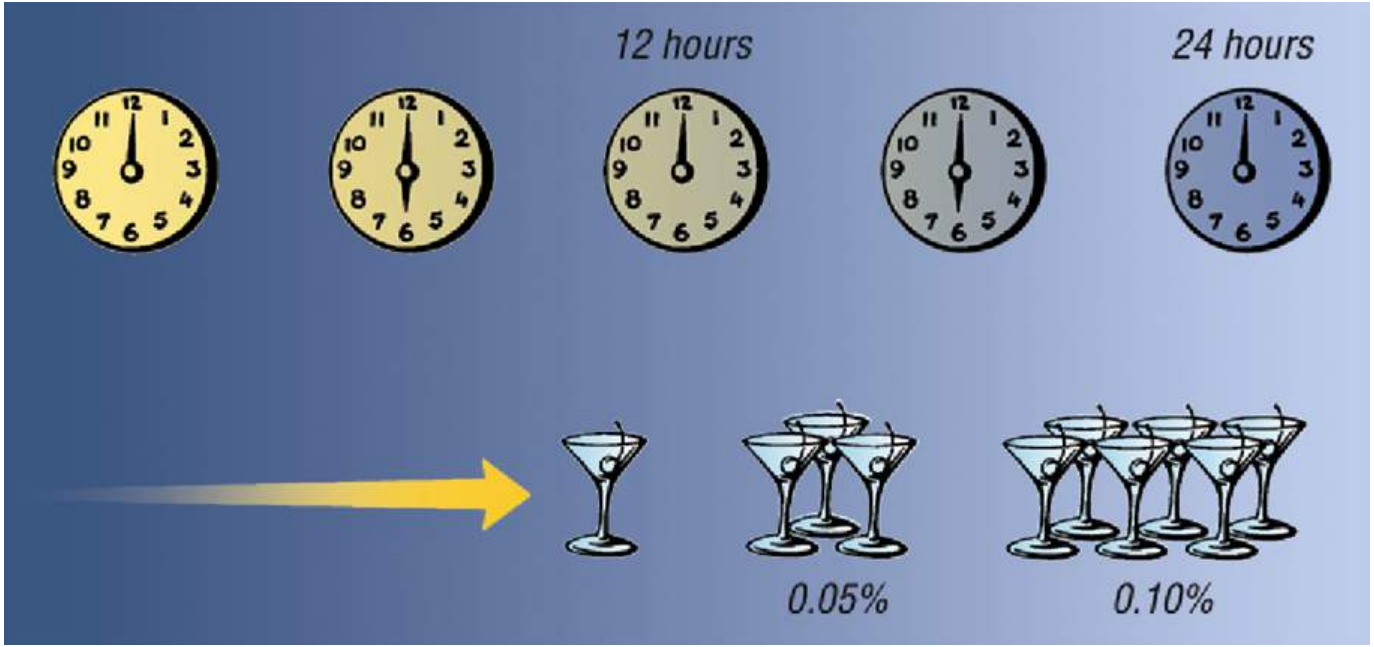
GENERAL SYMPTOMS
→ Mood changes
→Impaired alertness
→Impaired performance speed and accuracy
→EEG slows

LABORATORY SLEEP DEPRIVATION- 72 hours awake
Greatly impaired performance & mood, occasional hallucinations, great difficulty staying awake.

EXTREME SLEEP DEPRIVATION- 205 hours (8+ days) awake
mild nystagmus, hand tremor, intermittent slurring of speech, ptosis, sluggish corneal reflexes

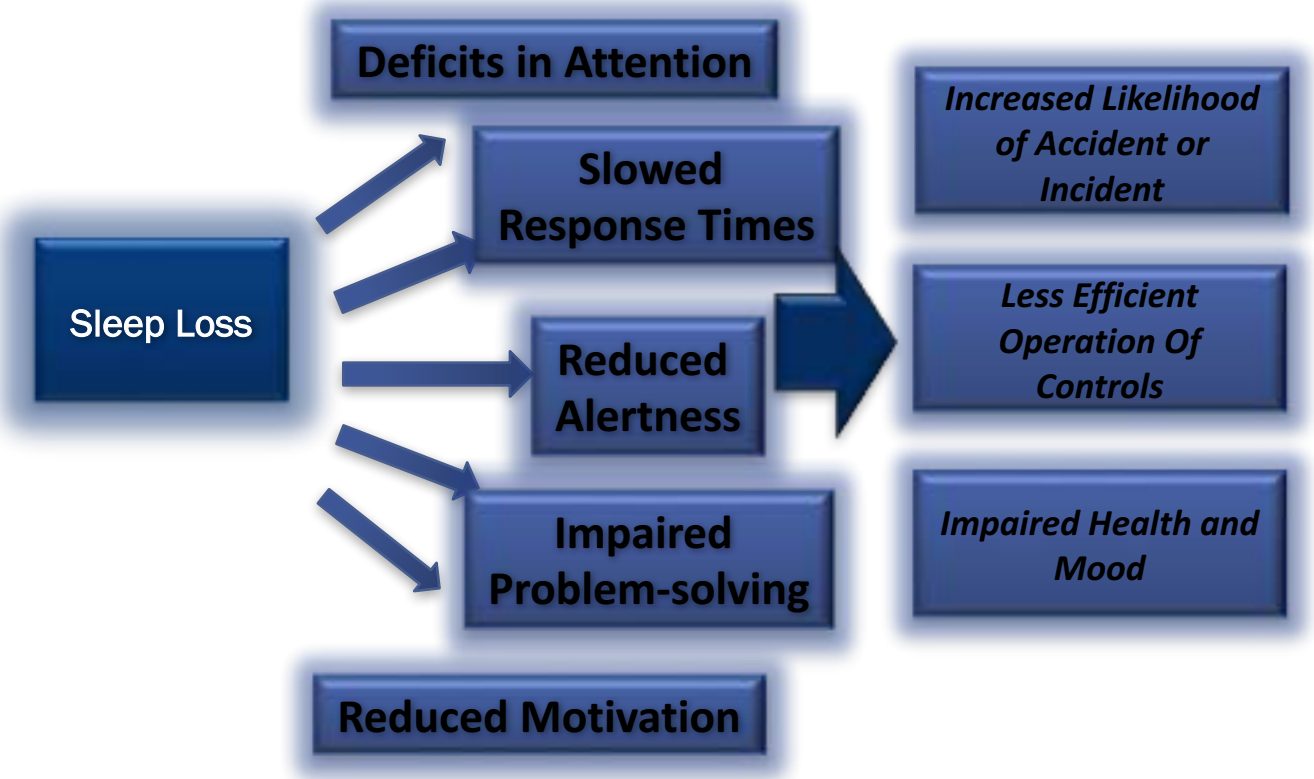
11-22 days awake
– death in laboratory rodents

Acute Wakefulness Impairs Performance



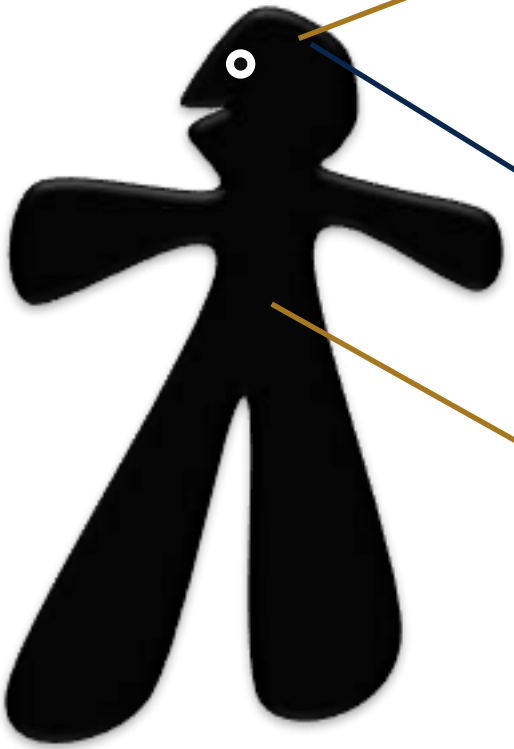
Per Lamond and Dawson (1999) recreated for the North American Fatigue Management Program for Commercial Motor Vehicle Operators

Consequences of acute sleep loss



Sleep loss results in deficits that impact health, performance and safety in operational and non-operational environments

Sleep is Vitally Important...



