

ICAO / IATA / IFALPA

Asia-Pacific FRMS Seminar

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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



What is fatigue?

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

Fatigue



VAS
KSS
Samn-Perelli

Sleep

Sleep Diaries

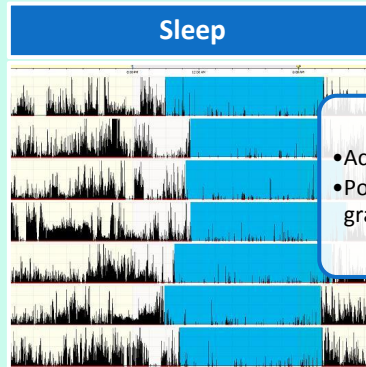
Objective

Circadian Rhythms



- Temperature
- Biological testing

Sleep



- Actigraphy
- Polysomnography

Performance



- Simple mental tasks
- Complex behaviours

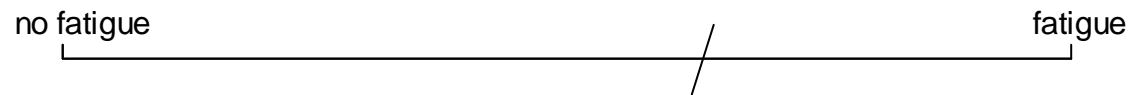


Subjective fatigue assessments

➔ There are several well-established subjective measures, including:

