Daytime Sleepiness - Risk Profile, Causes & Preventive Options

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www.stz-eyetrial.de
... travelling in uncharted waters
... high relevance
Overview

- The problem, causes, consequences
- Prevention
  - Technical solutions
  - Individual
  - Regulatory
Problem Daytime Sleepiness

- 30% of the German population report frequent problems with daytime sleepiness
- Decreased quality of life
- Important cause of accidents
Sleepiness in Aviation

- Exceptionally high risk for fatal accidents
- Unphysiological working schedules e.g. in pilots and crew
- Jet lag
- Every 2. pilot reports unvoluntary sleep attacks (Balpa)
- Ground: monotonous tasks for operators and regulators 24/7
Sleepiness is different from Fatigue

Sleepiness
- related to poor quality of quantity of night sleep

Fatigue
- Psychological problem or related to stress or physical
- Not related to night sleep quality or quantity
- E.g. in insomnia, depression, multiple sclerosis
Sleepiness

is different from

Fatigue

Someone who is fatigued must not necessarily be sleepy

Sleepy subjects often suffer from fatigue, too
Obstructive sleep apnea syndrome (OSAS)
Obstructive sleep apnea syndrome (OSAS)
Breathing arrest destroys sleep

**Diagram:**
- EEG (C2-A2)
- EEG (C4-A1)
- EMG_tant.links
- EMG_tant.rechts
- EMG_submental
- EOG_links
- EKG
- EOG_rechts
- Luftfluß
- Atemexkursionen Thorax
- Atemexkursionen Abdomen
- HbO2-Sättigung

**Annotations:**
- "Arousal"
- "Obstructive Apnöe"
- "HbO2-Desaturation"

**Text:**

**Abb. 3.1:** 2-Minuten-Darstellung einer Polysomnographie bei einem Patienten mit obstruktivem Schlaf-Apnoe-Syndrom. Die Markierungen zeigen 2 obstruktive Apnoen mit konsekutiver HbO2-Desaturation und terminierenden Arousalreaktionen (EEG).
Consequences / complications

- Hypertension
- Stroke, heart attach
- Small vessels damage
- Eye diseases
- Hypoxy brain damage
  - Daytime sleepiness, attention impaired
- Depression
- Erectile dysfunction
- Poor quality of life

Relative Riscs for traffic accidents by diseases

- Visual impairment general 1.09
- Alkoholism 2.00
- Sleep apnea, narcolepsy 3.71
What is sleepiness?
How can we measure it?
The neuropsychological model of attention (Posner & Rafal 1987)

- vigilance
- sustained attention
- divided
- Aufmerksamkeit
- selective attention
- performance tests, conscious
- physiological tests, unconscious
- central nervous activation = alertness / sleepiness
"Such "fatigue waves" and a steadily declining pupil size almost always will be encountered eventually when the subjects remain quietly in darkness for lengthy periods without anything to do. This was sometimes forgotten ..."
(Irene Loewenfeld, The Pupil, 1999)
PST – the hi/story

- start of development 1993
- grants: Fortüne and DFG
- UKT Patent since 1997
- Licence by AMTech since 1997

\[
PUI = \frac{1}{(N-16) \cdot \Delta t} \sum_{i=2}^{N} |d_i - d_{i-1}|
\]
Method
Pupillographic Sleepiness Test (PST)

- Infrared Video Pupillography (25 Hz)
- 11 Minutes
- Automated Analysis
- Parameter
  - Pupillary-Unrest-Index (PUI)
The mobile Version: Fit-for-duty, F2D

- **Parameter**
  - Relative Pupillary-Unrest-Index (PUI)
Typical findings

Outcome: Pupillary Unrest Index, PUI (mm/min)

PUI 4.3 mm/min

alert

PUI 17.4 mm/min

sleepy
Current applications of pupillography

Sleep Medicine („sleep lab“)

First Reference values for school age (6-18J)

Occupational Medicine

Oberösterreich 1180 truck and bus drivers: 22.5% excessively sleepy
Sleepiness in the workplace

- Miners
- Transportation
- Flight crews
Sleepiness in miners at extended shift durations

U-Bahn - Erweiterung Arge Olympiapark, München
Study Design

Construction site: 12 hrs shift duration with 10 hrs + 2 hrs break (?), distributed freely

Day shift 1 week – night shift 1 week – week off

6 a.m. until 6 p.m.  6 p.m. until 6 a.m.  —

• each day 4 miners 3 tests
• 1 miner per 4 teams
After 8 hours shift duration already 50% of miners are excessively sleepy!