Memory, Learning & Memory
- -REM important for mood & learning
- -Memory is impaired when sleep is not consolidated

Performance
- -Cognitive performance
- -Attention & task completion
- -Prevents accumulated deficits
- -Concentration, problem solving
- -Judgment, decision malong

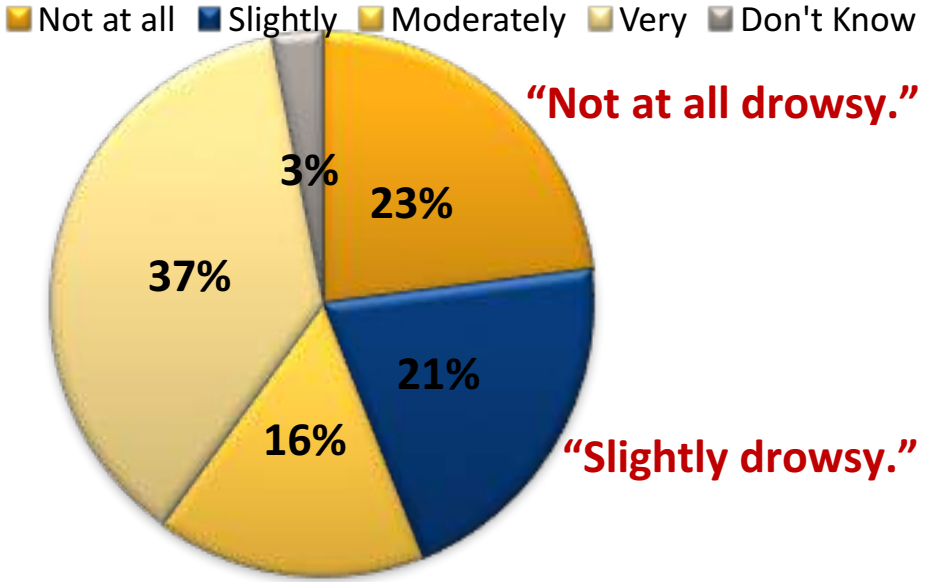
Physical wellbeing & performance
- -Growth Hormone secretion during deep sleep
- -Immune system
- -Weight management (carbohydrate craving)
- -Pain tolerance/sensitivity
- -Glucose management

Many Asleep-at-the-Wheel Drivers Never Feel Drowsy!

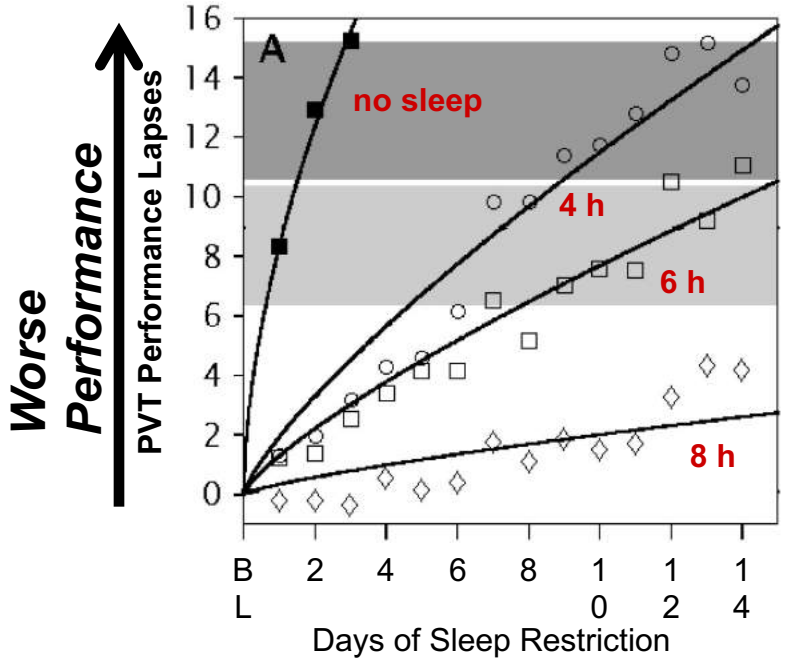
University of North Carolina Study:

Interviews with 312 motorists who had crashed after falling asleep at the wheel

44% Indicated they were not drowsy or only slightly drowsy



Reported sleepiness isn't indicative of performance impairment



Redrawn from Van Dongen, et al., 2003

Objective Signs of Sleepiness

- Eyelids droop
  - Loss of focus
- Yawning
- Thoughts:
  - Wandering, disjointed
  - Scattered, dreamlike visions
- Head movements:
  - Gentle swaying
  - Jerks
- Reduced field-of-view (“tunnel vision”)
- Body movements:
  - Fidgeting, shifting positions
  - Adjusting windows, HVAC
- Unstable crewmember performance
- Delayed or incorrect responses
- Microsleeps

Timing and Duration of Sleep

- Sleep need is individual
  - Most need between 7 and 9 hrs of sleep daily
  - Long & Short Sleepers; Morning Larks & Night Owls
  - Ageing
- Sleep is most efficient at times cued by the circadian clock (e.g. at night)
  - Sleep at any time is beneficial and effectively supplements the major sleep period at night
- All sleep contributes to the daily total

Sleep Debt

Consequences of not meeting your daily sleep need

- Chronic sleep loss increases risk of fatigue
- Days of chronic sleep loss leads to an accumulation of sleep debt, which increases the risk of fatigue
- **Avoid** sleep debt:
  - Establish your daily sleep need
  - Meet your daily sleep need
  - Exceed your daily sleep need to bank sleep

Are You Chronically Sleep-Deprived?

- Do you fall asleep in 5 minutes or less?
- Can you nap almost anywhere, any time?
- Do you feel sleepy when you are bored?
- Do you fall asleep easily while watching TV or in movies?
- Do you ever fall asleep while stopped for traffic lights?

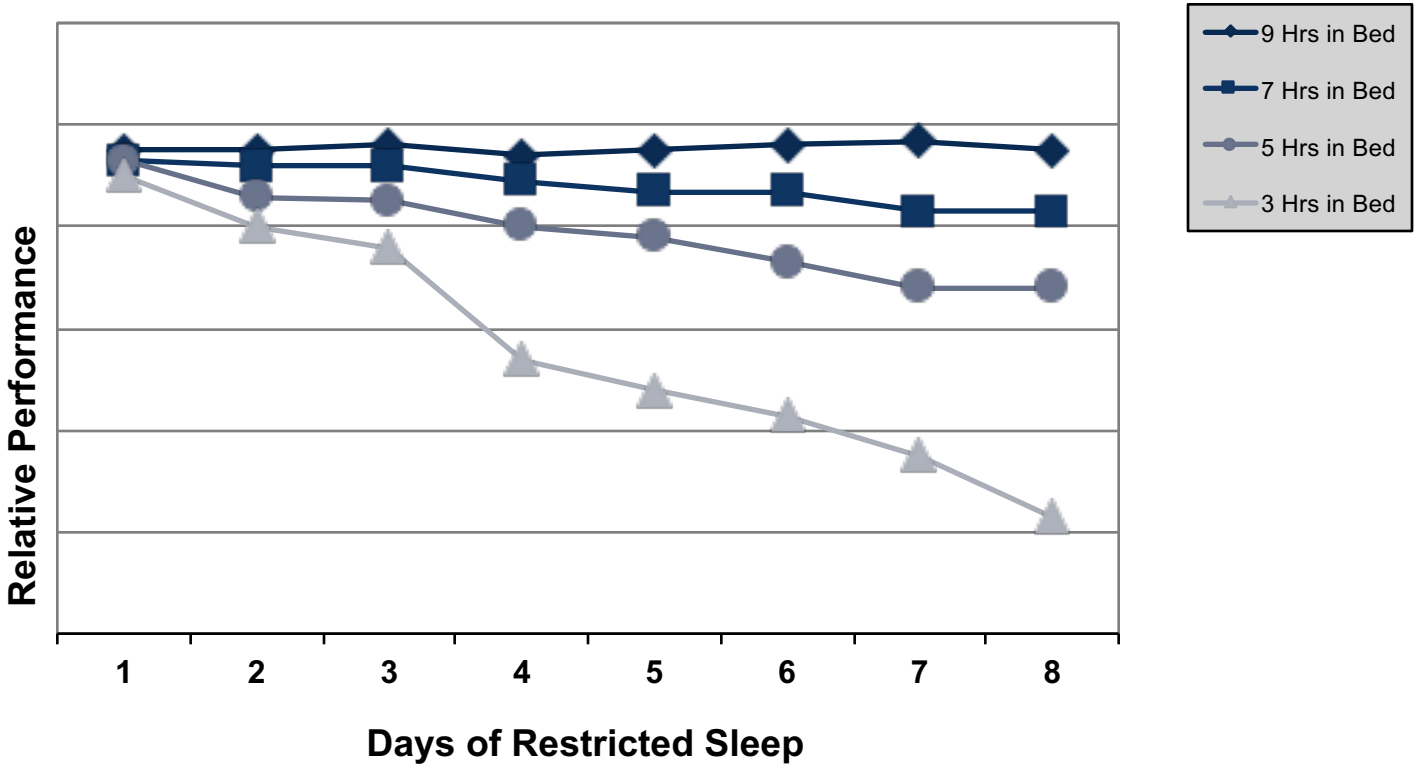
Repay Your Sleep Debt

- If you answered “yes” to the previous questions, you are probably ***chronically sleep deprived***.
- In other words, you have a ***sleep debt.***
- Like financial debt, you need to pay it back.
- Only one way to pay your debt → ***SLEEP!***

Recovery from Sleep Deprivation

- Begins following one night of good sleep
  - May not be complete until you have several nights of good sleep, more than “usual” amount.
- To some extent, extra sleep can be “banked”, i.e. restoring a full reservoir provides a reserve.
- Solution:
  - Don’t get sleep deprived to begin with.
  - Get more than one good night’s sleep on days off.
  - **To rapidly recover, sleep more than your “usual” amount for several nights.**

