



***Fatigue Risk Management:
An integral part of
Safety Management
Systems***

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A New Paradigm

- **Prescriptive regulations:**
 - Historically rather than rationally derived
 - Not scientifically defensible
 - Operationally inflexible
 - Not risk-based so can lead to paradoxical outcomes
- **Non-prescriptive models:**
 - Derived rationally [at least in theory]
 - Scientifically defensible
 - Operationally flexible
 - Risk-based

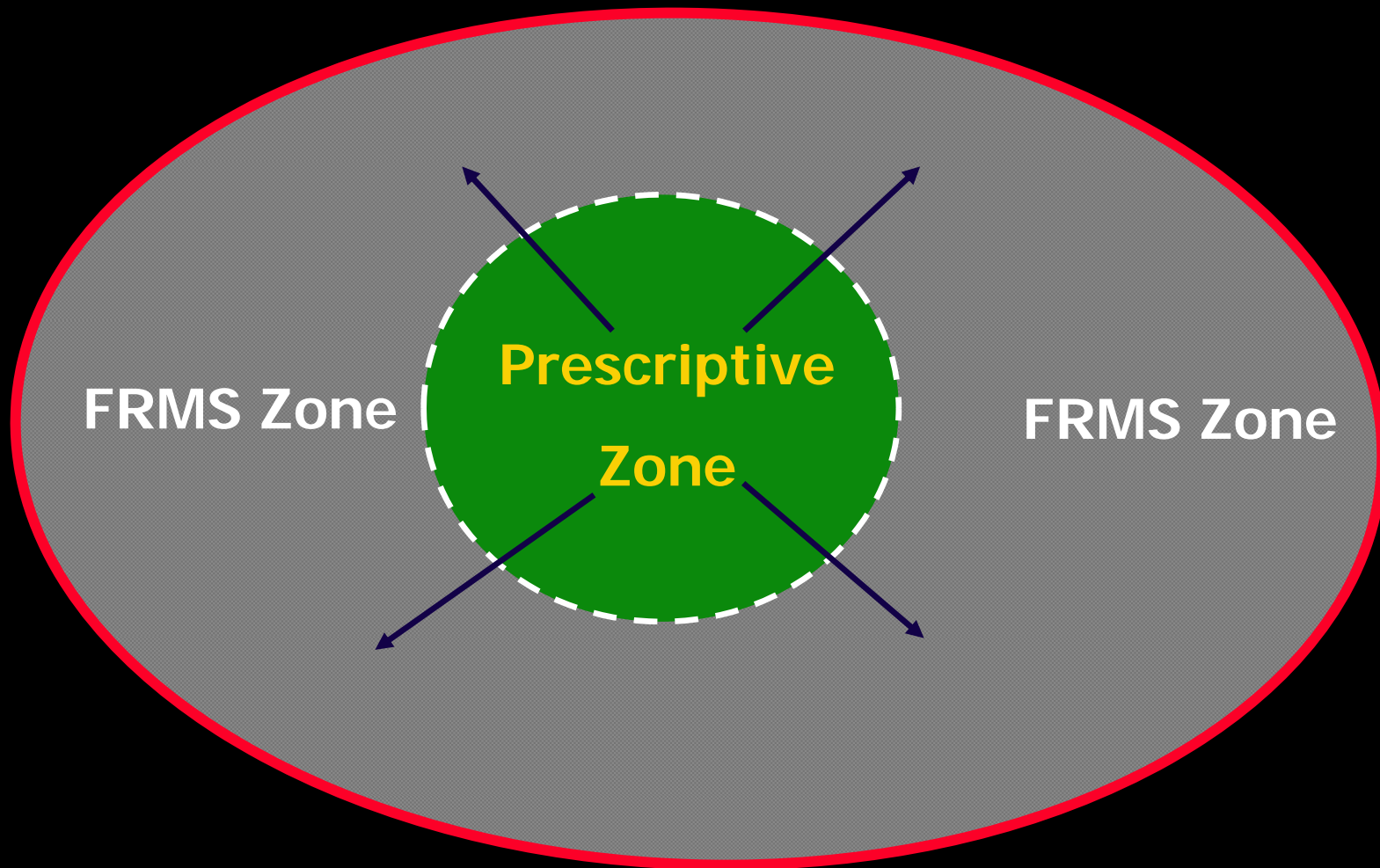
A New Paradigm

- **Decision to move away from an industrially focused prescriptive model toward a Safety Management System [SMS] model of fatigue risk regulation**

