



Fatigue Management: Technological advances and Fatigue Risk Management Systems

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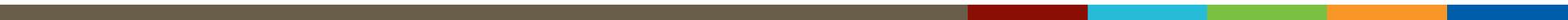
Imelda Wong, PhD

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Board of Scientific Counselors, May 19, 2021

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Emergence / adoption of fatigue detection technologies



Foundations in transportation industry to address road safety

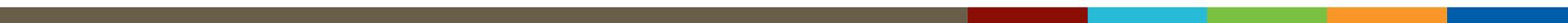
Emergence / adoption of fatigue detection technologies



Foundations in transportation industry to address road safety



Increasing interest from other industries and occupational health and safety groups



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Global market on Driver Monitoring Systems projected to grow from \$1.6 bn (2019) to \$2.4 bn (2027)

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Concerns include:

- Keeping up with the technology
- “What is the right technology for me/our organization?”

Ranking fatigue detection technologies

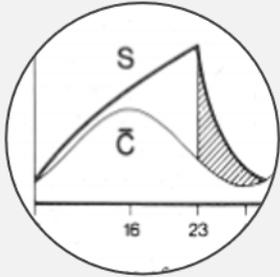


Ranking fatigue detection technologies



Ranking fatigue detection technologies

Ease of use



Biomathematical models

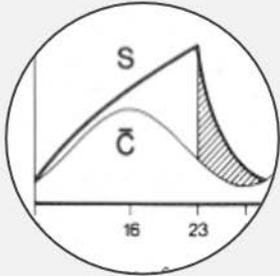


Fitness for Duty Tests

Accuracy / Effectiveness

Ranking fatigue detection technologies

Ease of use



Biomathematical models



Fitness for Duty Tests

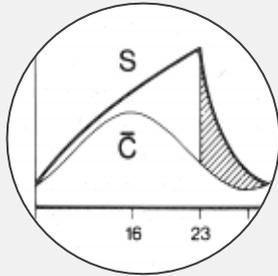


Task Performance

Accuracy / Effectiveness

Ranking fatigue detection technologies

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Fitness for Duty Tests



Task Performance

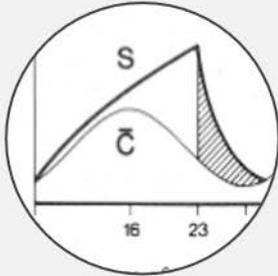


Worker monitoring

Accuracy / Effectiveness

Ranking fatigue detection technologies

Ease of use



Biomathematical models



Fitness for Duty Tests



Task Performance



Worker monitoring

Accuracy / Effectiveness

Worker monitoring fatigue technologies (passive)

- **Brain activity (EEG)**



Data Source: Muse

Worker monitoring fatigue technologies (passive)

- **Brain activity (EEG)**
- **Posture/head nod**



Data Source: Alertme Lifesaver Alert

Worker monitoring fatigue technologies (passive)

- **Brain activity (EEG)**
- **Posture/head nod**
- **Ocular measures**
 - Duration/rate of blinks
 - Eyelid closure



Data Source: OptAlert

Worker monitoring fatigue technologies (passive)

- **Brain activity (EEG)**
- **Posture/head nod**
- **Ocular measures**
 - Duration/rate of blinks
 - Eyelid closure
- **Galvanic skin response**



Data Source: BodyBug

Worker monitoring fatigue technologies (passive)

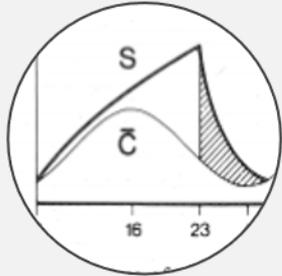
- **Brain activity (EEG)**
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 - Duration/rate of blinks
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- **Galvanic skin response**
- **Heart rate variability**



Data Source: Harvard Health

Ranking fatigue detection technologies

Ease of use



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Fitness for Duty Tests



Task Performance



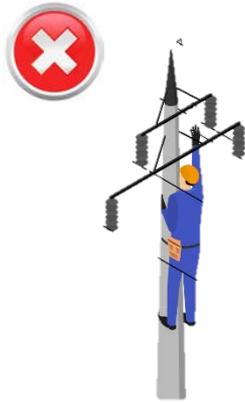
Worker monitoring



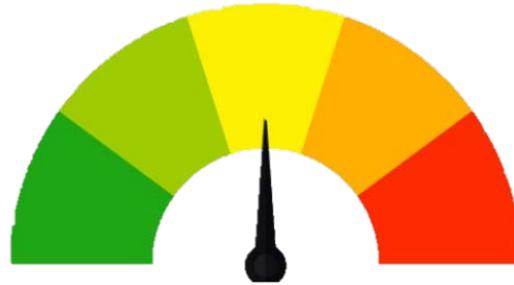
Hybrid Solutions

Accuracy / Effectiveness

Defining a fatigue “threshold”



