Fatigue from Sleep Loss and Circadian Misalignment: A Fatigue Risk Management Framework for Emergency Medical Services

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Light input keeps the biological clock synchronized to external day and night.
Sleep/Wake Regulation: Timing and Duration

• Longer periods of wakefulness cause greater pressure for sleep
• Longer periods of sleep provide greater recovery from sleep pressure

Homeostatic process

• There is greater pressure for sleep at night than during the day
• This is true even after sleep deprivation ("second wind")

Circadian process

• The homeostatic and circadian processes interact, as formalized in the two-process model of sleep regulation

Working Nights: Dual Sleep and Fatigue Challenge

- The homeostatic drive for sleep builds up steadily over time awake.
- At the same time, the circadian drive for wakefulness diminishes across the night and early morning.
  - Thus, the two effects amplify each other, and cognitive performance degrades across the work period.
  - In addition, the circadian process restricts sleep duration during the early evening, making it difficult to get enough sleep.

Van Dongen HPA, Jackson ML, Raj S.  
Early Shift Start Case Study: MetroNorth Train Crash NY, Dec. 2013

Van Dongen, February 2016
Cumulative Fatigue from Chronic Sleep Restriction

Graphs show daytime averages

Duty Hours, Sleep/Wake Regulation and Fatigue Risk Management in EMS Settings

countermeasures

relative risk of errors, incidents and accidents

modulators in the environment

light

sleep inertia

instability
time on task

fatigue (cognitive impairment)

• Neurobiological comes with the individual
• Operational comes with the task at hand