We don’t adapt to being chronically sleep deprived…



Caffeine

- The most widely used stimulant
- In coffee, tea, most sodas, energy drinks, some medications
- Generally safe and healthy if used in moderation
- Improves alertness and performance
- Effects and tolerance vary widely
- Effective fatigue countermeasure, but **not a substitute for sleep**

Substances & behaviors that affect sleep and alertness

Caffeine

- Moderate use can inhibit sleep, sustain performance
- Risk of tolerance, withdrawal, overconsumption

Medication

- OTC and prescription can contain stimulants that undermine sleep : caffeine, ephedrine, pseudoephedrine

Alcohol

- Rapid sleep onset but overall sleep disruption
- Worsens sleep disordered breathing

Nicotine

- Temporary activation causes sleep disruption

Exercise

- When done regularly: Improves sleep quality, increases sleep duration and total SWS, reduces WASO, improves mood.
- Short term activating/ alerting effects

Social factors

- Sleep is usually displaced for caregiver responsibilities; secondary employment; schooling

Caffeine

PRODUCT	Caffeine (MG) per serving
Coffees & Teas	
Coffee	110
Coffee, decaf	5
Espresso	90
Espresso, decaf	10
Instant coffee	75
Caffe Latte	90
Brewed, imported brands	60
Brewed, Major U.S. Brands	40
Soft Drinks	
Mountain Dew	55.5
Diet Coke	46.5
Coca-Cola	34.5
Dr. Pepper, regular or diet	42
Sunkist Orange Soda	42
Pepsi-Cola	37.5
Diet Pepsi	36
Caffeinated Waters and Energy Drinks	
Red Bull	80
Full Throttle	144
Monster	160
Wired X505	505
Chocolate	
Baker's chocolate	26
Chocolate milk beverage	5
Chocolate-flavored syrup	4
Cocoa beverage	6
Dark chocolate, semisweet	20
Milk chocolate	6
Medications	
Anacin	26
Dexatrim	200
Dristan	30
Excedrin, max. strength	130
Midol	32
NoDoz, max. strength; Vivarin	200
NoDoz, regular strength	100

- The most widely used stimulant
- Generally safe and healthy if used *in moderation*

- Effective fatigue countermeasure, but not a substitute for sleep
  - Can increase alertness and performance and overall energy
  - Can improve reaction time
  - Works quickly (in about 30 minutes)
  - The effects last for 3-5 hours in most people

- Effects and tolerance vary widely
  - Is addictive; Cutting back can cause withdrawal symptoms
  - Can cause gastrointestinal problems
  - Coffee is a mild diuretic (increases urine production)
  - May worsen some sleep disorders
  - High levels promote stress, anxiety, and irritation

- **Caffeine within 6 hrs of bedtime can impair sleep**

Sleep is mainly regulated by two factors

Homeostatic

"How long have you been awake?"

- pressure to sleep builds with every hour awake.

Circadian

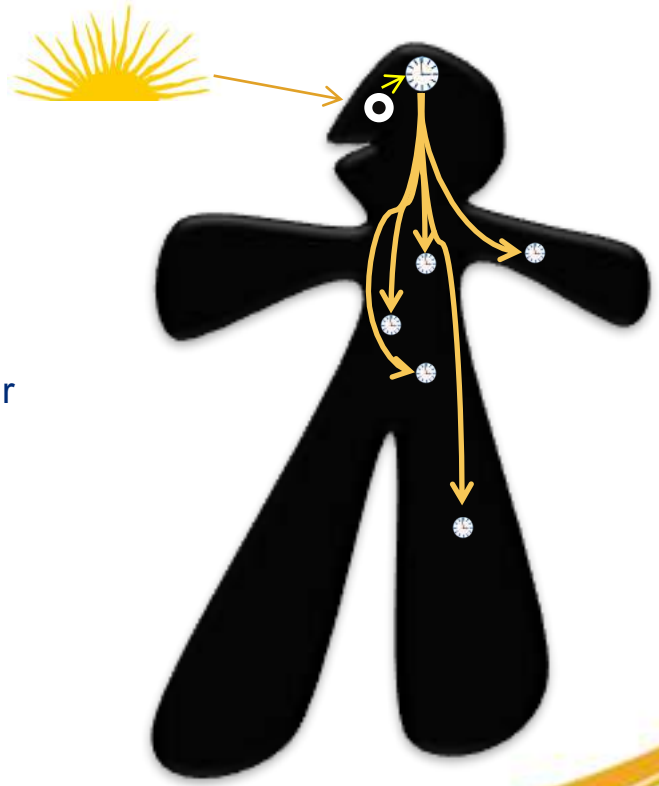
"What time is it?"

- Preference is for sleep is at night

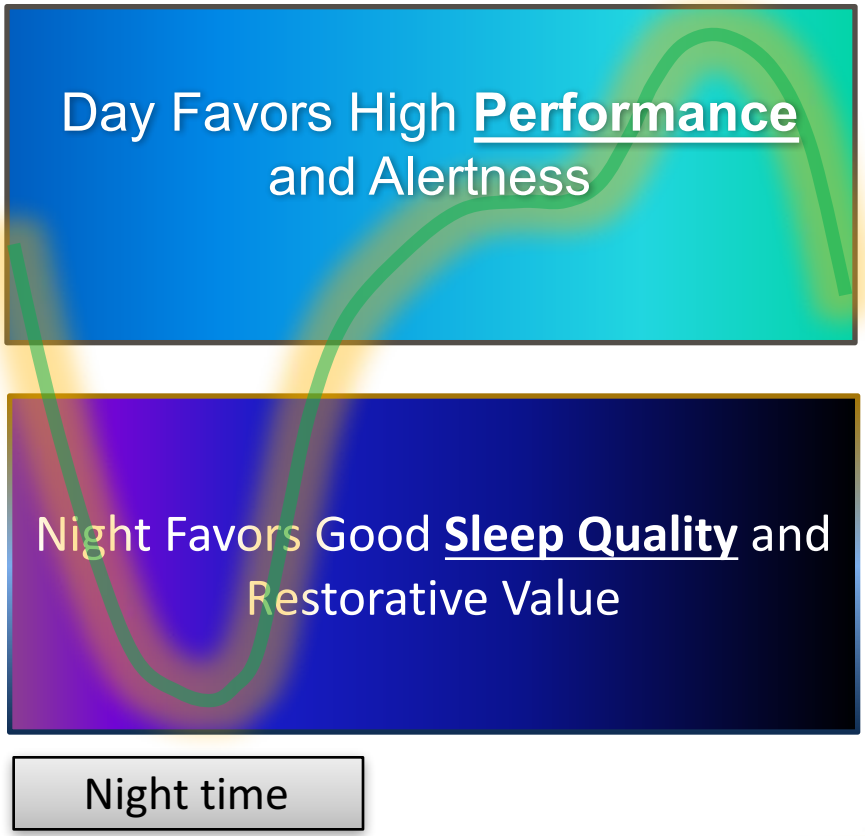
THE CIRCADIAN CLOCK

The Circadian Clock

- Master clock in the brain
  - Regulates functions throughout the body
- Circadian rhythms are endogenous and adaptable
- Light cues synchronizes the master clock to the environment
  - Coordinates the body's functions with the 24-hour day
  - Reset the clock to another time (zone)

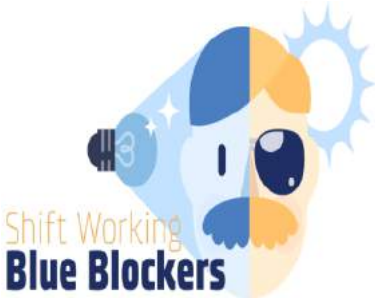


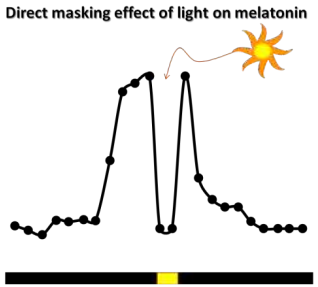
Circadian Activation



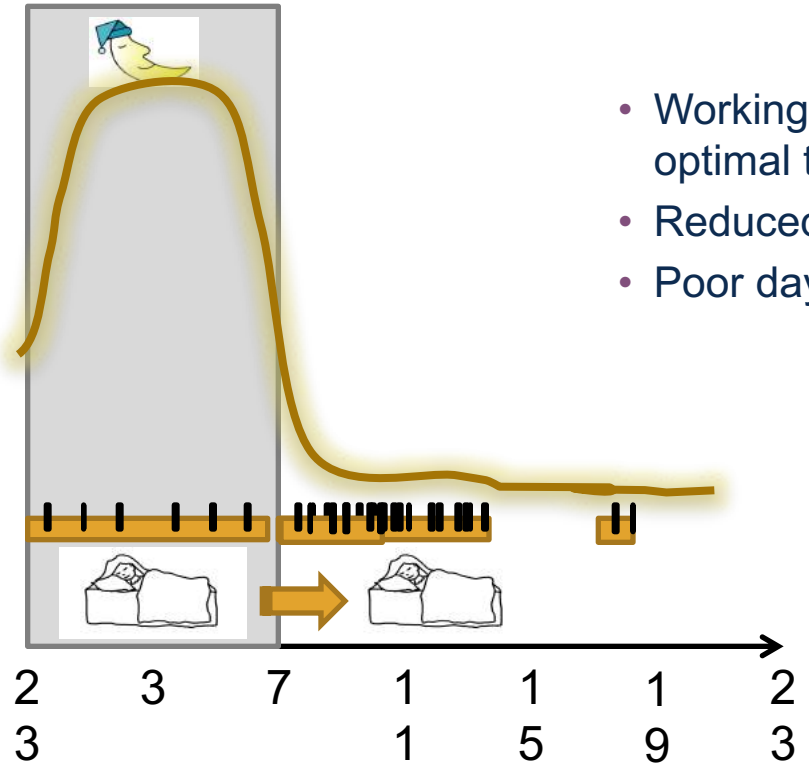
Light Synchronizes the Circadian Clock

- Light is the most powerful cue for the circadian clock
- The circadian clock is sensitive to light **intensity** and **color**
  - Separate from visual systems
  - Melatonin suppressed by light, esp. blue light
  - Alerting effects
- The pattern of light and darkness synchronizes the clock to the environment
  - Advance or delay



