# Technology Enabled Management of Sleep Loss as a Strategy to Mitigate the Underlying Cause of Fatigue in Transportation

Jeffrey Durmer, MD, PhD
Chief Medical Officer, FusionHealth

Sleep Recover Perform

FusionHealth®

# Defining and Identifying Fatigue

# Fatigue is Defined By its Effects

| *Cognitive subscale* | *Never* | *Rarely* | *Sometimes* | *Often* | *Almost always* |
|---|---|---|---|---|---|
| 1. I have been less alert | 0 | 1 | 2 | 3 | 4 |
| 2. I have had difficulty paying attention for long periods of time | 0 | 1 | 2 | 3 | 4 |
| 3. I have been unable to think clearly | 0 | 1 | 2 | 3 | 4 |
| 4. I have been forgetful | 0 | 1 | 2 | 3 | 4 |
| 5. I have had difficulty paying attention for short periods of time | 0 | 1 | 2 | 3 | 4 |
| 6. I have had difficulty making decisions | 0 | 1 | 2 | 3 | 4 |
| 7. I have been less motivated to do anything that requires thinking | 0 | 1 | 2 | 3 | 4 |
| 8. I have had trouble finishing tasks that require thinking | 0 | 1 | 2 | 3 | 4 |
| 9. I have had difficulty organizing my thoughts when doing things | 0 | 1 | 2 | 3 | 4 |
| 10. My thinking has been slowed down | 0 | 1 | 2 | 3 | 4 |
| 11. I have had trouble concentrating | 0 | 1 | 2 | 3 | 4 |
| | | | | Cognitive subscale score _____ | |

| *Physical subscale* | *Never* | *Rarely* | *Sometimes* | *Often* | *Almost always* |
|---|---|---|---|---|---|
| 12. I have had to pace myself in my physical activities | 0 | 1 | 2 | 3 | 4 |
| 13. I have been less motivated to do anything that requires physical effort | 0 | 1 | 2 | 3 | 4 |
| 14. I have trouble maintaining physical effort for long periods | 0 | 1 | 2 | 3 | 4 |
| 15. I have trouble maintaining physical effort for short periods | 0 | 1 | 2 | 3 | 4 |
| 16. I have been physically uncomfortable | 0 | 1 | 2 | 3 | 4 |
| 17. I have been less able to complete tasks that require physical effort | 0 | 1 | 2 | 3 | 4 |
| 18. I have needed to rest more often or for longer periods | 0 | 1 | 2 | 3 | 4 |
| | | | | Physical subscale score_____ | |

| *Psychosocial subscale* | *Never* | *Rarely* | *Sometimes* | *Often* | *Almost always* |
|---|---|---|---|---|---|
| 19. I have avoided/eliminated certain tasks, activities and lifestyles | 0 | 1 | 2 | 3 | 4 |
| 20. I have been less motivated to participate in social activities | 0 | 1 | 2 | 3 | 4 |
| 21. I have been limited in my ability to do things | 0 | 1 | 2 | 3 | 4 |
| | | | | Psychosocial subscale score_____ | |
| | | | | Total MFIS-SCI score = _____ | |

Modified Fatigue Impact Scale
(Fatigue Severity Scale)



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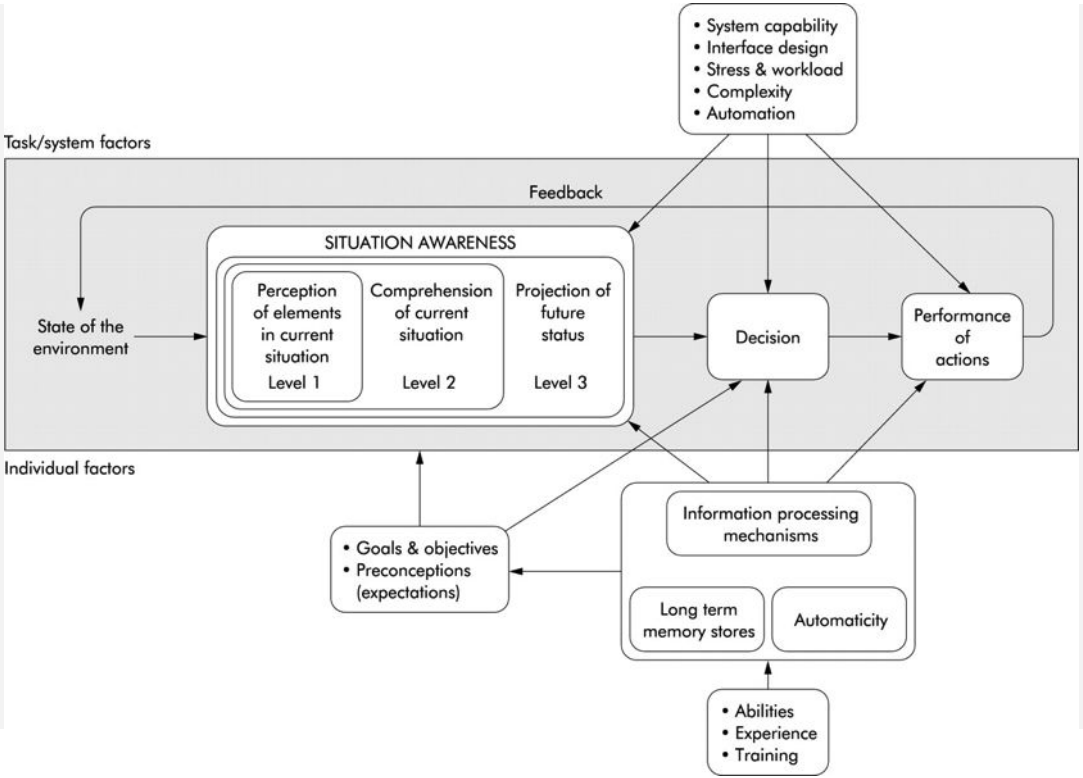
# Studying the Effect of Fatigue on Situational Awareness




