Effect of Sleep Deprivation on Human Behavior

Clinical and Research Basis for Legal and Policy Implications

Ramesh Sachdeva, MD, PhD, MBA, JD
Professor of Pediatrics
Golisano Children’s Hospital – Critical Care and Sleep Medicine

Senior Vice President
Strategic Affairs, Regional Strategy and Quality
SUNY Upstate Medical University
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# Average Sleep Duration Over 24 hours

## SLEEP DURATION

<table>
<thead>
<tr>
<th>Animal</th>
<th>Sleep Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horses</td>
<td>2 hours</td>
</tr>
<tr>
<td>Elephants</td>
<td>3+ hours</td>
</tr>
<tr>
<td>Cows</td>
<td>4 hours</td>
</tr>
<tr>
<td>Giraffes</td>
<td>4.5 hours</td>
</tr>
<tr>
<td>Humans</td>
<td>8 hours</td>
</tr>
<tr>
<td>Rabbits</td>
<td>8.4 hours</td>
</tr>
<tr>
<td>Chimpanzees</td>
<td>9.7 hours</td>
</tr>
<tr>
<td>Red Foxes</td>
<td>9.8 hours</td>
</tr>
<tr>
<td>Dogs</td>
<td>10.1 hours</td>
</tr>
<tr>
<td>House Mice</td>
<td>12.5 hours</td>
</tr>
<tr>
<td>Cats</td>
<td>12.5 hours</td>
</tr>
<tr>
<td>Lions</td>
<td>13.5 hours</td>
</tr>
<tr>
<td>Platypuses</td>
<td>14 hours</td>
</tr>
<tr>
<td>Chipmunks</td>
<td>15 hours</td>
</tr>
<tr>
<td>Giant Armadillos</td>
<td>18.1 hours</td>
</tr>
<tr>
<td>Little Brown Bats</td>
<td>19.9 hours</td>
</tr>
</tbody>
</table>
Definition & Type of Sleep

Sleep

Physiologically is reversible unconsciousness, brainwave patterns – sleep stages, eye movements, loss of muscle tone with need for compensation after deprivation

Types

• Human Sleep – 3 Stages & REM
• Unihemispheric Sleep
• Hibernation and Sleep
Effects of Sleep Deprivation

Sleep Deprivation

Brain: Cognitive function, memory, and executive function (prefrontal cortex)

Growth:
- Growth hormone
- Obstructive Sleep Apnea in children
- Immune system – healing

Depression:
- fMRI

Appetite:
- Ghrelin (from stomach)
- Leptin (from fat cells)
**LOST MEMORIES**

The **hippocampus**, a moon-shaped structure in the temporal lobe, exhibits a distinct pattern of neural activity when the waking mind encodes (learns) new information. Scientists believe our brain later “replays” the same activity pattern while we’re sleeping to help the info stick. Lose sleep, lose long-term memories.

**ANGER**

Sleep loss primes us to focus on negative experiences, misinterpret facial expressions and pick fights. Emotional volatility may partly be a product of interrupted communication between brain regions. FMRI of the well-rested brain shows connectivity between the **amygdala**, a limbic system structure critical to emotional processing, and the **medial prefrontal cortex**, which helps regulate feelings (i.e., tells us to chill). Sleep deprivation cuts this connection, letting your revved-up amygdala (and your mood) run wild.

**FALSE MEMORIES**

The sleep-starved brain may fail to encode memories successfully in the first place, thanks to altered function in the **hippocampus**, as well as **prefrontal cortex** and **parietal lobe** regions. One study found that people are more likely to incorporate misinformation into memories of events observed after a night without sleep.

**CEREBRAL SHRINKAGE**

Healthy adults getting poor sleep lose volume in the **frontal**, **temporal** and **parietal** lobes, one study showed. Researchers don’t yet understand if sleep loss causes shrinkage or vice versa.