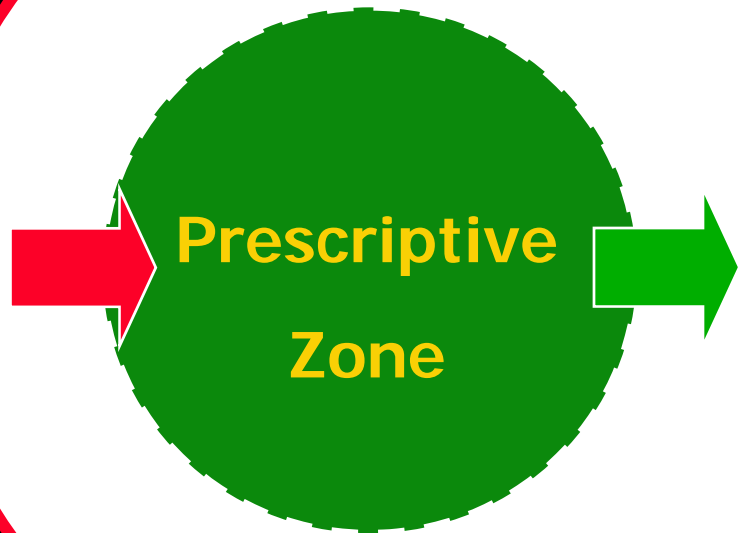
Goals are to

- **reduce fatigue-related accidents with acceptable impact on operational flexibility.**
- **Provide a scientifically and legally defensible framework and measurable outcomes**
- **Provide a a risk-based framework**
- **Provide a rational migration path from HOS to SMS**

Alternate compliance model



Alternate compliance model



Acknowledges unique operational requirements

Ensures resource/risk profile is appropriate

Punishes poor SMS performance with return to the prescriptive zone

Rewards appropriate use of SMS with flexibility and competitive advantage

A minimum prescriptive framework

Work-related fatigue is unlikely to be a problem in a work place for staff whose schedule or roster involves

- less than 48h 'at work' and 'on call' per week
- work periods less than 12h
- breaks between work periods of more than 12h
- less than 12h of 'night work' per 7 day period
[i.e. total weekly hours worked between 2100h-0900h]
- at least one break of 36h or more per 7 day period

If any of the above are not true a FRMS is probably required

[For pilots additional limits for sectors and 'stick time' would be required]

Performance-based definition for a Fatigue Risk Management System

- the operator will implement [as part of their SMS] a management system to minimize the risks associated with fatigue
- an FRMS should be
 - scientifically and legally defensible,
 - reported and auditable
 - address all reasonably foreseeable events
 - appropriate to operator resource/risk profile

The Key Elements of an FRMS

1. There should be a written Fatigue management plan for all **reasonably foreseeable** events
2. There should be **competency-based** training and education programs for the identification and management of fatigue-related risk
3. There should be a quantitative methodology for ensuring appropriate sleep and wake durations at both the **individual** and **organizational** level
4. There should be a quantitative methodology for determining compliance with 1-3

Creating a Shared FRMS Policy

QuickTime™ and a
Photo - JPEG decompressor
are needed to see this picture.

FRMS policy framework *[management]*

The operator is responsible for providing staff with a work schedule that

- does not require **excessive wakefulness** and
- provides the opportunity to obtain **sufficient sleep**.

In determining this, the employer shall take into account normal *non-work activities and responsibilities* of the employee.