Oneway Analysis of ln PUI By Tageszeit

<table>
<thead>
<tr>
<th></th>
<th>a) morning</th>
<th>b) noon</th>
<th>c) evening</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 – 7</td>
<td>13:30 – 14:30</td>
<td>17:30 – 18:30</td>
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</tbody>
</table>
Truck- and Busdrivers in Oberösterreich (N=1180)

Investigating Crew Fatigue during long-haul flight

The Karolinska Sleepiness Scale (KSS)
This scale asks people to rate how sleepy they feel right now. Any of the values from 1-9 can be ticked, not only those with a verbal description.

1 = extremely alert
2
3 = alert
4
5 = neither sleepy nor alert
6
7 = sleepy, but no difficulty remaining awake
8
9 = extremely sleepy, fighting sleep

Figure B4 shows KSS ratings from 25 flight crewmembers across ultra-long range flights from Singapore to Los Angeles. 

Figure B3: The Karolinska Sleepiness Scale (KSS)
Investigating Crew Fatigue during long-haul flight

Figure B7: Mean Reaction Time on the PVT Task on Flights from S Los Angeles
Solid line – data for the command crew
Dotted line – data for the relief crew

Figure B11: Polysomnographic recording in flight
Prevention of sleepiness-related accidents

**Automobile industry**
- Vehicle based (Assistenzsysteme)

**Public / Government**
- Preparation of streets

**Medicine**
- Early detection and treatment of sleep disorders in professional transportation

**Personal responsibility of individuals**

**Police**
- Traffic controls
- PST feasible

**Automobile industry**
- Vehicle based (Assistenzsysteme)
Individual countermeasures: only a power nap can fight sleepiness!

... and caffeine

Referenzen, z.B.:
Horne JA & Foster SC (1995) *Sleep Research* 24, 437
Horne JA & Reyner LA (1999) *Sleep Research Online* 2 (Suppl 1), 678
Reyner LA & Horne JA (1997) Psychophysiology 34, 721-725
Reyner LA & Horne JA (2000) Psychophysiology 37, 251-256
LeDuc PA (2000) Military Psychology, 12, 249-266
Is the PST feasible in a traffic control by the police?

**Method:**
- Traffic control at road house associated with voluntary trial participation
  - In 137 LKW-Fahrern
- 6 weeks
  - W 1, 3 and 5 from 10:00h - 16:00h and Wo 2, 4 and 6 from 4:00h - 10:00h

Subjective data:
- Questionnaires
- Stanford sleepiness scale (SSS)
- Epworth sleepiness scale (ESS)

* Peters, T., Grüner, C., Durst, W., Hütter, C., Wilhelm, B. Sleepiness in Professional Truck Drivers Measured with an Objective Alertness Test during Routine Traffic Controls: Submitted to International Archives of Occupational and Environmental Health
Results & Discussion

- Percentage of excessive sleepiness 7%
- This means 3,000 sleepy truck drivers per day at the „Stuttgarter Kreuz“
- High proportion (99 von 137) of drivers had consumed caffeine in the hours before the recording
- Limitation Selection
  - Drivers of large companies
  - Reality: majority self-employed or SME (higher pressure)
Prevention of sleepiness-related accidents

**Regulatory**
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**Driver Attention Time for a Break**
- 2 3 4 5 6 7 8 9 10
First steps

„Leitfaden Schlafapnoe G25“

Limitations

- Non-binding
- Subjective reports critical (Scale, Questionnaire)
- Body measures (waist-hip ratio) critical
- No new methods

Motivation

- Changes FeV Anl. 4 and 5
Begutachtungs-Leitlinien zur Kraftfahrereignung

Kapitel 11.2 Tagesschläfrigkeit
Stepwise diagnostics

Medical History, Epworth sleepiness scale + sleepiness/alertness test

Evaluation of daytime sleepiness

Test run

- Sleep medical Qualification
  - Sleepiness/alertness test
  - Vigilance test

Condition: monotony, e.g. highway, min. 0,5 hrs

Recommended addition
Next steps for regulatory countermeasures for sleepiness-related accidents in professional drivers

Coming into force winter 2013/14
What is important to avoid sleepiness related failures and accidents in aviation?

- Alertness management
- Duration of time-on-duty
- Duration of Rest periods
- Individual chronotype
- Opportunity for power naps
Fatigue Risk Management Systems FRMS

- **Information** about basic functions of sleep and alertness

- **Training**
  - individual behaviour and management
  - duty rosters
FRMS

Fatigue Risk Management Systems

Implementation Guide for Operators

1st Edition
July 2011

recommendable reading for more details…
Overview

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More information about sleep and sleepiness: www.dgsm.de