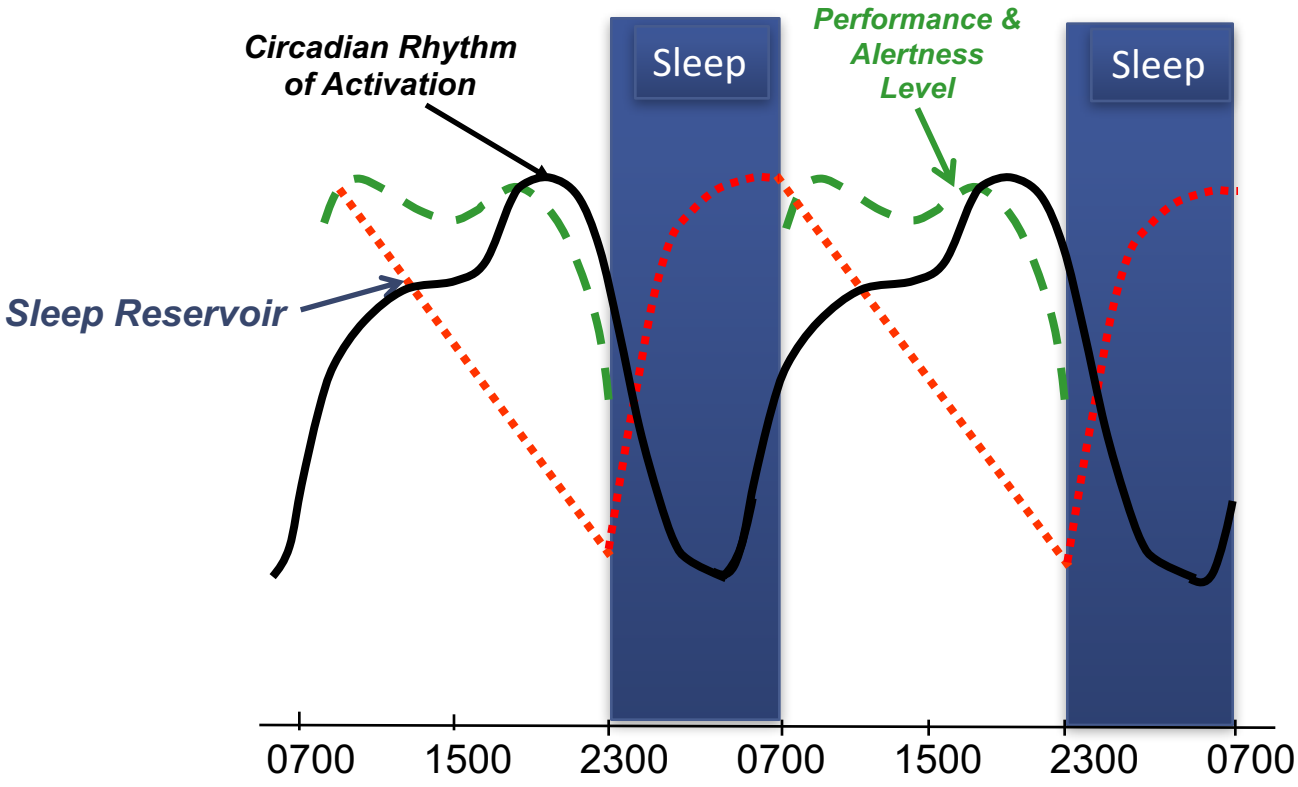


Night Work is a Common Circadian Disruption

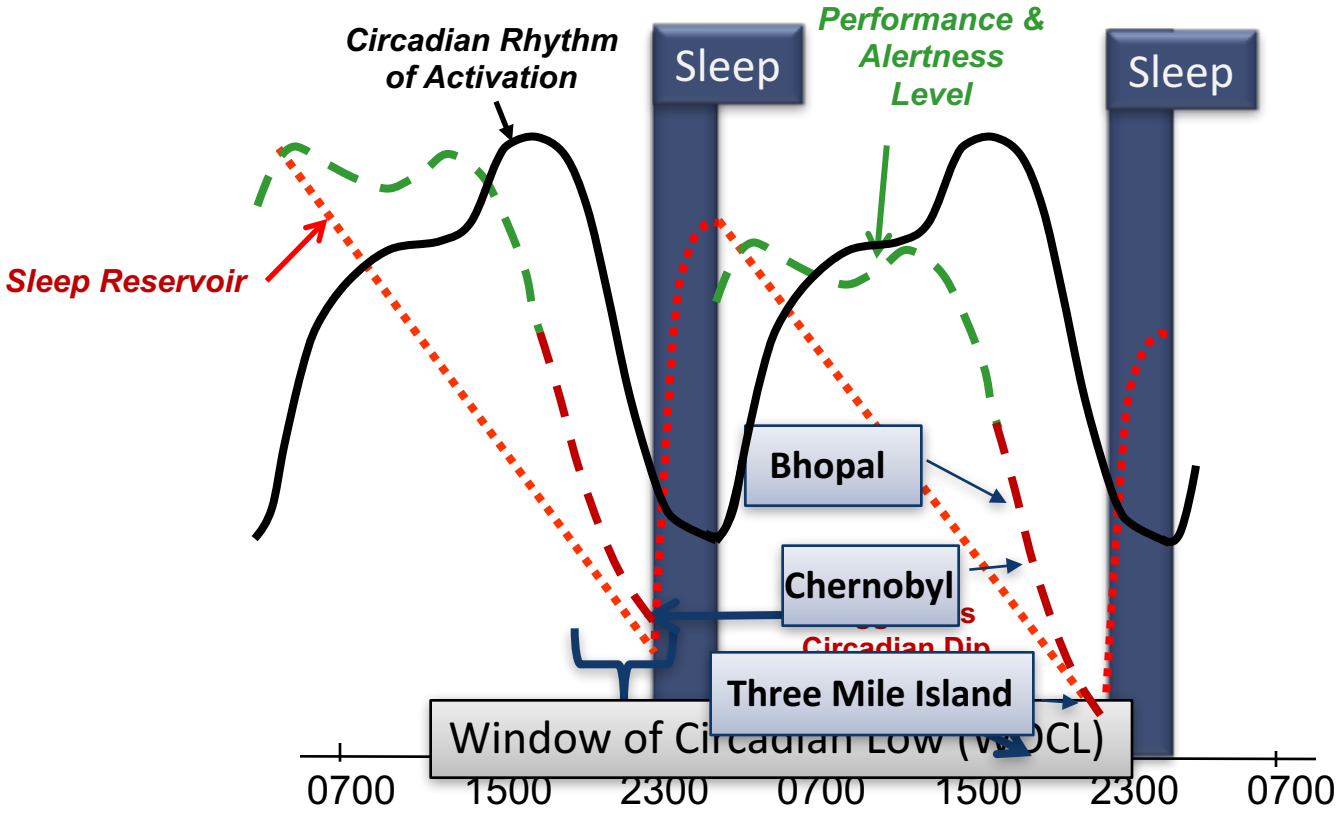


- Working at night moves sleep away from optimal times.
- Reduced performance at work
- Poor daytime sleep quality

Sleep reservoir and circadian rhythm interact to maintain daytime performance



Sleep Exaggerates Circadian Impairment



WAYS TO MANAGE FATIGUE

Sleep and Circadian related drivers of fatigue risk

CIRCADIAN	- Early morning nadir in performance - Nighttime propensity for sleep - Reduced effectiveness of daytime sleep - Peak in sleep inertia coincides with CBT_{min}
SLEEP HISTORY	- 8 hours of sleep /24 hours reduces risk - Transient sleep inertia upon awakening
CONTINUOUS HOURS AWAKE	- Risk of impairment increases at > 16 hours awake
SLEEP DEBT	- Cumulative effect of chronic sleep restriction - Accumulation of sleep debt in disrupted sleep