The Focus is on the Task

The Focus is During the Task

*Model of Situational Awareness in Dynamic Decision Making (Endsley, 1995)*



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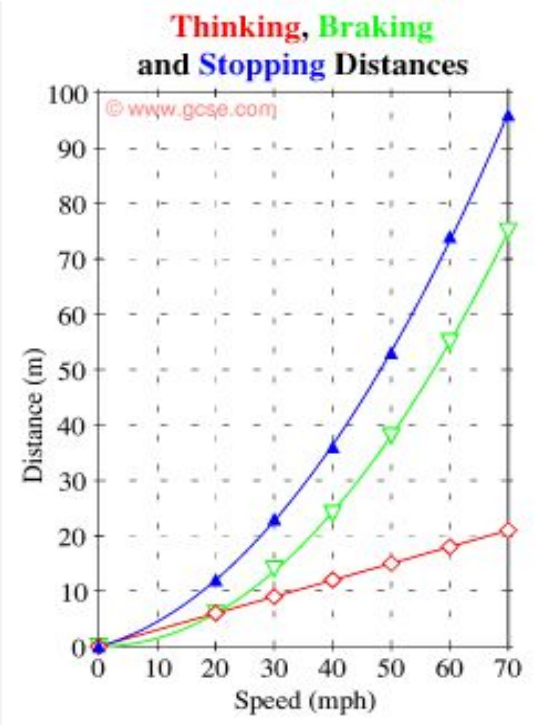
# Tools that Focus on Individuals *During* a Task







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# New Focus on the Individual Before a Task

## Biometrics Predict Risk for Situational Awareness Related Accidents

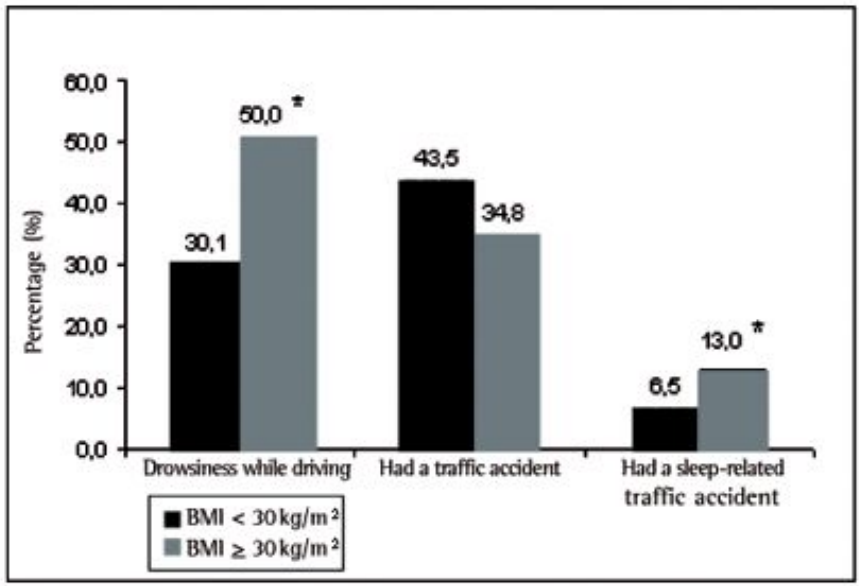


**Figure 3 - Drivers divided according to sleepiness, number of accidents and BMI, in percentages p < 0.05; BMI: body mass index**

Focus on the Person BEFORE the Task

Predict and Prevent Accidents

Viegas, Carlos Alberto de Assis, & Oliveira, Haroldo Willuweit de. 2006. Prevalence of risk factors for obstructive sleep apnea syndrome in interstate bus drivers. J Brasileiro de Pneumologia, 32(2), 144-149