FRMS policy framework

[employee]

The employee is responsible for using their allocated time away from work to obtain **sufficient sleep** in order to work safely.

If this has not been possible, **as a requirement of the FRMS**, the employee must notify their employer that they may have had insufficient sleep.

Competency-based Training

- Ensure that all relevant staff are aware of the organizational fatigue management policy and can identify and manage risks associated with fatigue at a personal and organizational level.
- Ensure that all relevant staff who are responsible for organizational decisions that impact on the length of wakefulness and/or the opportunity to obtain sufficient sleep know their responsibilities and understand how to use the appropriate risk mitigation strategies

Ensuring appropriate sleep and wakefulness

- An effective FRMS should identify insufficient sleep and excessive wakefulness
 - At the individual and organizational level
 - Prospectively [**planned**] and retrospectively [**actual**]
 - As a potential root cause of incidents and accidents

Ensuring appropriate sleep and wakefulness




Prescriptive approaches



Assumes that compliance ensures safety




Assigns no responsibility to an employee



Relies on subjective assessment of an internal psychological state

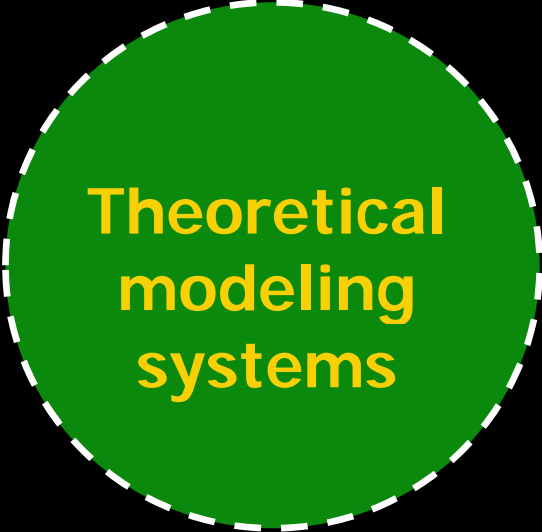


Does not address risk



Does not provide explicit management strategies for risk mitigation when fatigue occurs and individual is compliant

Ensuring appropriate sleep and wakefulness




Theoretical modeling systems




To be practical models need to predict fatigue from work/rest not sleep wake data



Current theoretical models are not evidence-based



Theoretical models are based on average data rather than statistical distributions



Current theoretical models predict fatigue based on physiological but not social data

Ensuring appropriate sleep and wakefulness



Estimates fatigue based on statistical distributions of prior sleep and wake



Does use real world data that includes social activity

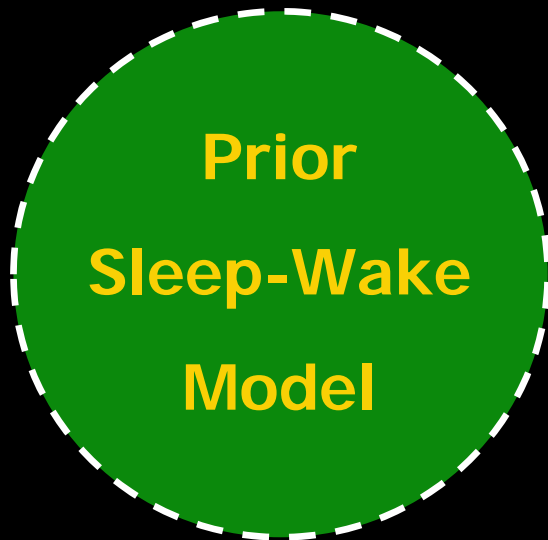


Does not have specific sleep/wake data derived from aviation populations



Does not predict individual sleep/wake on a specific occasion

Ensuring appropriate sleep and wakefulness



Scientifically defensible



Simple and practical.