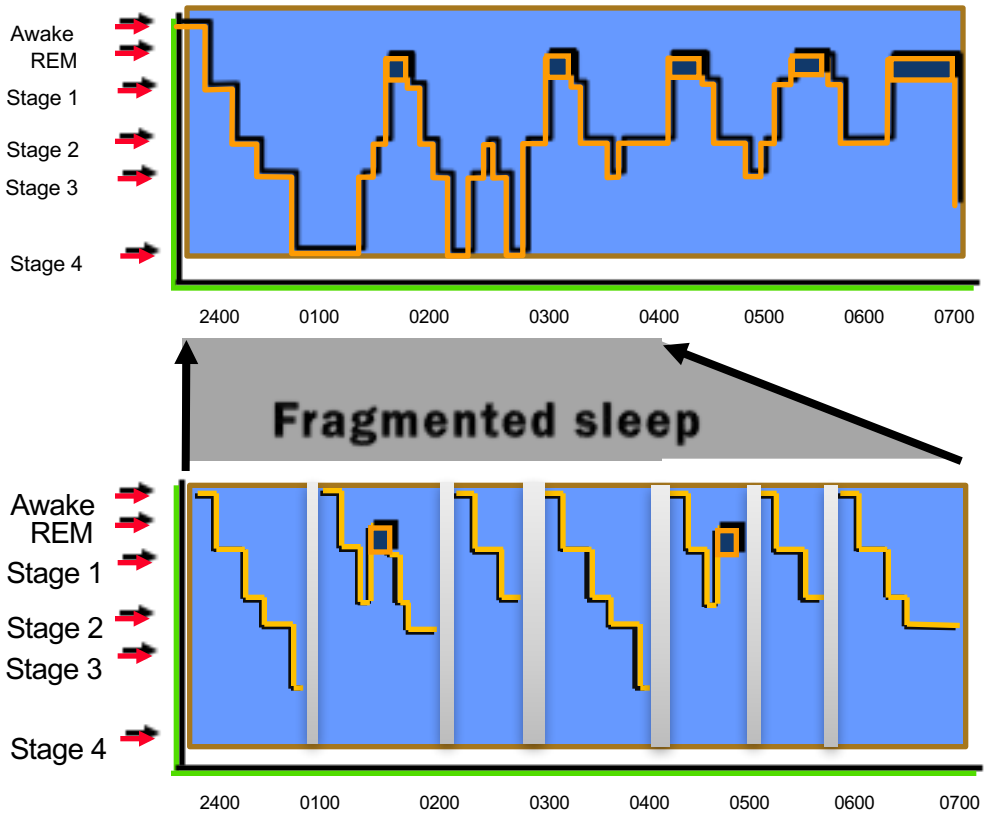
Establish Good Sleep Habits

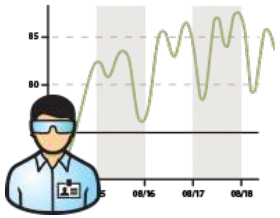
- Make time for sleep: Bank sleep wherever possible
- Get treatment for your sleep disorder. If you're having trouble sleeping or staying awake, talk to your doctor.
- Manage the social factors that affect your sleep
  - Talk to/ Include your fiends and family on your sleep and work schedule
- Develop a sleep routine
  - Darken bedroom if sleeping in the daytime (black-out curtains, aluminum foil)
  - Create a dark, relaxing, quiet, comfortable & cool sleep environment
- Make healthy life choices
  - Nutrition, Water, Exercise, Stress management

Enough Good Quality Sleep

- **Right Amount (7 to 9 hrs per day)**
  - Main sleep + Naps
  - Consistently, avoiding days with minimal sleep
- **Right Time**
  - Go with your circadian rhythm
  - Plan, look ahead when timing sleep
- **Right Place**
  - Bed comfort
  - Darkness of room
  - Avoid cell phones or entertainment devices in the bedroom
  - Limit noise and interruptions
  - Temperature (cool is best)

Sleep: Normal versus Fragmented





As a rule of thumb:
1 interruption = 5 min lost sleep value

8 hrs of fragmented sleep can equal only 5.5 hrs of normal sleep

Make healthy lifestyle choices

- Will support general good health, better quality of alertness and performance during the day and better sleep at night
- Exercise
  - Aim for at least 2.5 hours per week
  - Supports deep sleep and helps maintain a healthy weight
- Avoid Nicotine
  - not an effective stimulant and habit can disturb sleep
- Manage Stress
  - Good strategies reduce sleep disturbances, improve quality of wake periods
- Maintain Positive Relationships
  - A supportive family and rewarding social life are vital to quality of life.
  - Identify and resolve family and social problems when they arise.
- Nutrition
  - Good foods: grains, fruits, vegetables, low-fat milk products, lean meats, fish, nuts

Use products that affect sleep and alertness carefully

Sleep Aids

- Use as prescribed. Certain products stay in your system longer than others. Avoid using long –acting products

Alertness Aids and stimulants

- Use prescription stimulants only as indicated. Beware of the alertness crash that can occur within hours of ingestion
- Use caffeine with caution

Natural Products and Nutrition

- Can be a part of a bedtime routine to promote sleep
- Supplements (e.g. melatonin) are not tested or regulated
- Tryptophan containing foods: milk, turkey, tuna, bananas, nuts. Herbal teas.

OTC Medications

- Certain antihistamines can promote sleepiness.

Alcohol

- Avoid using as a sleep aid. Can intensify some sleep disorders.

Avoid the accumulation of sleep loss

- Meet your sleep need every day
  - Adjust bedtimes to get the required time in bed
  - Supplement sleep with naps– especially for daytime sleep/ The total amount of sleep in the day sustains performance
- Avoid carrying a sleep debt
  - Bank sleep: get extra sleep as soon as the opportunity affords itself.
- Seek treatment for sleep problems

Value of Naps

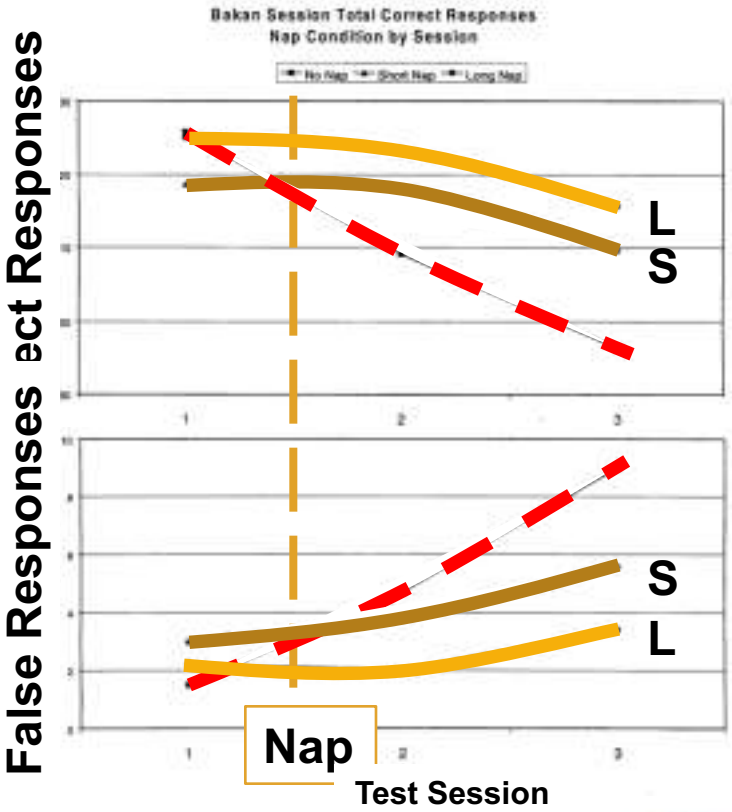
Supplement Sleep with Naps

- Total amount of sleep within a day contributes to sustaining alertness and performance levels
  - Naps as short as 20 minutes can be restorative
- Sleep will be easier at some times of day than others:
  - Best nap placement: in the late night, early morning hours and post lunch
  - Longest sleep onset: late morning and early evening
- Understand your individual sleepiness pattern: alertness log

Strategic Napping

- Pre-work naps
  - especially duty periods that start in the evening
- During the day-time
  - to supplement night-time main sleep
- During “split duty”
  - where rest facilities are present

Performance After Short and Long Naps (Simulated ATC Night Shift)