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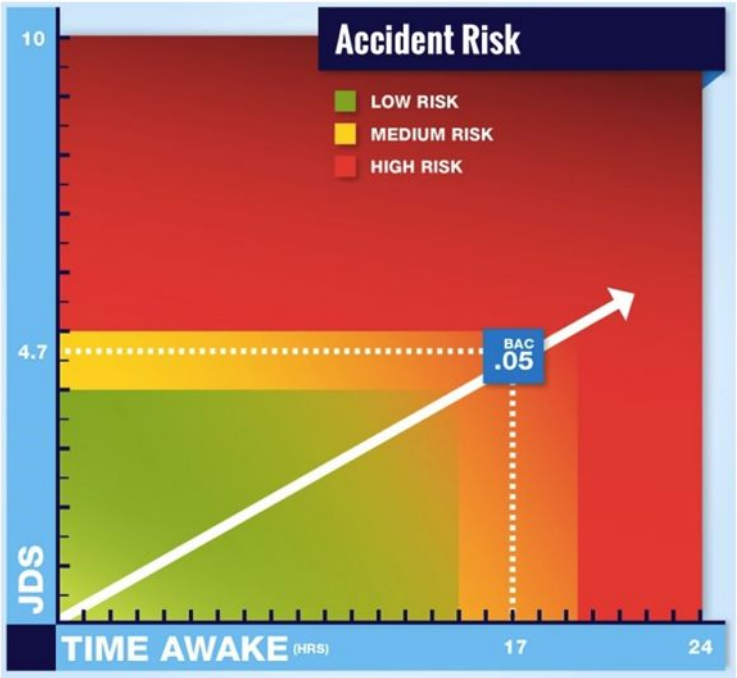
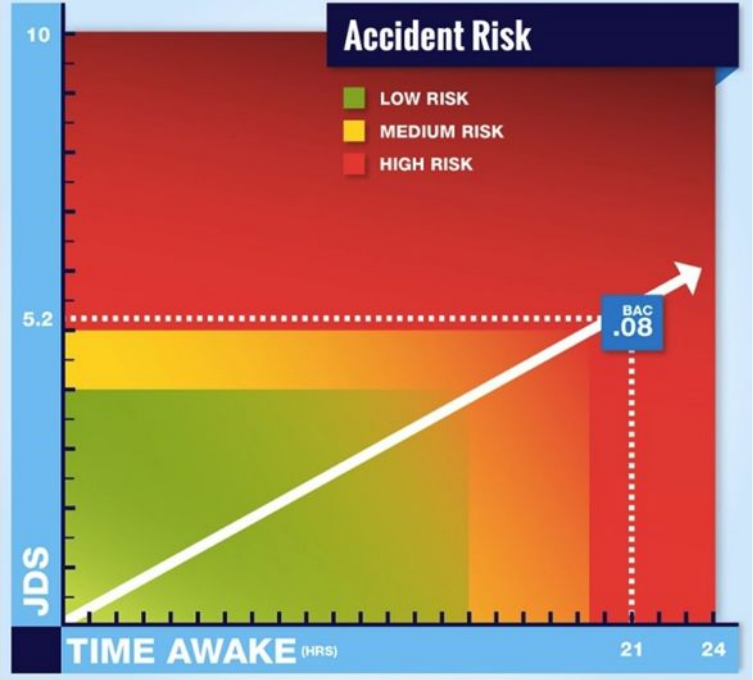
# Research on the Individual Risk Factors

## Sleepiness is Equivalent to Alcohol Intoxication when it comes to Accidents




Williamson AM and Feyer AM. Moderate sleep deprivation produces impairments in cognition and motor performance equivalent to legally prescribed levels of alcohol intoxication. Occup Environ Med 2000;57:649-55



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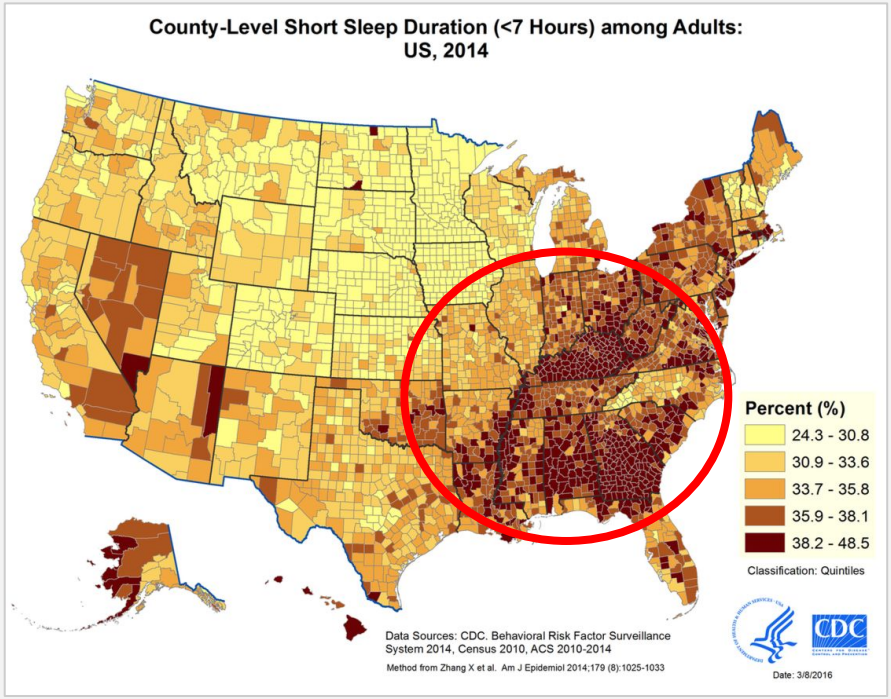
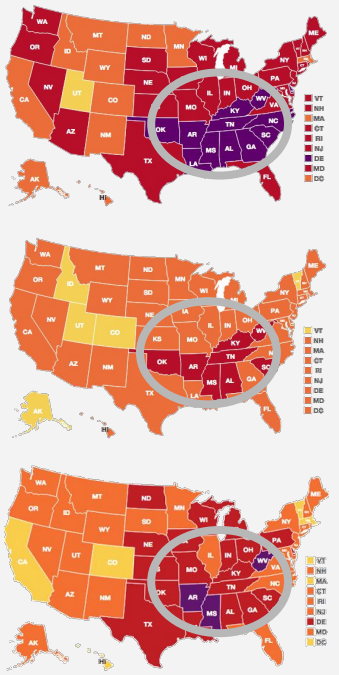
# Research on People with Chronic Diseases