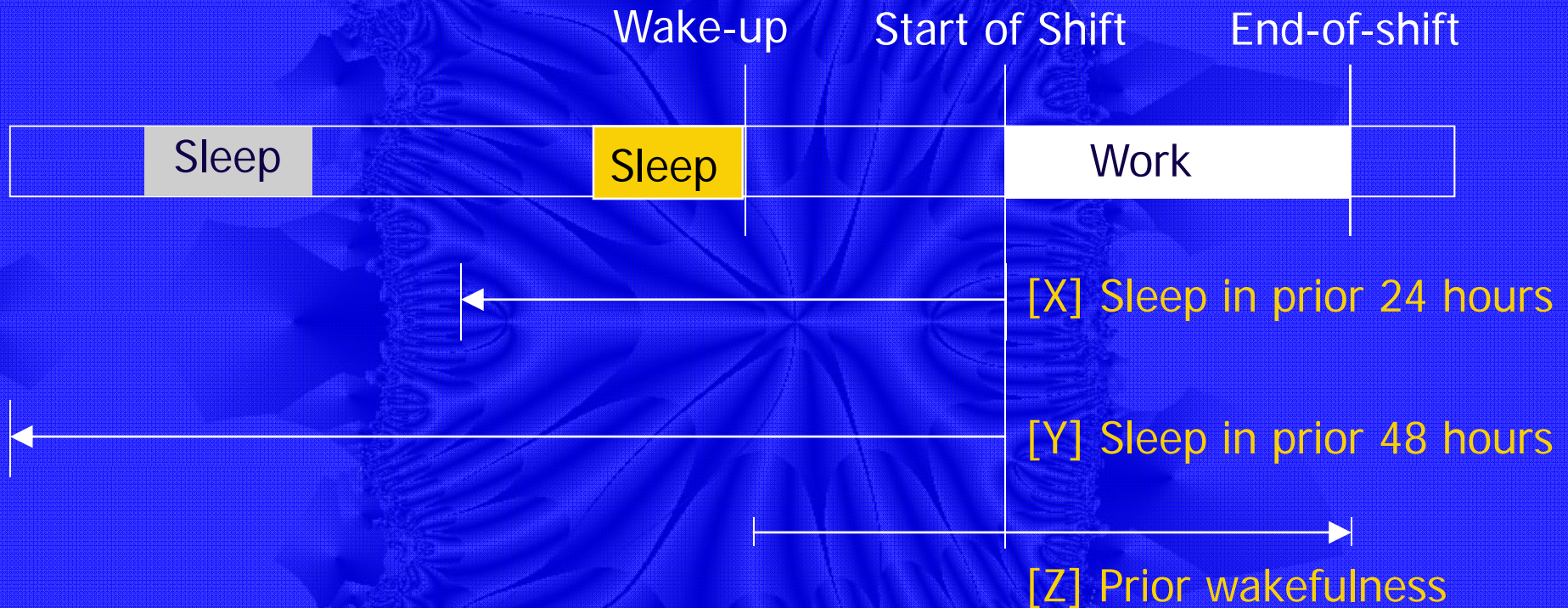


Scales from individual to aggregate levels



Provides a risk based framework for decision making

Prior Sleep Wake Model



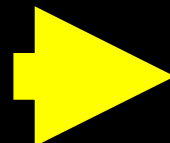
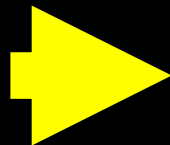
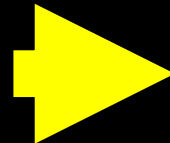
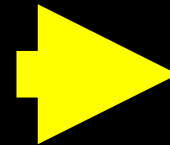
Fatigue is unlikely to be a problem when X, Y and Z are above task and/or occupationally defined thresholds

Sleep and Wake Rules

- **[sufficient sleep]** Must obtain X hrs sleep in the 24hrs prior, and Y hrs sleep in the 48hr prior to commencing work
- **[excessive wake]** The period from wake-up to the end of shift should not exceed the amount of sleep obtained in the 48 hrs prior to commencing the shift
- **[risk mitigation]** Non-compliance indicates that fatigue may be a potential problem and the individual should calculate a risk score and notify their line manager and the organization should engage in an auditable fatigue risk reduction process