All groups equated on break time

Short nap (S) = 45 min
Long nap (L) = 120 min

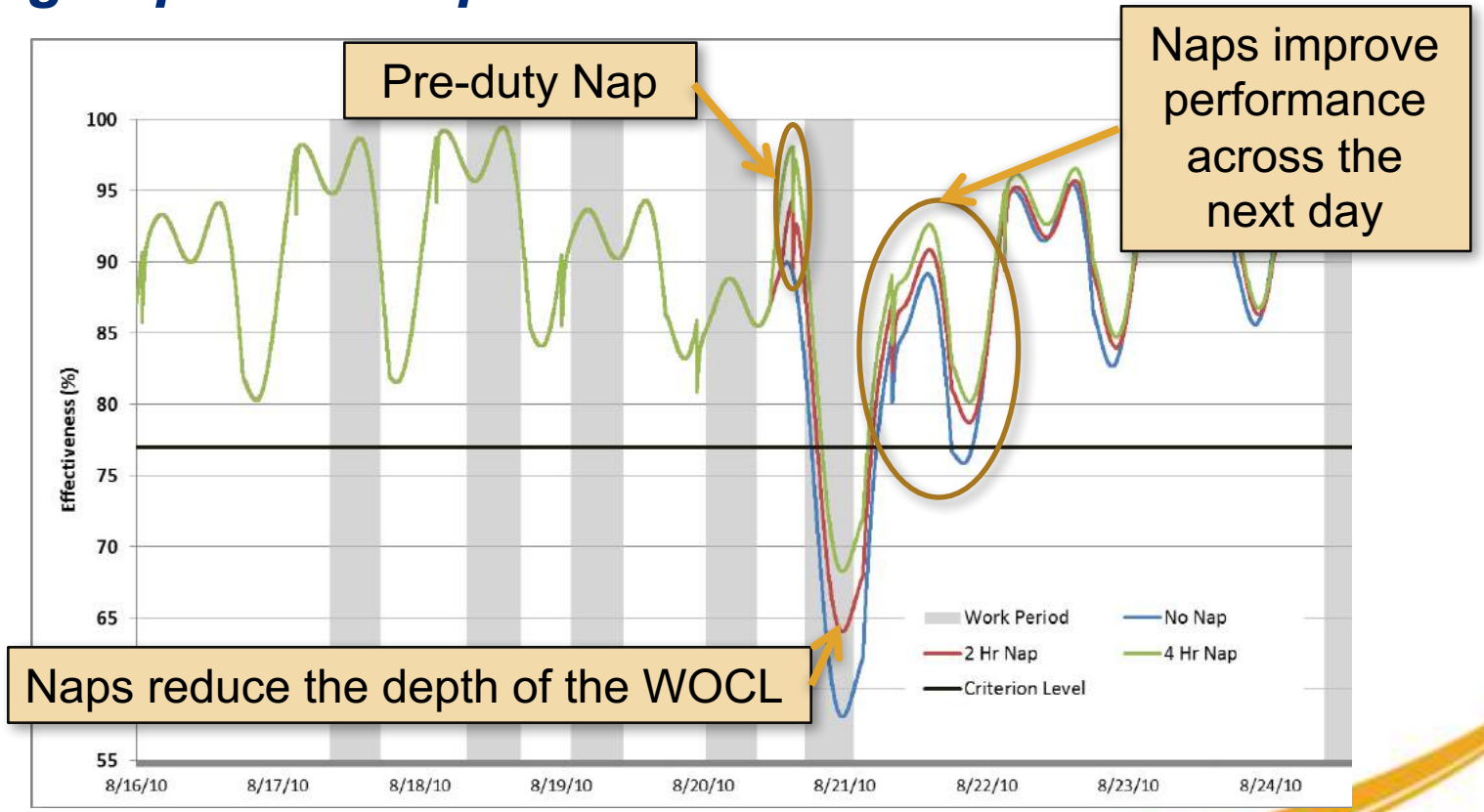
Della Rocco, Comperatore, Caldwell, Cruz , (2000) The effects of Napping on Night Shift Performance, DOT/FAA/AM-00/10

Sleep Inertia

- Grogginess upon awakening
- Can last 20 minutes or more
- Can affect performance
- Performance recovers before subjective drowsiness – don’t let grogginess discourage napping
- Plan for recovery prior to resuming safety critical tasks
- Caffeine helps

Effects of Pre-Duty Naps

Lasting impact of Naps

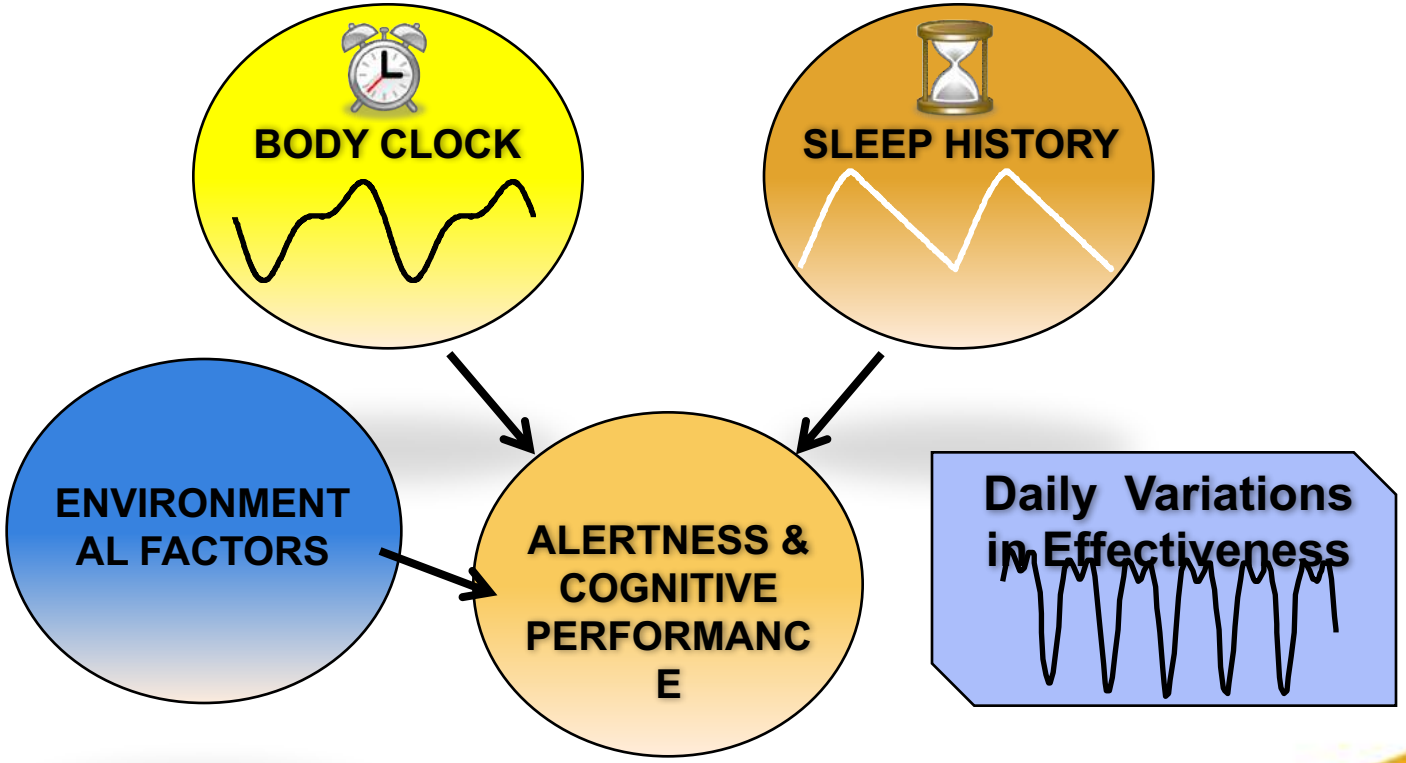


Seek treatment for sleep disorders

- Reduce the *quality* of sleep
- Excessive Daytime Sleepiness (EDS) is a common symptom and fatigue risk

Obstructive Sleep Apnea	• Breathing interruptions result in reduced blood oxygen levels and excessive brain activity during sleep • Loud, disruptive snoring • Waking with gasping or choking
Circadian rhythm sleep disorder	• Inability to sleep and wake at the times required for normal work, school and social needs • EDS
Insomnia	• Chronic inability to fall asleep and/or stay asleep • EDS
Restless leg syndrome	• Extreme leg discomfort while sitting or lying that results in urges to move the legs to stop unpleasant sensations • Disrupts sleep, leads to EDS

Environmental Factors Can Influence the Expression of Physiological Fatigue



Task and Workload management

- Task and workload can affect performance with and beyond the effects of fatigue
  - Fatigue more likely to be expressed during monotonous tasks with low stimulation
  - Especially affects cognitive tasks: more complex and intense work deteriorates more rapidly
  - Longer time on task can allow underlying fatigue to have an effect on performance
  - Sleep loss exacerbates the effect of time on task
- Take frequent breaks to avoid the accumulation of time-on-task, especially in the early morning hours at the circadian minimum

Fatigue Management Actions

NUTURE GOOD HABITS

- Sleep hygiene (at home and away);
- Avoid the accumulation of sleep loss
- Careful use of products that affect your sleep and alertness:
- Task and workload management
- Maintain a healthy lifestyle

BEFORE DUTY
Fitness for Duty Check

- Do I feel fatigued?
- Did I get the sleep I need (7-9 hours) in the last day?
- Have I been awake longer than 16 hours?
- Will I have been awake longer than 16 hours at the end of by on-duty period?
- Have I used my prescribed sleep therapy in the last 3 days?
- Have I consumed any medications or products that would affect my alertness?

