THE DEFINITION OF HUMAN FATIGUE

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Fatigue is an impairment of mental and physical function manifested by a cluster of debilitating symptoms, usually including excessive sleepiness, reduced physical and mental performance ability, depressed mood and loss of motivation, which may result from a variety of causes including:

1. **Sleep deprivation:** Fatigue develops as the result of an extended time awake (acute sleep deprivation), or reduced time asleep, or disrupted or poor quality sleep (partial sleep deprivation), or from the cumulative effect of multiple days with shortened or disrupted sleep such as may occur in jobs with extended work hours or with night shift work (chronic sleep deprivation)[1].

2. **Sleep disorders:** Fatigue manifested as excessive daytime sleepiness is the most common presenting complaint in sleep disorders, such as obstructive sleep apnea, restless legs syndrome, narcolepsy or most of the other 85 different sleep disorders listed in the International Classification of Sleep Disorders[2].

3. **Illness or disease:** Fatigue is common in many diseases and illnesses (ranging from flu to cancer) which may occur as a direct result of the metabolic or other systemic pathophysiological disturbances of that disease, as a secondary consequence of sleep disturbances caused by other symptoms such as pain, nausea etc., or as the primary presenting complaint (e.g. chronic fatigue syndrome).

4. **Therapeutic Side-Effect:** Fatigue is a commonly listed side-effect of prescription or over-the-counter pharmacological drugs, or may occur as the result of other therapeutic interventions (e.g. surgical procedure).

5. **Heavy Stressful Physical or Mental Exertion:** Fatigue occurs as the result of extended hours of work with heavy muscular activity (e.g. lumberjack, or marathon runner), continued stress or danger (e.g. combat fatigue) or intense mental exertion (student taking LSAT examinations) which occurs either during the task or as a rebound effect after the task, in proportion to the relative fitness (and/or prior training) of the individual.

6. **Stimulant Drug Usage:** Fatigue often occurs as a person rebounds after the initial euphoria or "high" induced by illegal or prescription stimulant pharmacological substances.

Unlike the engineering use of the word "fatigue" which is used to describe irreversible failure of a material as a result of stresses over an extended period of time, the medical definition of "fatigue" usually refers to a loss of physiological and psychological function as a result of extended wakefulness, heavy work, excessive stimulation, illness or stress which can usually be reversed in whole or in part by rest, sleep, treatment or recovery from the condition that caused it.

Because there are multiple aspects of fatigue, it is often helpful to more precisely define fatigue either in terms of the predominant symptom (e.g. excessive sleepiness), the cause (e.g. obstructive sleep apnea), the body system predominantly involved (e.g. mental fatigue), or the outcome risk (e.g. driver fatigue).

One way fatigue can be precisely defined and measured in terms of its most common and easily measurable symptom - "excessive sleepiness". Excessive sleepiness can be measured by a variety of subjective (e.g. Epworth Score) and objective tests including the Multiple Sleep Latency Test (MSLT), the Maintenance of Wakefulness Test (MWT) and measurement of the frequency and duration of microsleep lapses - short lapses into sleep of typically 2-20 seconds in length in the middle of periods of wakefulness[3].

This definition of fatigue in terms of "excessive sleepiness" is particularly useful. It has become widely accepted in:

1. **Medical Diagnosis**

   Approximately 85 specific sleep disorders and multiple other conditions which cause excessive sleepiness are defined in the International Classification of Sleep Disorders[2].

2. **Regulatory Agency Approval of Prescription Drugs**

   The treatment of excessive sleepiness per se (without addressing the underlying etiology) is now an accepted rationale in prescription drug regulations (e.g. FDA or Health Canada approval of Modafinil for the treatment of excessive sleepiness)[4].

3. **Public Policy And Work-Rest Hours Regulation**

   There is a broad body of regulations in certain industries, including transportation, which govern hours of work and rest so as to prevent excessive sleepiness and fatigue (e.g. FMCSA or Transport Canada Hours of Service regulations of truck drivers designed to prevent driver fatigue by protecting time off-duty available for sleep and encouraging drivers to use it)[5,6].

4. **Criminal Laws**

   A criminal statute was enacted and signed into law in New Jersey in 2004 (and has been proposed in various other states in the USA), with fatigue impairment and excessive sleepiness caused by extended periods of time awake being equated in terms of legal penalty to impairment caused by drug or alcohol intoxication[7].

Thus fatigue and its major symptom excessive sleepiness, is well recognized in law and regulation as a significant body impairment, malfunction and source of ill-health and of accident and injury risk.

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1 Moore-Ede, M; The Twenty-Four Hour Society: Understanding Human Limitations in World That Never Stops, Addison-Wesley, Reading MA 1993

2 International Classification of Sleep Disorders, 2nd Edition, American Academy of Sleep Disorders, 2005

3 Moore-Ede, M. Fatigue in Transportation Operations. Clin Occup Environ Med, 2:11-27, 2002

4 http://www.medscape.com/viewarticle/524428

5 Moore-Ede, M., and Schlesinger, B. Scientific basis for challenges to work-rest & hours-of-service regulations. Journal of Transportation Law, Logistics and Policy, 71(3):262-279, 2004

6 http://canadagazette.gc.ca/partII/2005/20051116/html/sor313-e.html

7 New Jersey Code (2004) Death by auto or vessel. In: NJC 2C, New Jersey Code of Criminal Justice, Section 11-5, NJC, USA.

ABOUT THE AUTHOR

For 30 years, Dr. Martin Moore-Ede has been a leading expert on managing the risks of human fatigue in transportation and industrial businesses that operate 24/7. After experiencing the challenges of fatigue as a surgeon-in-training working 36-hour shifts, Dr. Moore-Ede was one of the first to define the challenges of living, working and sleeping in a 24 hour a day, 7-day a week world. As a Harvard Medical School professor (1975 – 1998), he led the team that discovered the biological clock in the human brain that controls the timing of sleep and wakefulness. He pioneered research on how the human body can safely adapt to working around the clock and sustain optimum physical and mental performance. In 1983 he founded CIRCADIAN and as Chairman and CEO, he has guided its growth so that CIRCADIAN now advises over half the Fortune 500 companies on 24/7 workforce solutions.

Dr. Moore-Ede graduated with a First Class Honors degree in Physiology from the University of London, and received his medical degrees from Guy's Hospital Medical School, and his Ph.D. in Physiology from Harvard University. He has published 10 books, and more than 145 scientific papers on human fatigue, errors and accidents and the physiology of sleep deprivation and circadian rhythms. He has served on multiple national and international committees, and has won numerous awards. He is a frequent guest on television, radio and print. He regularly testifies before Congressional committees, and advises government agencies on Hours of Service regulations in the US, Canada and the U.K.

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