**SLURRED SPEECH**

The temporal lobe, the brain region associated with language processing, is highly active in well-rested people but inactive in their exhausted and enunciation-challenged counterparts.
Sleep and Law

Criminal Action:
- Actus rea
- Mens rea

Parasomnias:
- Non REM – sleepwalking
- REM behavior disorder
- Medication related parasomnia – Ambien defense

Issue: was person awake and able to make a decision not to act – automatism
Sleep Deprived Drivers: Legal Implications

- **Bushnell v. Bushnell**, 103 Conn. 583, 131 A 432 (1925) – husband liable for injury negligence after asleep while driving

- **State v. Valyou**, 910 A. 2d 922-924 VT (2006) – defendant dozed off but continued to drive and resulted in injury

- **Maggie’s Law** (2003) in NJ and Arkansas Act 1296 (2013) – sleep deprived driver can be convicted of vehicular homicide – reckless homicide if driving after 24 hours of sleeplessness
Sleep Deprived Drivers - Liability of Employers

• **Doctrine of respondeat superior**

• *Dunlap v. W. L. Logan Trucking Co.*, 161 Ohio App. 3d 51, 66 (2005) – employer liable for negligence to allow tractor trailer driver with OSA for death of a woman

Sleep Deprivation in Health Care

- **The Libby Zion Case** – March 1984
- **The Bell Commission** from NYS Commissioner of Health identifying 19 recommendations including work hours
- **NYS Health Code Rule 405.4** (1989) related to duty hours for post graduate trainees and residents in hospitals
- **Accrediting Council for Graduate Medical Education** (2003) – Resident work hours
Sleep deprivation similar to being drunk

- Study to compare post call performance during heavy call rotation (q4-5) with BAC = 0.04 - 0.05 during a light call rotation

- Prospective study from University of Michigan with 34 pediatric residents in AMC

- Post call performance during heavy call rotation is comparable to impairment with BAC = 0.04 - 0.05 with light call related to sustained attention, vigilance, and simulated driving tasks

Arnedt, et al., JAMA, 2003
Liability of Sleep Deprived Employees and Residents

Brewster v. Rush Presbyterian – St. Lukes Medical Center. 836 NE2d 635 (IL App 2005)

• PGY1 Internal medicine resident worked 36 hours and caused injury to 23-year old woman resulting in permanent disability

• The injured woman sued the medical center for negligence - no liability identified for injuries to non-patient third parties

Cf. Robertson v. LeMaster. 301 SE2d 563 (WV 1983)

• Railroad employee made to work 27 hours – railroad company had a duty to third party if foreseeable risk

Faverty v. McDonald’s Restaurants of Oregon. 892 P2d 703 (OR App 1995)

• High school student working at McDonalds in Oregon asked to work overnight – died while driving home – was a foreseeable risk and restaurant found liable
Sleep Deficit: The Performance Killer

- National Highway Traffic Safety Administration – 1.35 million accidents in US over 5 years because of driver fatigue
- “Putting yourself or others at risk while driving or working at an impaired level is bad enough; expecting your employees to do the same is just as irresponsible.”
- Need for executive policies in companies to promote healthy sleep practices – implications for business travelers.
Emerging Issues in Sleep Deprivation

Institute of Criminology at University of Cambridge - “It’s a milestone”

- Thibodeaux DNA evidence proved innocence after false confession
  - 15 years on death row – 1996 Louisiana Murder
  - Implications for sleep deprivation during police interviews

- Sleep deprivation may violate 8th Amendment

- Prohibition on cruel and unusual punishment (unpublished 5th Circuit 2014)
  - Texas prisoners sleep deprivation claim

- Ongoing litigation now in Eastern District of California Federal Court regarding inmates’ lawsuit over sleep deprivation

- Human Rights
  - International Law
  - Includes sleep within its definition of torture
Sleep deprivation and Medical Errors – Future Research


• Mixed evidence with equivocal and contradictory studies
• Implications for sleep deprivation after post graduate training in attending physicians – not fully studied

https://dailynurse.com/8-essential-sleep-tips-shift-workers/
Sleep Medicine and Health Disparities in Children and Adults – Areas of Future Legal Challenges

American Academy of Pediatrics estimates 30 million children covered by Medicaid

- Sixty-six percent of children with Government-issued insurance were denied appointments by specialists for OSA and had an average wait time of 141 days to get a sleep study compared to 49.9 days with private insurance.

Health Care Disparities in Adults

- Differences in referral for sleep study between patients with Medicaid and Medicare. Loss to follow up of 42% in minority serving institutions compared to 7% in middle class-serving hospitals.

Venkateshiah, et al., Sleep Medicine Clinics, 2017
The Evolving Story of Sleep