Risk-based Decision Tree

1. Add **2 points** for each hour of sleep below the 24h threshold
2. Add **1 point** for each hour of sleep below the 48h threshold
3. Add **1 point** for each hour of wake beyond the 48h threshold
4. Refer to organizational decision tree for response



Fatigue Score	Countermeasure
0 points	No action required unless checklist symptoms reported
a-b points	Document locally and work with local & self monitored countermeasures e.g. collegial checks, caffeine, self-managed breaks, task rotation, check routines
c-f points	Document externally, Work with additional externally monitored CM's. eg. Napping, external supervisory checks, task reassignment
g+ points	Document externally and immediately. Do not come to work, do not collect \$200; stay at home until FFW

Sleep Loss - Single Night

study	methodology	dependent variable	conclusions
Wilkinson (1966)	TIB restricted (7.5,5,3,2,1,0hr)	Vigilance & Addition	Vigilance impaired when sleep <5hr Mental function impaired when sleep <3hr
Taub & Berger (1973)	TIB restricted to 5hr	Vigilance & Addition	Vigilance impaired when sleep <5hr Mental function maintained
Rosenthal et al. (1993)	TIB restricted (8,6,4,0hr)	MSLT	Sleep onset latency (SOL) decreased to 2 -7min when sleep <6hr
Gillberg & Akerstedt (1994)	TIB restricted to 4hr	MSLT & Simple RT	Increase in sleep propensity; RT performance impaired
Devoto et al. (1999)	TIB restricted (8,5,4,3,2,1hr)	MSLT	SOL decreased to 2.5 - 5 min when sleep <5hr sleep
Belenky et al. (2003)	TIB restricted (9,7,5,3hr)	Vigilance (PVT)	Vigilance impaired when sleep <3hr