## Data Demonstrates Poor Sleep May Drive Disease

Over ⅓ of US adults Do Not sleep 7 or more hours/night

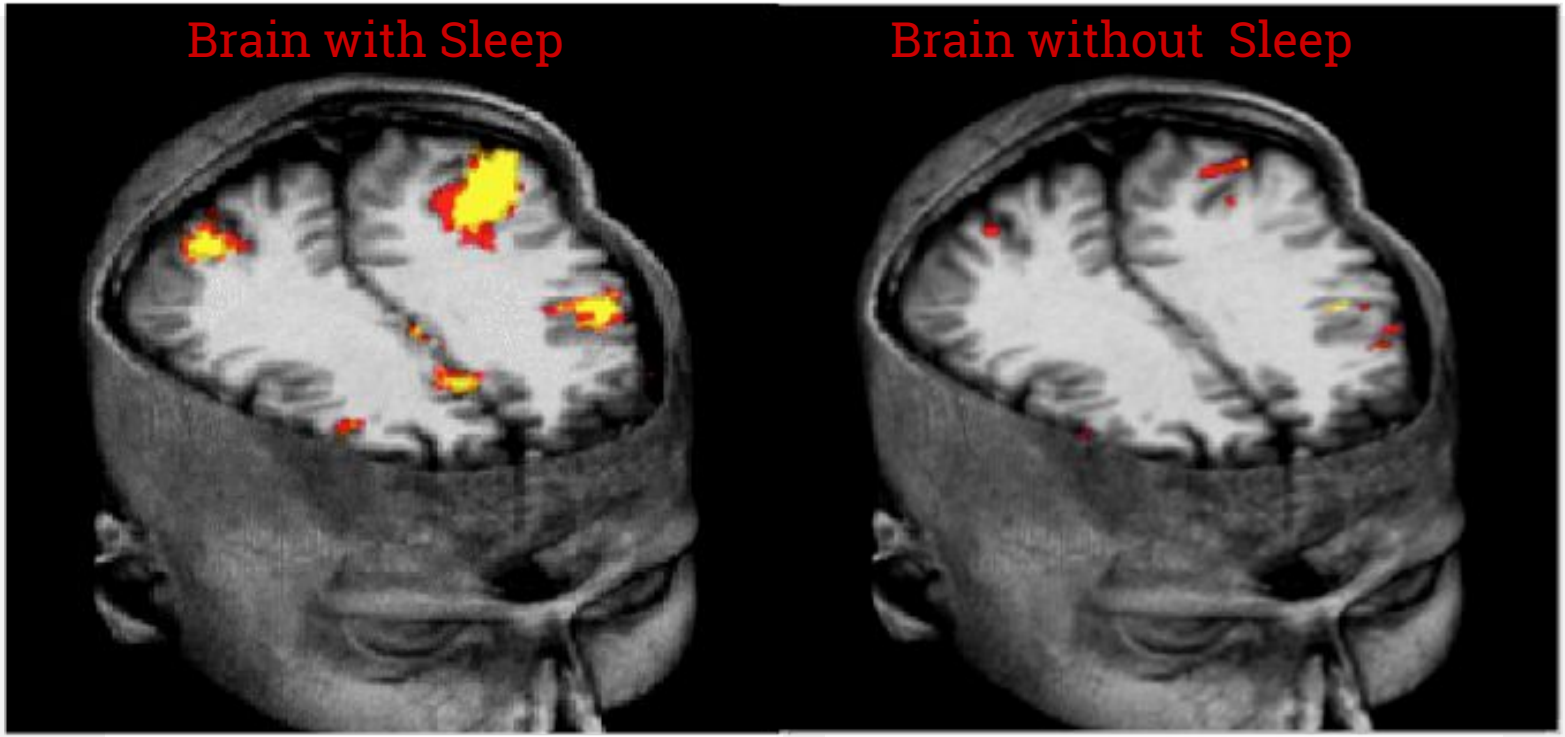
Adults in the Southeast and Appalachian Mountains had the lowest average sleep times



*Liu Y et al., Prevalence of healthy sleep duration among adults-US 2014, MMWR Morb Mortal Weekly Rept 2016;65:131-141.*

# Sleep Deprivation Affects All Cognitive Skills




Sleep - Normal Activity & Preserved Performance

Sleep Deprivation - Loss of Activity & Loss of Performance

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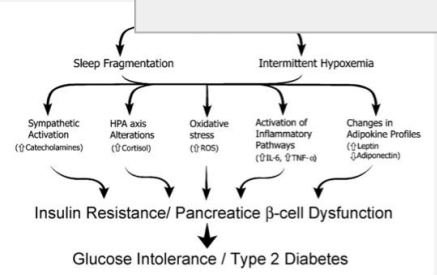
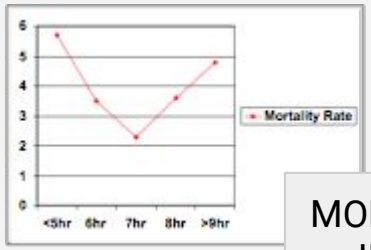
# Body System Functions Depend on Sleep