Sensor reading



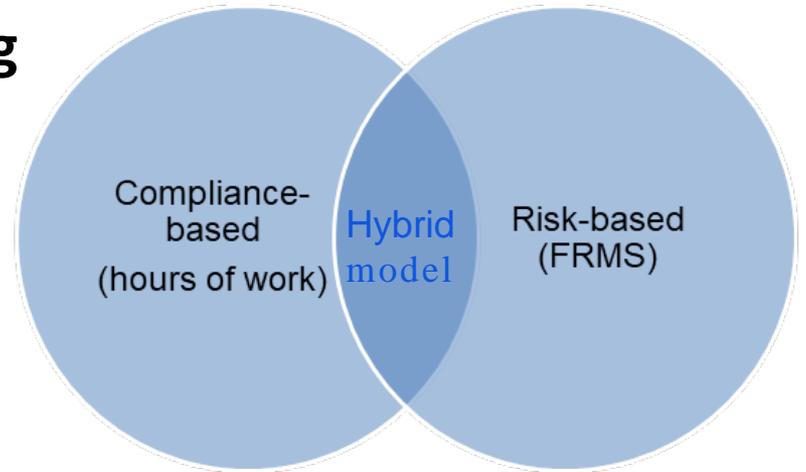
- Fatigue is on a continuum, not a cut point
- Fatigue “threshold” depends on task
- Risk = likelihood + consequence
- Fatigue mitigation strategies should consider this

Fatigue Risk Management Systems (FRMS)

- **Risk-based approach vs. hours of service**

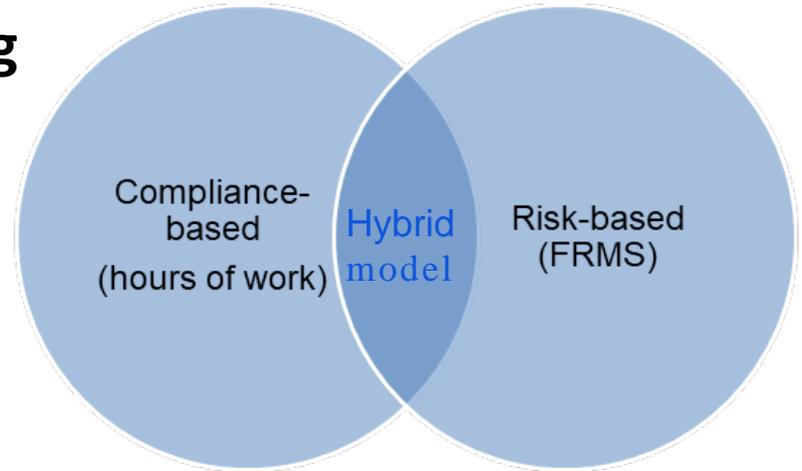
Fatigue Risk Management Systems (FRMS)