Sleep Loss - Multiple Nights

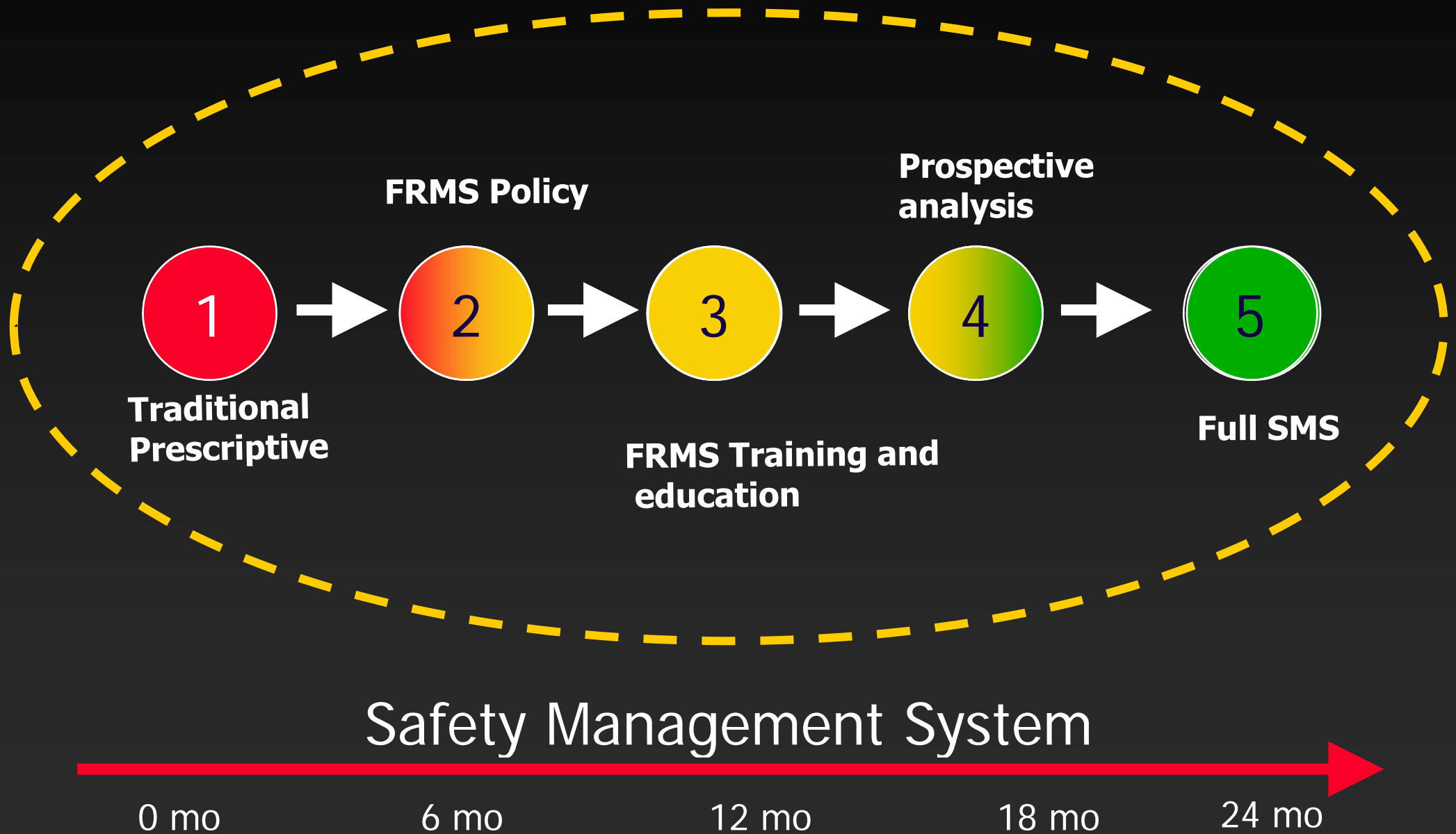
study	methodology	dependent variable	conclusions
Hamilton et al. (1972)	TIB restricted for 4 nights (7.5, 6, 4hr)	Vigilance & Addition	Cumulative impairment when sleep <4hr
Carskadon & Dement (1981)	TIB restricted to 5hr for 7 nights	MSLT & Subj Sleepiness (SSS)	SOL decreased after 2 nights (SOL=7min after 7 nights); SSS increased after 1 night
Carskadon & Dement (1982)	TIB reduced to 4hr for 2 nights	MSLT	SOL decreased after 1 night, further decreased after 2 nights
Tilley & Wilkinson (1984)	TIB reduced to 4hr for 2 nights	Simple RT	Performance impaired after 1 night, greater impairment after 2 nights
Blagrove et al. (1995)	Sleep reduced to 4.3h for 6 nights	4 Cognitive tasks & Subjective ratings	Mental function impaired after 3 nights Vigilance deficits not observed
Dinges et al. (1997)	TIB restricted to 5hr for 7 nights	PVT & MSLT	Vigilance impaired after 2 nights Decreased SOL after 5 nights
Belenky et al. (2003)	TIB restricted for 7 nights (9,7,5,3hr)	PVT & MSLT	Vigilance impaired after: 2 sleeps <3hr 3 sleeps <5hr SOL decreased to: 2.5 min after 2 sleeps <3hr 3 min after 5 sleeps <5hr

Performance Management System

Management to demonstrate a methodology that ensures

- 1. All relevant employees are aware of relevant fatigue-related risk, know their responsibilities and have signed the FRMS policy**
- 2. All relevant employees have been appropriately trained and are competent to make decisions consistent with the fatigue management policy**
- 3. All relevant employees are sufficiently alert to operate safely within the workplace [**prospectively & retrospectively**].**
- 4. All relevant exceptions are documented and corrective action is undertaken in a timely manner**

Development of Fatigue Risk Management Systems





Questions?

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