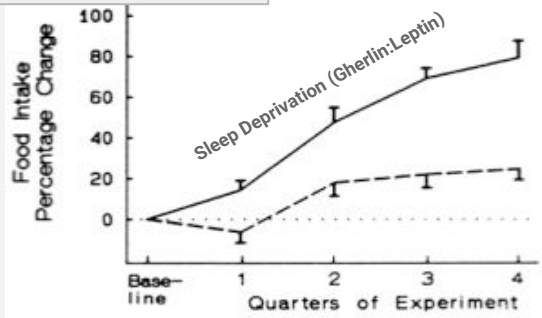
## CHRONIC DISEASES ACCELERATE

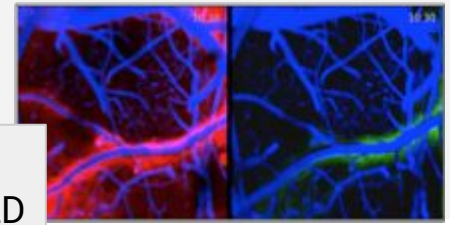



## MORTALITY RISK INCREASES 4 FOLD


## LOSE HORMONAL APPETITE REGULATION



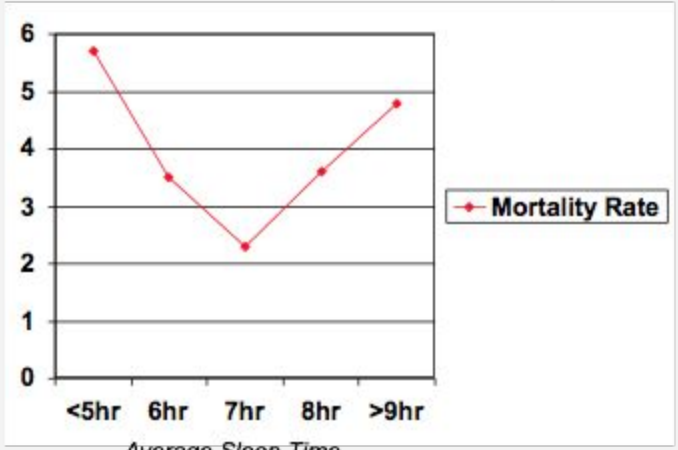



## TOXIC WASTE PRODUCTS BUILD IN BRAIN

*Adapted from: http://www.huffingtonpost.com/2014/01/08/sleep-deprivation_n_4557142.html*

# Sleep Duration is Correlated with Sickness Absence from Work

*10,308 British civil servants followed 17 years*




*3,760 working men and women 7.2 years*

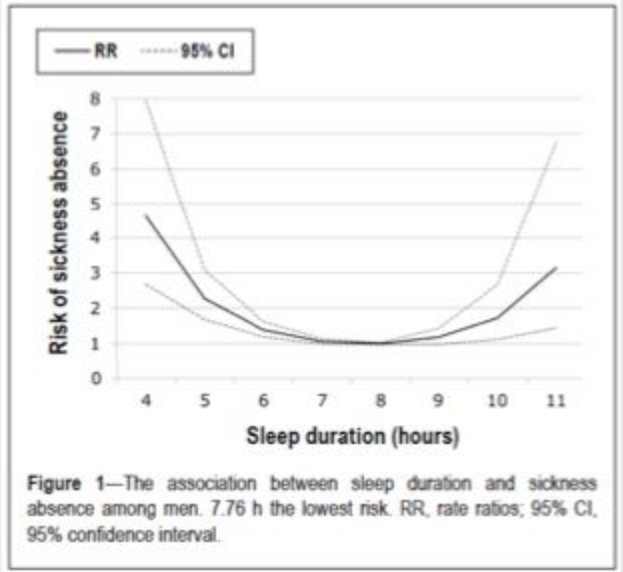


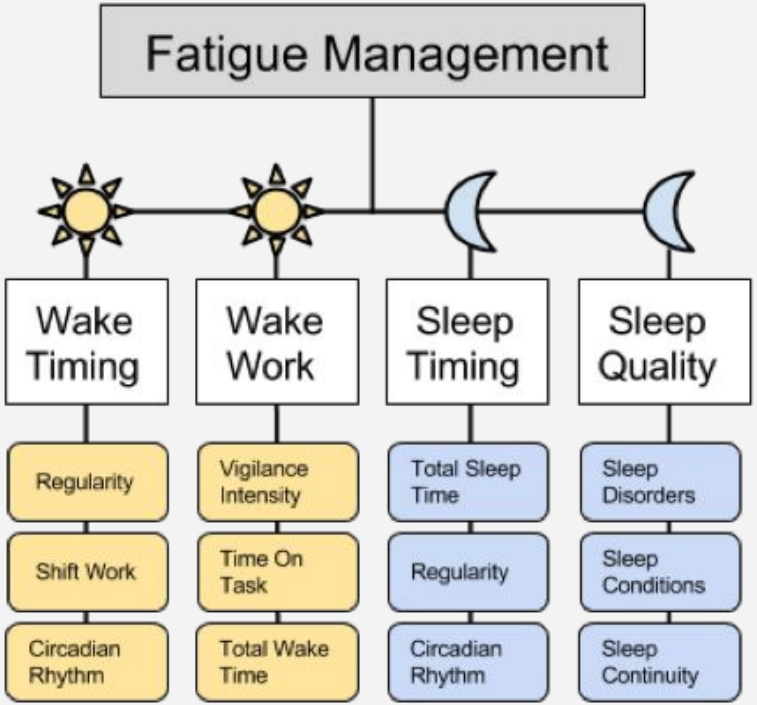

**Figure 1**—The association between sleep duration and sickness absence among men. 7.76 h the lowest risk. RR, rate ratios; 95% CI, 95% confidence interval.