- **Risk-based approach vs. hours of service; hybrid models emerging**



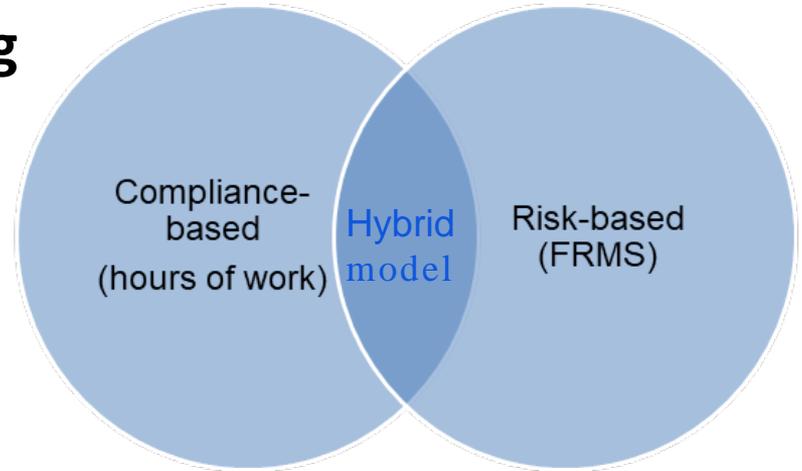
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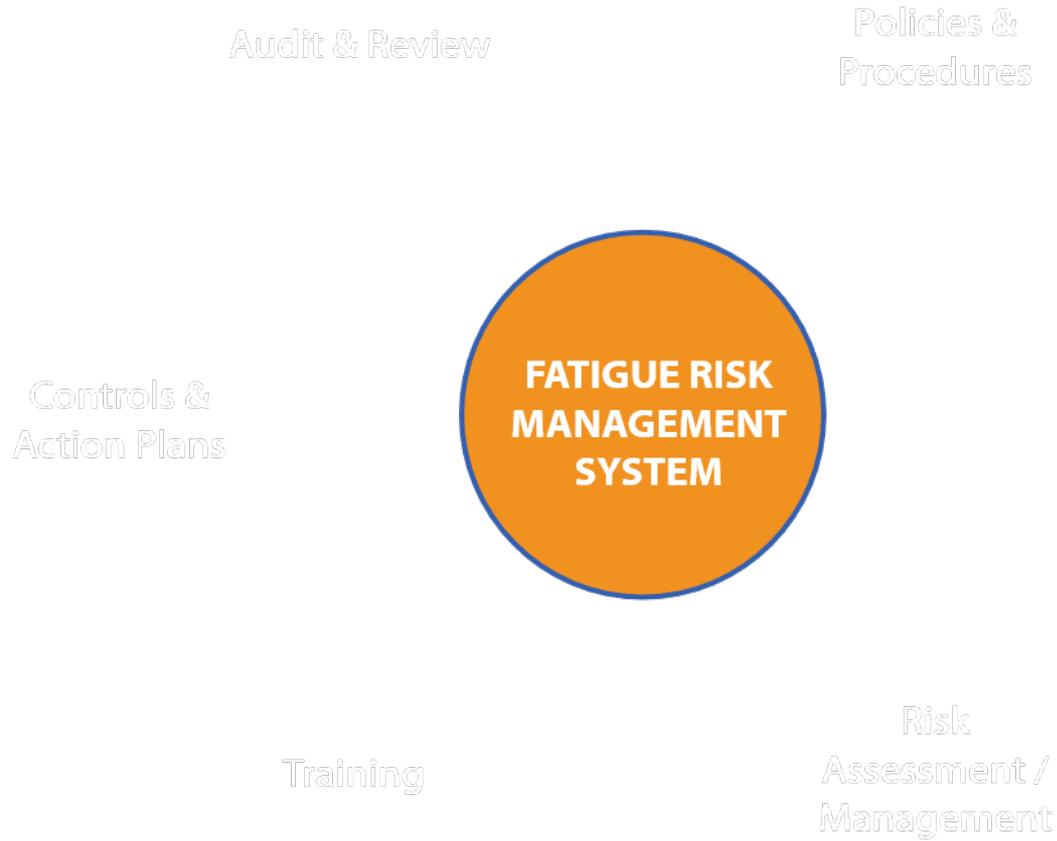
- Risk-based approach vs. hours of service; hybrid models emerging
- Reflects the need for multiple layers of defensive strategies: predictive, proactive, reactive