Consider a pre-duty nap/caffeine to reduce fatigue risk

ON-DUTY
Get to safety at the signs of sleepiness

- Inability to concentrate
- Difficulty keeping eyes open
- Sluggishness or lack of energy
- Don’t remember last five minutes
- Waves of sleepiness
- Strong desire to sleep

Sleep, if possible; posture, activity aids provide temporary relief

Fatigue Management Summary

- Avoid the accumulation of sleep loss
- Establish good sleep habits at home and away;
  - Supplement sleep with naps
  - Seek treatment for sleep disorders
- Manage light exposure and the circadian clock
- Use products and aids that affect your sleep and alertness with caution
- Manage your workload
- Maintain a healthy lifestyle

FATIGUE MANAGEMENT CHALLENGES AND SOLUTIONS

Fatigue Management Challenges

- Fatigue impairs performance, reaction times, judgment, mood
- You're more likely to be impaired if you:
  - Sleep less than 8 hours a day or less than you need
  - Work against the circadian clock
  - Get poor quality sleep
  - Have an accumulated sleep debt
- Sleep need & the effects of sleep loss depend on the individual
- A one-size-fits-all approach won't work for all personnel

Shift Work: Risk of Accidents

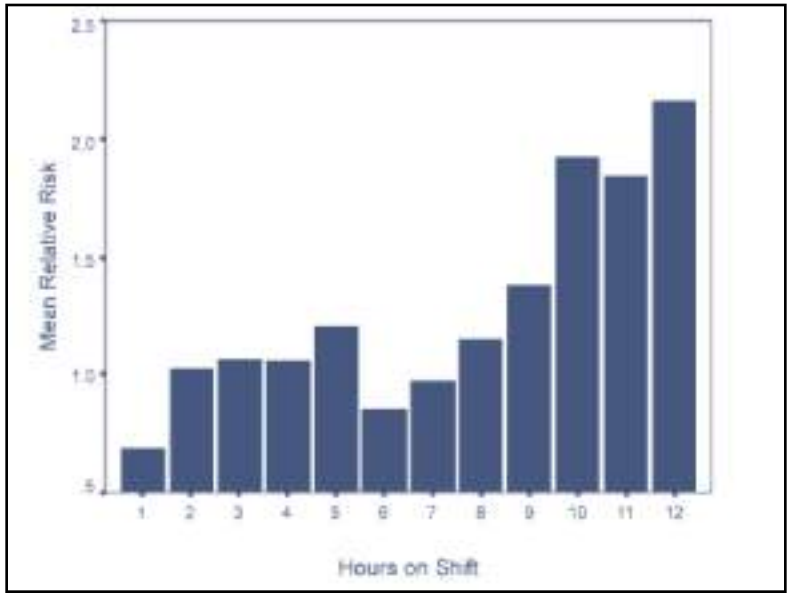
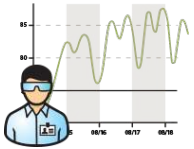


Chart Results

The risk of an accident or incident increases dramatically in shifts longer than 9 hours



Folkard S. Tucker P. (2003). Shift work, safety and productivity. Occupational Medicine (Oxford). 53(2):95-101.

Shift Work: Risk vs. Successive Night Shifts

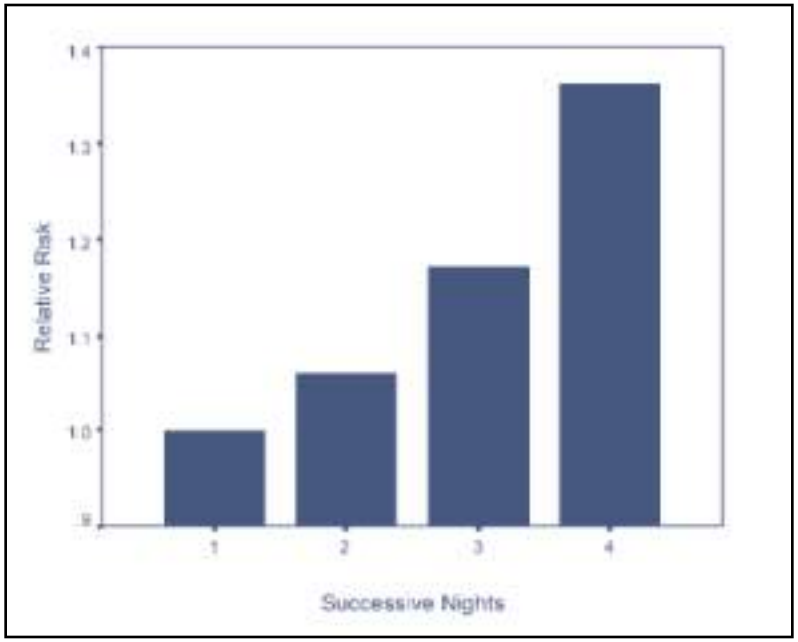
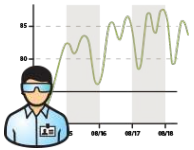


Chart Results

The risk of an accident or incident increases with successive night shift periods



Folkard S. Tucker P. (2003). Shift work, safety and productivity. Occupational Medicine (Oxford). 53(2):95-101.

Working at Night

Challenges

- Reduced alertness at night (circadian)
- Poor daytime sleep quality
- Accumulating sleep debt over consecutive days
- Alerting light in the morning
- Risk of drowsy driving

Solutions

- Manage the workload around times of circadian low alertness
- Adjust sleeping area for daytime sleep
- Add an evening nap to get to 8 hours of total sleep per day
- Do a self check before driving: been awake for 16 hours? Nap before driving
- Pay down the sleep debt and start banking sleep

Working an Irregular Schedule

Challenges

- Sleep gets last priority in daytime activities;
- Insufficient sleep increases the likelihood of impairment; made worse during times of circadian lows.
- Likelihood of sleep may not be favorable at available times (internal or external reasons)
- Insufficient opportunity for a planned nap

Solutions

- Plan sleep opportunity; (advance TIB to get 8 in bed, avoid evening light, activity)
- Create social environment to promote sleep
- Use naps to make up for lost sleep – (aim for 8 in 24)
- Bank sleep
- Avoid secondary employment or commitments that significantly reduce sleep opportunity

Overtime, swaps & trades

Before taking on extra work, think about:

- How many nights have you worked in a row?
- How long will your workday be?
- Will your start time change or stay the same?
- Will you have enough time to recover before you go back to work?

FRMS Methods to Manage Fatigue

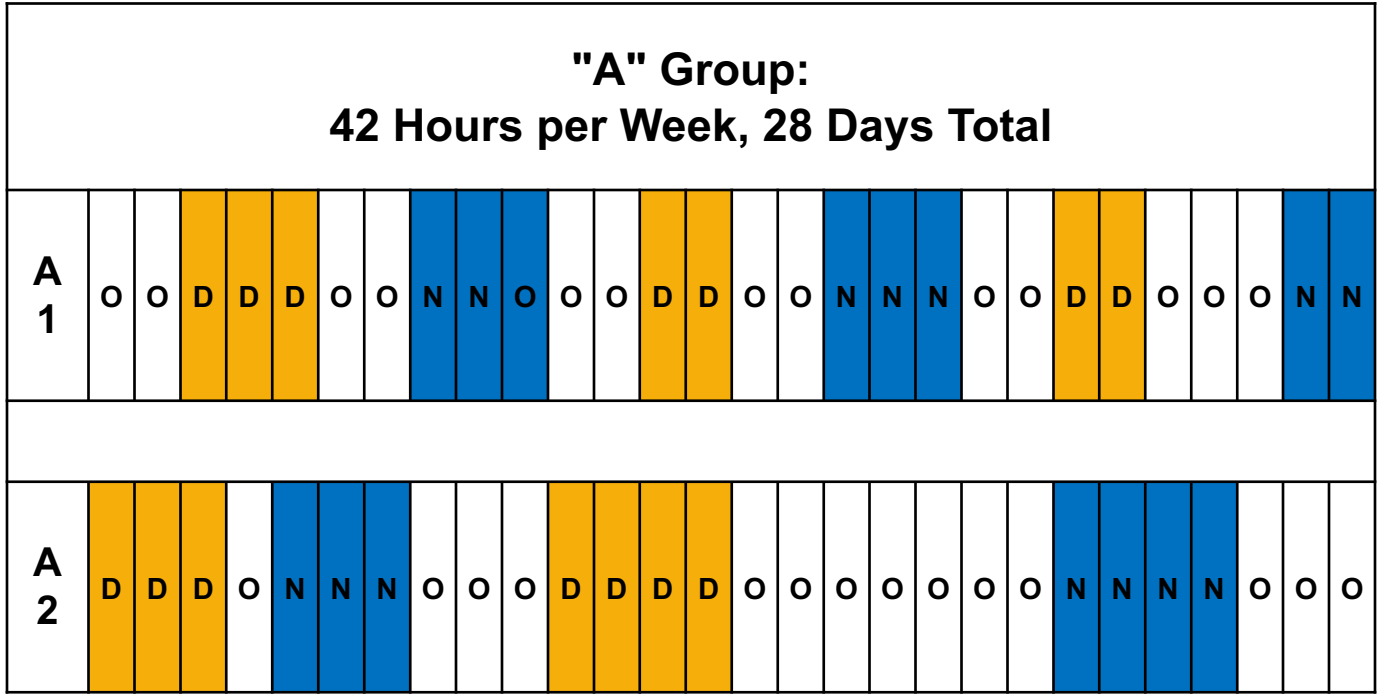
- Goals:
  - Apply scientific principles to proactively avoid fatigue created by the work schedule
- Methods:
  - Additional duty and rest policies
  - Fatigue reports and root cause analysis
  - Fatigue training
  - Sleep disorder screening and treatment
  - Fatigue related events and root cause analysis
  - Policies for non-punitive “fatigue declaration”
  - Studies of actual sleep and performance
  - Proactive biomathematical modeling of schedules

Biomathematical Fatigue Models to Identify Explicit and Verifiable Fatigue Factors

- **Time of Day**: between midnight and 0600 hrs.
- **Recent Sleep**: less than eight hours in last 24 hrs.
- **Continuous Hours Awake**: more than 17 hours since last major sleep period.
- **Cumulative Sleep Debt**: more than eight hours accumulation since last full night of sleep *(includes disrupted sleep).*
- **Time on Task/Work Load**: continuous work time without a break or intensity of work demands.
- All five factors **interact simultaneously** in non-linear relationships
- The model can estimate the level of degradation in performance and provide an *estimate of* ***schedule induced*** *fatigue risk*.