(Ferrie et al., Sleep 2007)

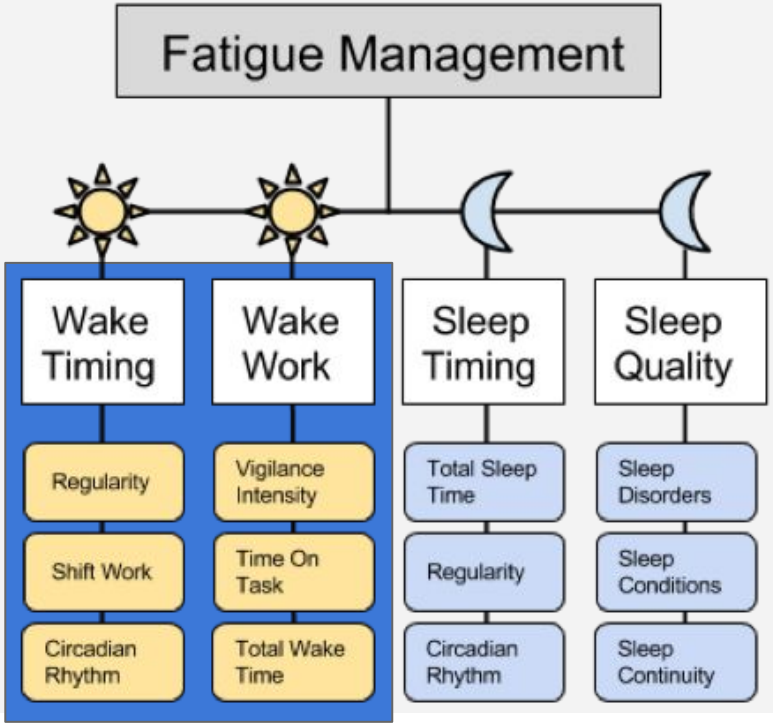
(Lallukka T et al., Sleep and sickness absence: a national representative register-based follow-up study SLEEP 2014;37(9):1413-25)

