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Measuring Fatigue
Overview

- Definition of fatigue
- What fatigue measures measure
- Current methods for measuring fatigue
- Selecting the right measure
- The FRMS framework
ICAO definition:

A physiological state of reduced mental or physical performance capability resulting from sleep loss or extended wakefulness, circadian phase, or workload (mental and/or physical activity) that can impair a crew member’s alertness and ability to safely operate an aircraft or perform safety related duties.
Measuring in different contexts

- No simple measure, just different ways of estimating the level of fatigue

- **In the Laboratory**
  - Use many different measures in the same experiment to build up a complete picture
  - There tends to be a strong correlation between the different measures

- **In an operational context:**
  - Need to select a very limited number of measures
  - Practical constraints

- How should we select what to use?
Measuring fatigue in operations

Subjective
- VAS
- KSS
- Samn-Perelli
- Sleep Diaries

Objective
- Temperature
- Biological testing
- Circadian Rhythms
- Actigraphy
- Polysomnography

Performance
- Simple mental tasks
- Complex behaviours
There are several well-established subjective measures, including:

- Visual analogue scales (VAS)
- Samn-Perelli seven-point fatigue scale (SPS)
- The Karolinska Sleepiness Scale (KSS)
Visual analogue scales

- Sometimes called linear analogue scales
- Typically a 10cm line with the end points labelled
- The subject marks the line at the appropriate point
- The distance along the line is measured and recorded

**Advantages:**
- simplicity
- sensitive to small changes

**Disadvantages:**
- points along the line are not defined
- comparison with other studies difficult
The Samn-Perelli 7-pt scale

1. Fully alert, wide awake.
2. Very lively, responsive, but not at peak.
3. Okay, somewhat fresh.
4. A little tired, less than fresh.
5. Moderately tired, let down.
6. Extremely tired, very difficult to concentrate.
7. Completely exhausted, unable to function effectively.
The Karolinska Sleepiness Scale

1. Very alert
2.
3. Alert – normal level
4.
5. Neither alert nor sleepy
6.
7. Sleepy, but no effort to keep awake
8.
9. Very sleepy, great effort to keep awake
Advantages of subjective scales:
• quick and easy to administer
• either paper-based or computer-based
• minimal disruption to the aircrew
• many studies have used the SPS and KSS, and provide data for comparison

Disadvantages of subjective scales:
• relatively easy to cheat
• may lack face validity
• do not always reliably reflect objective performance measures
When are they useful?

- Looking at a lot of crew members
- Identifying where problems might exist
  - Further investigation
  - Mitigation
- As one of several measures
- Included on Fatigue Report Forms
Subjective sleep assessment

- Sleep diaries
  - Where
  - Sleep and wake times
  - How much
  - How well

- Useful when
  - Looking at groups
  - Used with other measures
Actiwatches monitor activity
They can give an indication of when an individual may be asleep
Estimates the timing of periods of sleep and quality
Various models

IATA/ICAO/IFALPA FRMS Seminar, Bangkok, 201
Actiwatches: Pros and Cons

Advantages:
- not intrusive
- easy to administer
- can pick up unintentional sleeps, e.g. on the flight deck
- can be used alongside subjective measures

Disadvantages:
- Measures activity not sleep
- Cannot distinguish between sleep and still wake
- Not cheap
The pattern of brain activity changes with increasing fatigue
- Microsleeps (alpha waves)
- Rolling eye movements

Measures
- Sleep quantity and structure
- Sleep quality
- Waking alertness

Measurement requires
- Attachment of electrodes to head / face
- Technicians to accompany the aircrew

Gold standard
When is it useful?

To examine

- Subsequent fatigue levels
- Recovery from a series of duties

For example:

- sleep in hotel rooms on layover
- sleep in aircraft bunks on augmented flights
- sleep at home on return from transmeridian flights
Simple performance tasks: The PVT

- The Psychomotor Vigilance Task

- A sustained-attention task that measures the speed with which subjects respond to a visual stimulus.

- The test runs for 5-10 minutes

- The device records reaction time and the number of missed responses.
Performance tasks: Pros and Cons

Advantages:

• Simple to administer
• Little training required
• Short duration
• Can be carried out in ‘noisy’ surroundings
• Sensitive to changes in fatigue levels
• Has been validated

Disadvantages:

• Requires equipment to be purchased / hired and distributed to the crew
• Requires at least 5-10 minutes without any disturbance
• Impact on other operational activities
• Relationship with operational performance?
Air safety reports

- include fatigue factors in the reports of safety-related events
- monitor on a regular basis

Flight data monitoring

- difficult to identify the effect of fatigue due to the influence of other factors
Measuring circadian rhythms

Why might we want to?
- understanding the development of fatigue
- understanding the recovery process

How might we do it?
- continuous monitoring of body temperature
- collection and analysis of blood / urine / saliva samples

Generally impractical
“Fatigue” can be tricky to measure

Need a variety of measures

Some measures require specialist knowledge

Fatigue needs to be measured as part of an FRMS to:

• Identify times of higher fatigue risk
• Monitor effectiveness of mitigations
THANK YOU