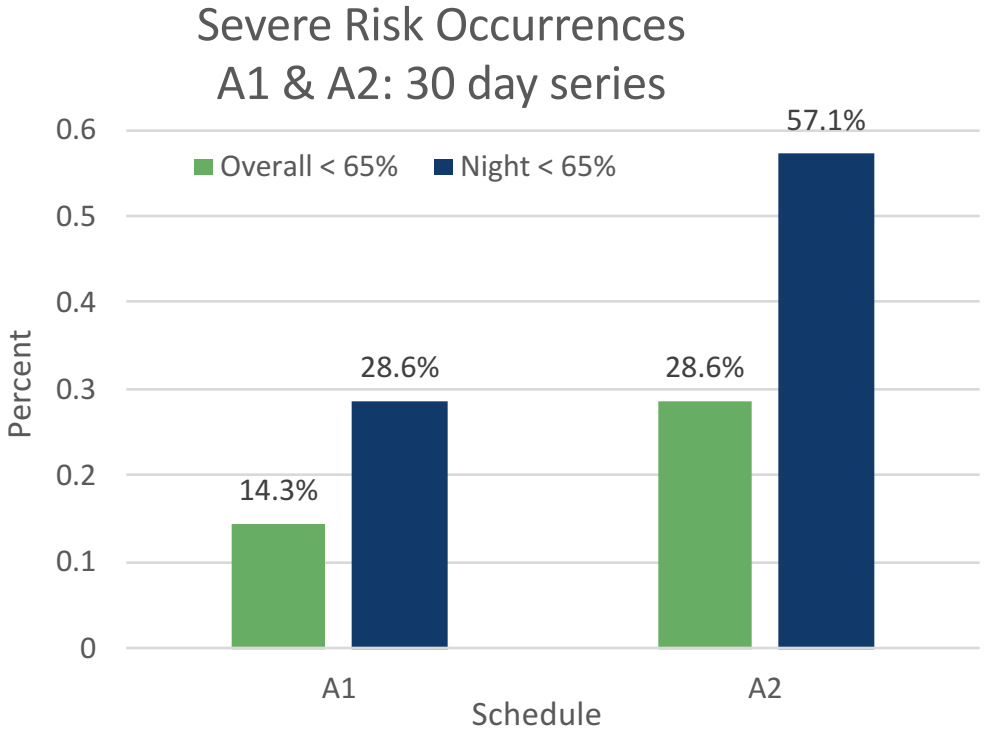
Shift Schedules Evaluated with **SAFTE®FAST**

12-Hr Work Schedules, 42 hrs/wk

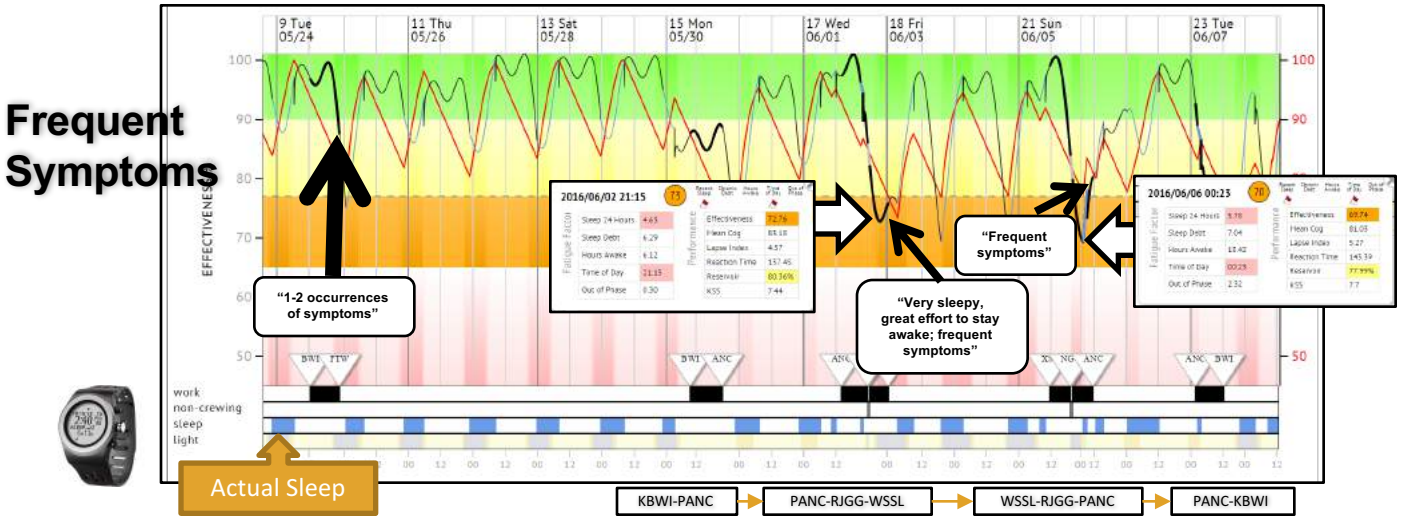


A1 and A2 Schedules

The A1 Schedule Poses Less Overall Severe Risk (occurrences below 65%)

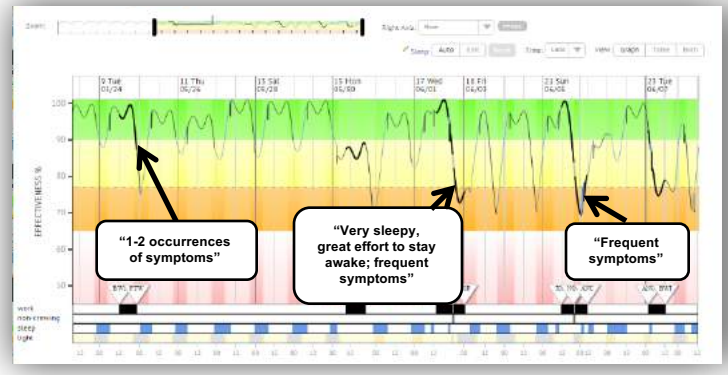


Modeling a Typical International Trip

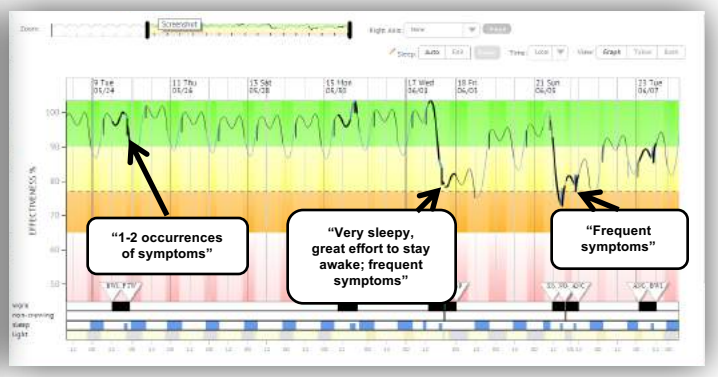


Predictions with Estimated Sleep

Trip with Actual Sleep



Trip with Estimated Sleep



Fatigue Management Summary

- Avoid the accumulation of sleep loss
- Establish good sleep habits at home and away;
  - Supplement sleep with naps
  - Create a comfortable environment
  - Seek treatment for sleep disorders
- Manage light exposure and the circadian clock
- Use products and aids that affect your sleep and alertness with caution
- Manage your workload
- Maintain a healthy lifestyle
- Use fatigue risk management tools, like modeling, to develop better scheduling patterns

QUESTIONS?

Quiz

1. **Which of the following is true about fatigue** (select all that apply)**:**

   - People can predict when and how they will be impaired by fatigue
   - Chewing gum is an efficient way to overcome drowsiness while you're driving
   - Fatigue has no proven impact on your ability to operate safely
   - Night work is a challenge because awake at time when body says sleep
   - Night work is a challenge because trying to sleep when body says wake

2. *True or False?*: **The more work experience you have the less you're likely to be impaired by fatigue**

3. **Which of the following are effects of sleepiness or fatigue?**

   - Drooping eyelids
   - Wandering disconnected thoughts
   - Waves of sleepiness
   - Impaired judgment
   - All of the above
   - None of the above

4. *True or False?*: **You have to be sleepy to be impaired by fatigue**

5. **Which of these is the most effective strategy to reduce the risk of being impaired by fatigue?**

   - Shake it off by walking around
   - A short nap
   - Chewing gum
   - Conversation with coworkers
   - Lose weight

Quiz- Answers

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