# A New Model of Fatigue Management

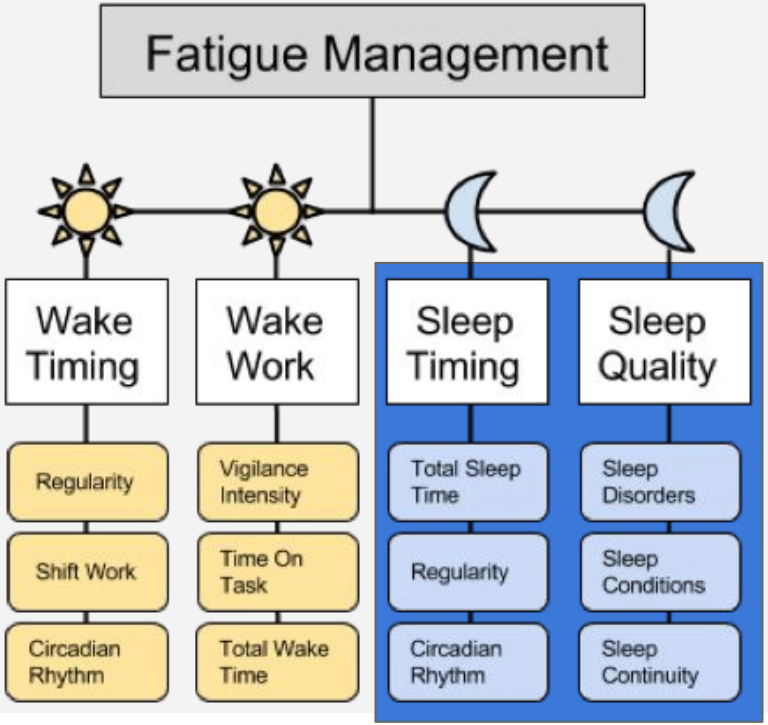
# Workplace Fatigue Management



# Many Safety Sensitive Workplaces Know…



# Most Workplaces Do Not Know...



# Engaging a Large Mobile Population

## AWARENESS

Wellness Programs

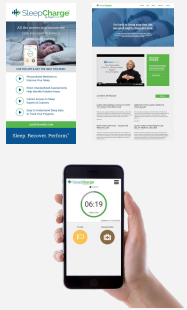
DM Programs

HR Programs

Safety & Risk

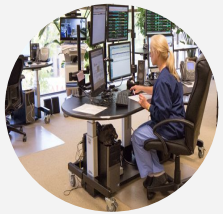
**Connect™**
Integration Points

## ENGAGEMENT



**SleepCharge™**
Member Experience

## GUIDANCE

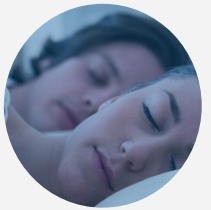


**Newton™**
Guidance Logic

## INTERVENTIONS

**Restful™**
Pathway Solutions

## MANAGEMENT



**Restful™**
Continuous Care

SUPPORT: Engagement Plan Design + Sleep Coaches + Sleep Therapists + Physicians

# Integrated Pathways Create Complete Solutions

GUIDANCE

**Resourceful™**
Tech & Materials

**Mindful™**
Thoughts
& Behaviors

**Powerful™**
Physical Performance

**Newton™**
Guidance Logic

INTERVENTIONS

**Breathing**

**Mind**

**Body**

**Rhythms**

Connected

**Restful™**
Pathway Solutions

MANAGEMENT

Tracking

**Sleep Coaching**

**Therapy Support**

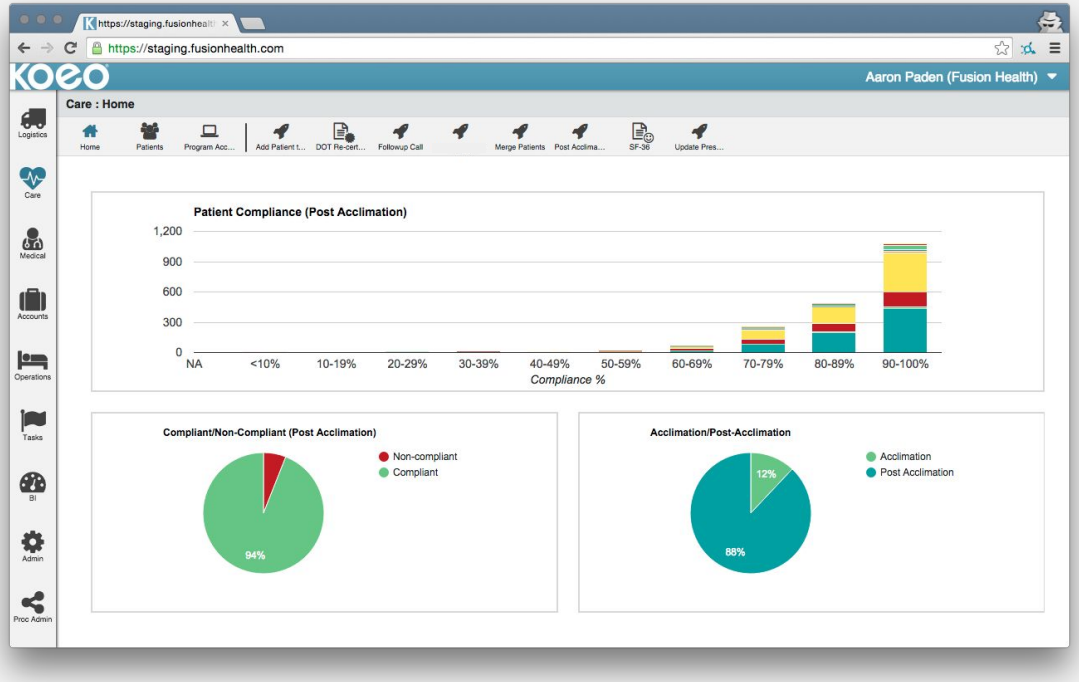
**Multi-Level Telemedicine**

Connected

**Restful™**
Continuous Care

# Fatigue Management: A New KPI for Business

# Obstructive Sleep Apnea Outcomes




## For All Participants (n=4,508)

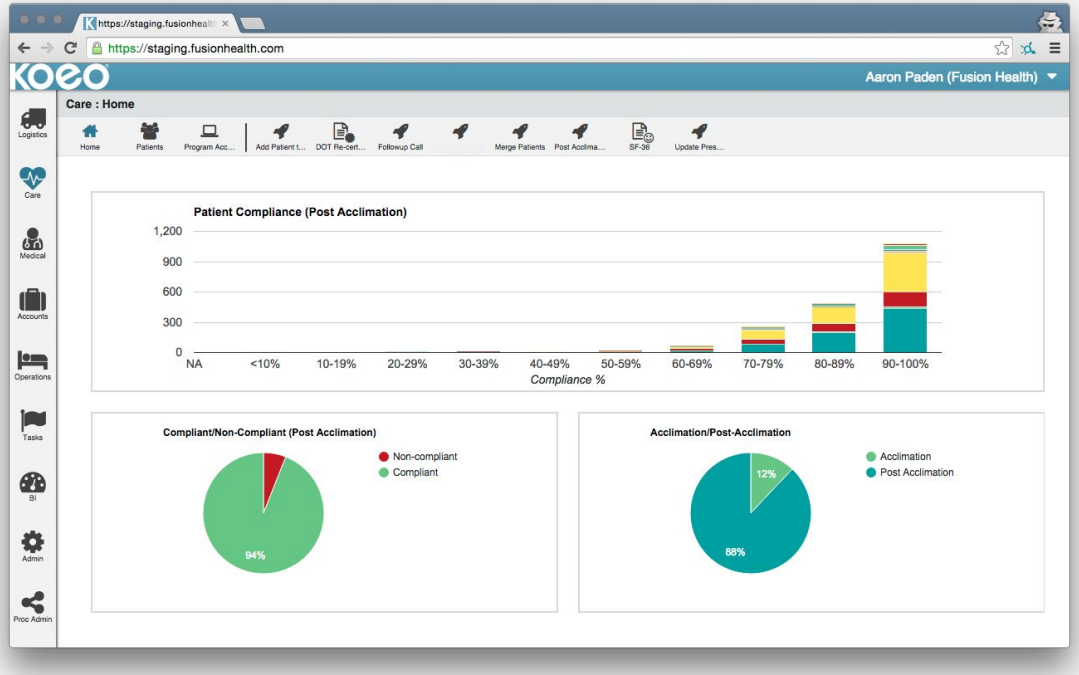
| | |
|---|---|
| Avg Age | 49.8 yr |
| Male / Female | 90% / 10% |
| Avg AHI reduced from | 34 to 1.5 |
| Avg. Daily Adherence | 96% |
| Days Use/Wk | 6.4 days |
| Hours Use/Day | 6.1 hours |
| Avg. Program Retention | 94% over 6 yr |