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

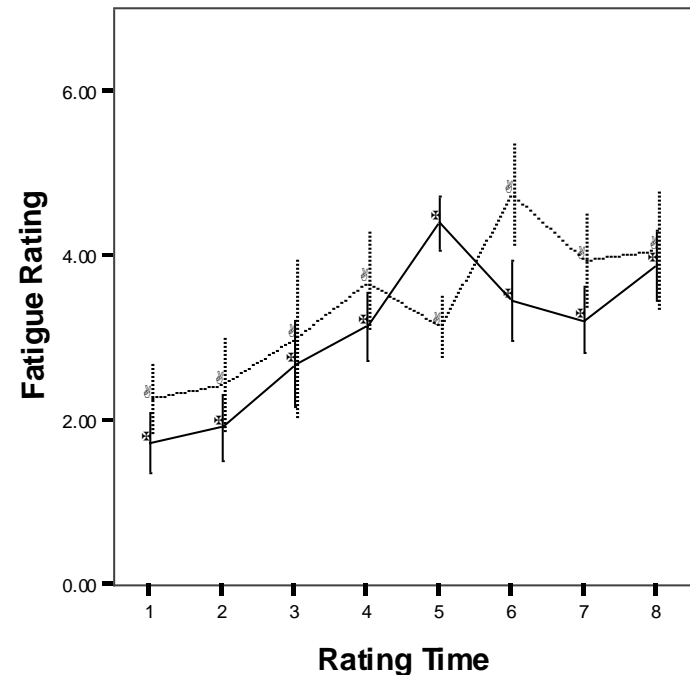
Visual analogue scales



- 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

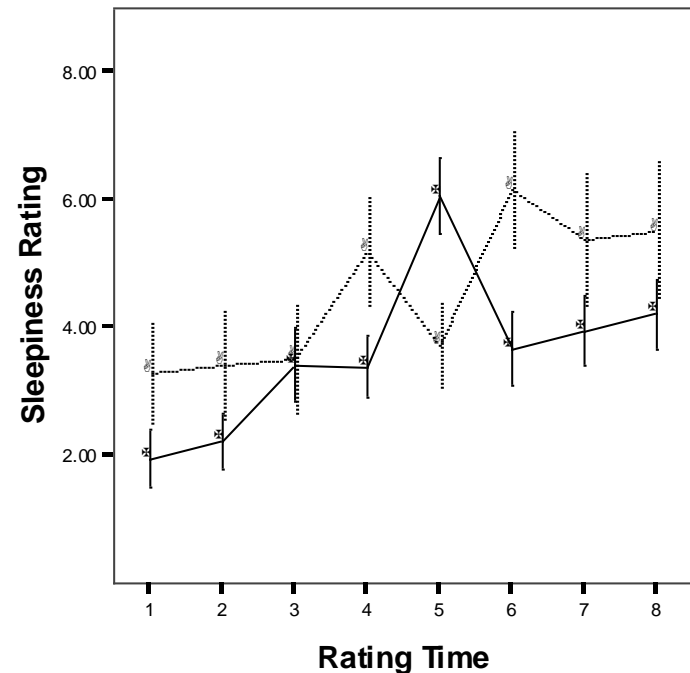
The Samn-Perelli 7-pt scale

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

In Flight

Date: // 0000 0200 0400 0600 0800 1000 1200 1400 1600 1800 2000 2200 2400

Date: // 0000 0200 0400 0600 0800 1000 1200 1400 1600 1800 2000 2200 2400

REST 1

START	PD Assessment: <input type="checkbox"/>	Alcohol Intake: <input type="checkbox"/>	Medication: <input type="checkbox"/>
Time (UTC) to bed	Rest rating: 1 2 3 4 5 6 7		
	Sleep quality: 1 2 3 4 5 6 7 8 9		
END	Rest rating: 1 2 3 4 5 6 7		
Time (UTC) to wake	Sleep quality: 1 2 3 4 5 6 7 8 9		
	Sleep Quality: 1 2 3 4 5 6 7		
Total duration of sleep (excluding awakenings)		hrs	mins

REST 2

START	PD Assessment: <input type="checkbox"/>	Alcohol Intake: <input type="checkbox"/>	Medication: <input type="checkbox"/>
Time (UTC) to bed	Rest rating: 1 2 3 4 5 6 7		
	Sleep quality: 1 2 3 4 5 6 7 8 9		
END	Rest rating: 1 2 3 4 5 6 7		
Time (UTC) to wake	Sleep quality: 1 2 3 4 5 6 7 8 9		
	Sleep Quality: 1 2 3 4 5 6 7		
Total duration of sleep (excluding awakenings)		hrs	mins

REST 3

START	PD Assessment: <input type="checkbox"/>	Alcohol Intake: <input type="checkbox"/>	Medication: <input type="checkbox"/>
Time (UTC) to bed	Rest rating: 1 2 3 4 5 6 7		
	Sleep quality: 1 2 3 4 5 6 7 8 9		
END	Rest rating: 1 2 3 4 5 6 7		
Time (UTC) to wake	Sleep quality: 1 2 3 4 5 6 7 8 9		
	Sleep Quality: 1 2 3 4 5 6 7		
Total duration of sleep (excluding awakenings)		hrs	mins

REST 4

START	PD Assessment: <input type="checkbox"/>	Alcohol Intake: <input type="checkbox"/>	Medication: <input type="checkbox"/>
Time (UTC) to bed	Rest rating: 1 2 3 4 5 6 7		
	Sleep quality: 1 2 3 4 5 6 7 8 9		
END	Rest rating: 1 2 3 4 5 6 7		
Time (UTC) to wake	Sleep quality: 1 2 3 4 5 6 7 8 9		
	Sleep Quality: 1 2 3 4 5 6 7		
Total duration of sleep (excluding awakenings)		hrs	mins

REST 5

START	PD Assessment: <input type="checkbox"/>	Alcohol Intake: <input type="checkbox"/>	Medication: <input type="checkbox"/>
Time (UTC) to bed	Rest rating: 1 2 3 4 5 6 7		
	Sleep quality: 1 2 3 4 5 6 7 8 9		
END	Rest rating: 1 2 3 4 5 6 7		
Time (UTC) to wake	Sleep quality: 1 2 3 4 5 6 7 8 9		
	Sleep Quality: 1 2 3 4 5 6 7		
Total duration of sleep (excluding awakenings)		hrs	mins

REST 6

START	PD Assessment: <input type="checkbox"/>	Alcohol Intake: <input type="checkbox"/>	Medication: <input type="checkbox"/>
Time (UTC) to bed	Rest rating: 1 2 3 4 5 6 7		
	Sleep quality: 1 2 3 4 5 6 7 8 9		
END	Rest rating: 1 2 3 4 5 6 7		
Time (UTC) to wake	Sleep quality: 1 2 3 4 5 6 7 8 9		
	Sleep Quality: 1 2 3 4 5 6 7		
Total duration of sleep (excluding awakenings)		hrs	mins

Rest rating:
 1=Fully alert, very awake
 2=Awake, very alert
 3=Awake, alert
 4=Awake, somewhat drowsy
 5=Awake, drowsy
 6=Awake, very drowsy
 7=Awake, unable to function
 8=Asleep
 9=Unsure

Sleep Quality:
 1=Excellent
 2=Very good
 3=Good
 4=Fair
 5=Poor
 6=Very poor
 7=Unsure