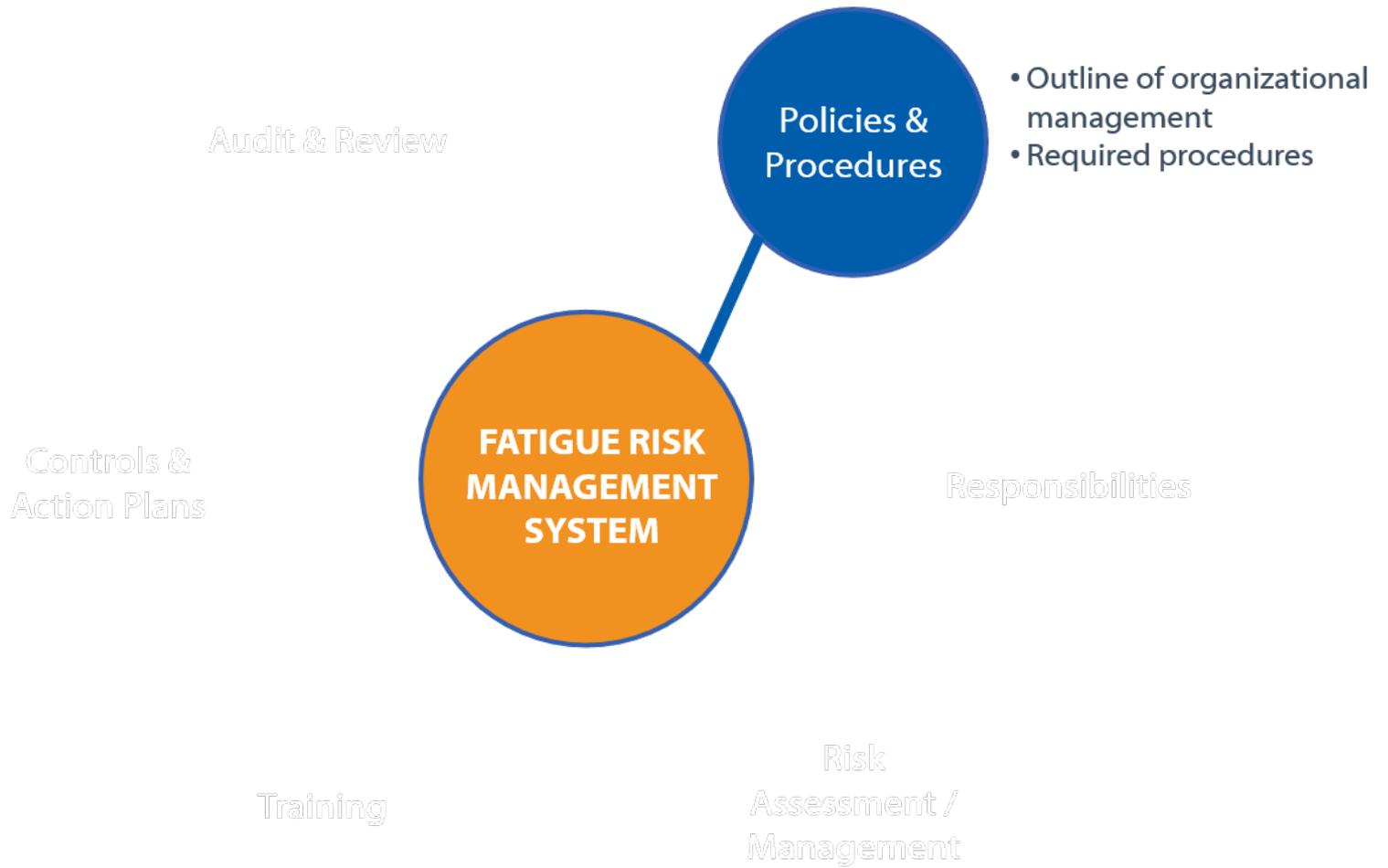


Fatigue Risk Management Systems (FRMS)

- **Risk-based approach vs. hours of service; hybrid models emerging**
- **Reflects the need for multiple layers of defensive strategies: predictive, proactive, reactive**
- **Shared responsibility of employers and employees**



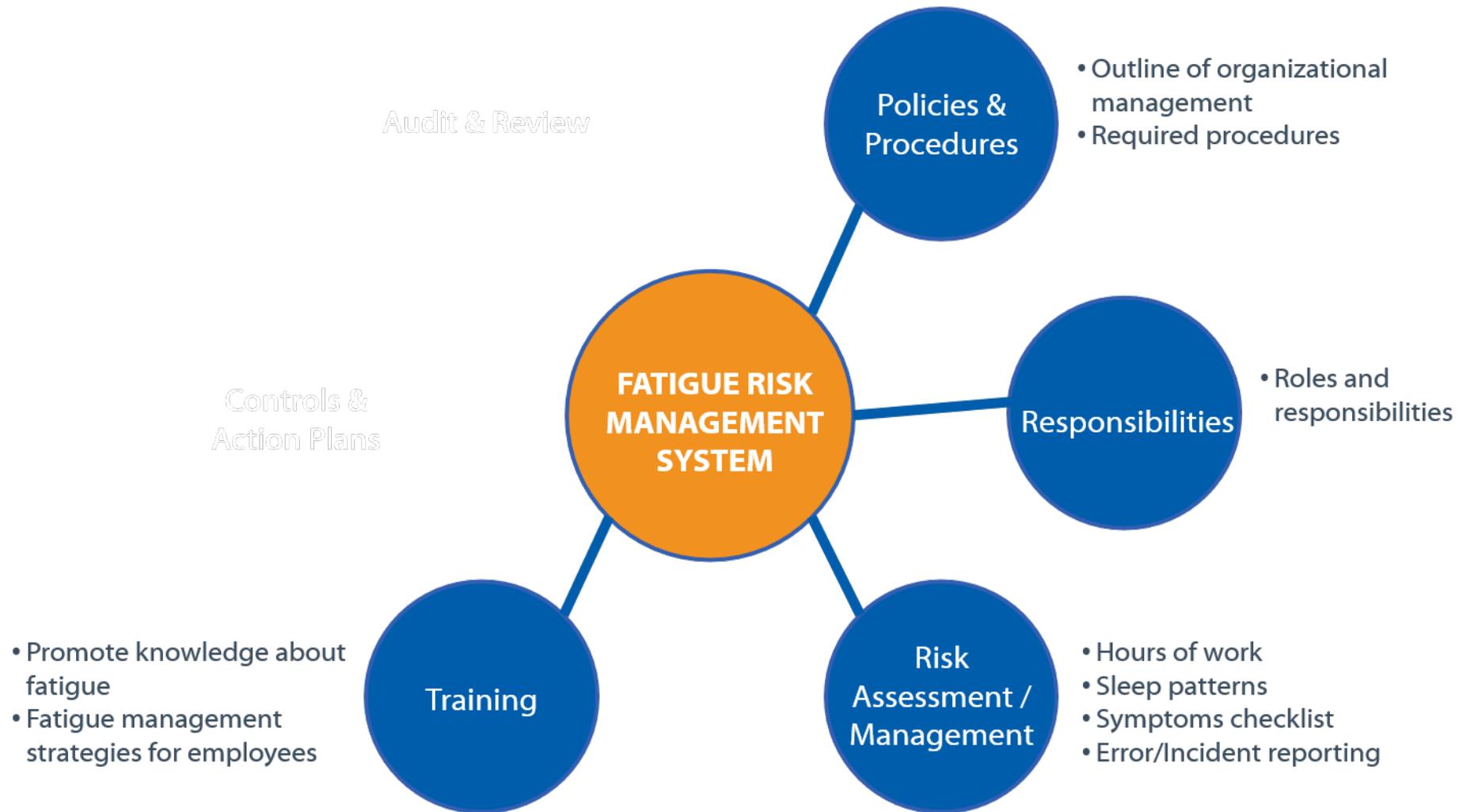






Audit & Review









Implementation and Effectiveness of Fatigue Risk Management Systems (FRMS)



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- **Studies show improved sleep/alertness among firefighters, nurses, pilots**



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Implementation and Effectiveness of Fatigue Risk Management Systems (FRMS)

- **Studies show improved sleep/alertness among firefighters, nurses, pilots**
- **Best if integrated with safety management systems and mature safety culture**
- **Limited evidence on safety outcomes**
- **Potential challenges: cost, complexity, culture**



NIOSH activities in fatigue detection and FRMS

- **Collaboration between Center for Work and Fatigue Research, Center for Motor Vehicle Safety and Center for Direct Reading and Sensor Technologies:
Interviews, literature review, science blogs**

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- **Miners: Project MANIFEST**
- **Commercial vehicle operators: evaluation of the North American Fatigue Management Program**

<https://www.cdc.gov/niosh/topics/fatigue/default.html>



Considerations for the future role of technologies



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- **Criteria for validation of device**



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- **Combined with other data sources**



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- **Integration into FRMS and SMS**



Considerations for the future role of technologies

- **Criteria for validation of device**
- **Combined with other data sources**
- **Caution of overreliance on technology**
- **Integration into FRMS and SMS**
- **Real world application of devices**



Questions for the Board

- With the influx of new fatigue detection technologies available on the commercial market, what can NIOSH do to promote their effective use within a holistic approach to fatigue risk management?
- Given the limited company resources and the complex, integrated efforts needed for FRMS, how can we help employers/workers develop this comprehensive approach?

Thank you!

For more information, contact CDC
1-800-CDC-INFO (232-4636)
TTY: 1-888-232-6348 www.cdc.gov

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