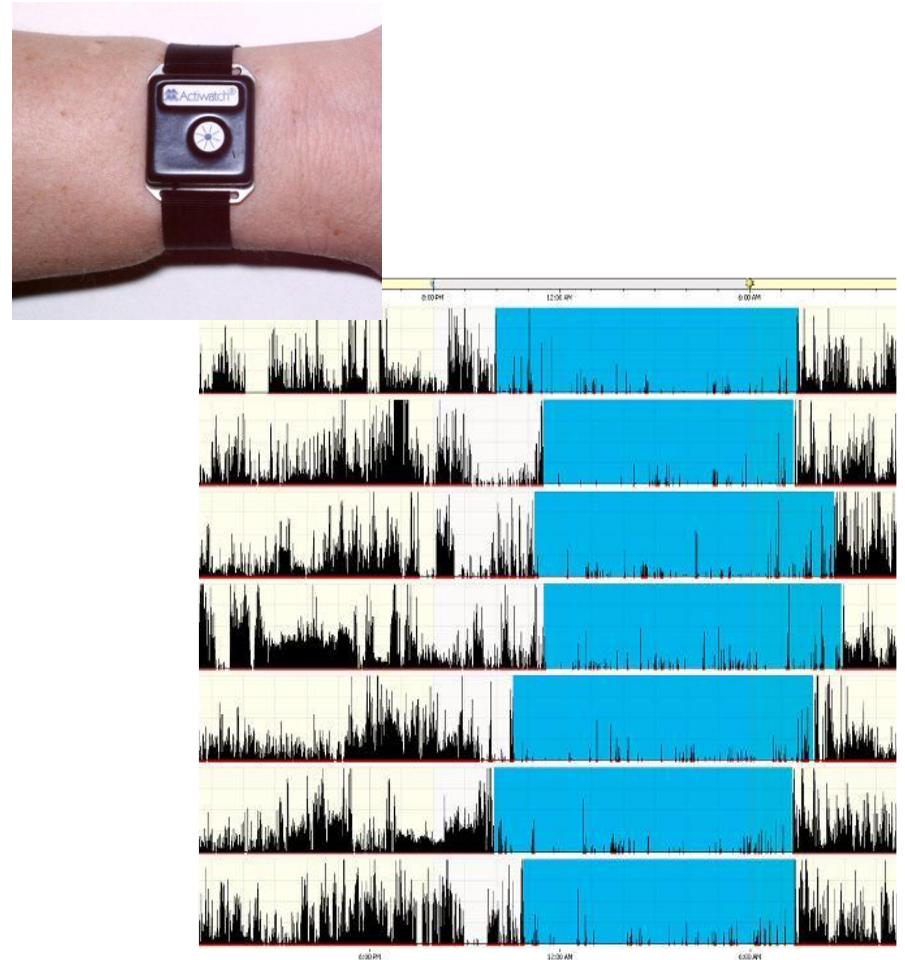
Sleep diary rating:
 1=Excellent
 2=Very good
 3=Good
 4=Fair
 5=Poor
 6=Very poor
 7=Unsure

ID:



Measuring sleep - Actiwatches

- 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



Actiwatches: Pros and Cons

→ Advantages:

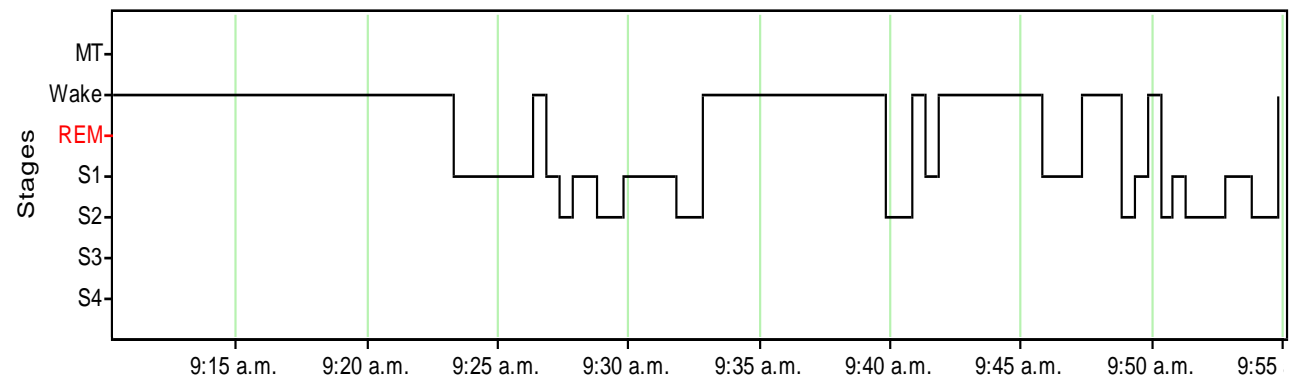
- not intrusive
- easy to administer
- can pick up unintentional sleeps, e.g. on the flight deck
- can be used alongside subjective measures

→ Disadvantages:

- Measures activity not sleep
- Cannot distinguish between sleep and still wake
- Not cheap

Polysomnography

- 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?

Monitoring effects on 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



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THANK YOU