# Obstructive Sleep Apnea Outcomes

n = 2,844 Professional Drivers

| Avg Hrs Succ Use | n | Avg Hrs Use/Day | Avg Days/Week | Test AHI | AHI 30d | Effort 30d | Compliance 30d |
|---|---|---|---|---|---|---|---|
| **> 8** | 435 | 8.7 | 6.9 | 49.4 | 1.3 | 98 | 96.0 |
| **7.5-7.9** | 199 | 7.8 | 6.9 | 30.0 | 1.5 | 99 | 97.0 |
| **7.0-7.49** | 295 | 7.2 | 6.9 | 32.0 | 1.2 | 98 | 95.0 |
| **6.5-6.9** | 344 | 6.7 | 6.9 | 39.0 | 1.2 | 98 | 94.0 |
| **6.0-6.49** | 344 | 6.3 | 6.8 | 37.3 | 1.3 | 96 | 91.0 |
| **5.5-5.9** | 354 | 5.7 | 6.7 | 37.8 | 1.3 | 94 | 88.0 |
| **5.0-5.49** | 260 | 5.3 | 6.6 | 37.8 | 1.3 | 92 | 85.0 |
| **4.5-4.9** | 258 | 4.8 | 6.4 | 33.9 | 1.1 | 89 | 82.0 |
| **4.0-4.49** | 164 | 4.3 | 6.1 | 34.3 | 1.3 | 83 | 76.0 |
| **< 4.0** | 191 | 2.9 | 4.6 | 33.9 | 1.8 | 62 | 54.0 |
| > 4 hrs | 2653 | 6.3 hrs/day | 6.7 days/wk | | | 94% Effort | 90% Compliance |

# Obstructive Sleep Apnea Outcomes




## For Professional Drivers (n=2,653)

| | |
|---|---|
| Avg AHI reduced from | 37 to 1.4 |
| Use ≥ 6hr/night | 60% |
| Days Use/Wk | 6.7 days |
| Hours Use/Day | 6.3 hours |
| QoL changes at 90 days: | |
| Mental Health | +19% |
| Physical Health | +14% |
| Vitality | +25% |
| Health Change | +38% |

# Two Year Matched Cohort Study

| Measure | Subjects | Matched Cohort | 12 Mo (n=96/96) | 24 Mo (n=85/85) |
|---|---|---|---|---|
| Med/Pharm. Costs | 22.4% | 45.1% | -22.8% pts | -22.7% pts |
| ER Visits | 11.5% | -5.4% | •-88.9% pts | 16.9% pts |
| Hospital Admits | 49.3% | 84.4% | -60.0% pts | -35.1% pts |
| Hospital Days | 70.0% | 394.0% | -923.1% pts | -324.0% pts |
| Preventable Accidents | -44.9% | 30.3% | ❖-68.8% pts | ★-75.2% pts |
| Incidents | 8.2% | 19.6% | 10.6% pts | -11.3% pts |

•p = 0.06
❖p = 0.02
★p = 0.04

Subjects
100 employees and 100 matched cohort recruited from existing employer population based on need for OSA evaluation

Matched Cohort
From claims over same time period – matched for age, gender, BMI, medical conditions, job, and cost quartile. No OSA diagnosis noted in claims data.

# SleepCharge™ by FusionHealth Program Outcomes

## *Fortune 500 Company*

VITALITY, SOCIAL FUNCTIONING, HEALTH, PRODUCTIVITY AND RETENTION

Employees are

**50%** **healthier**

**25%** **more productive**

SLEEPINESS, ACCIDENT INCIDENTS AND HEALTHCARE COSTS

**Reduced accident rates by**

**55%** in 1 Year

**SAVED**

**56%** in healthcare claims costs

Durmer, JS et al., Effect of mobile testing, treatment and care management for OSA on adherence and clinical outcomes in professional drivers, APSS, 2014; Durmer, JS et al., Economic benefits of care management for OSA in a prospective cohort of professional truck drivers, APSS, 2014



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# SleepCharge™ by FusionHealth Program Outcomes

## *Fortune "200" Company*

EFFECTIVE DELIVERY OF CARE
SIGNIFICANT PHYSICAL & MENTAL BENEFITS

Health Care delivery **improved by**

160%

Employees show

34%

**more Vitality**

MANUFACTURING ERROR RATES
HEALTH CARE SPEND WASTE

In 3 months,

40% +

**less Errors in Production**

**SAVED**

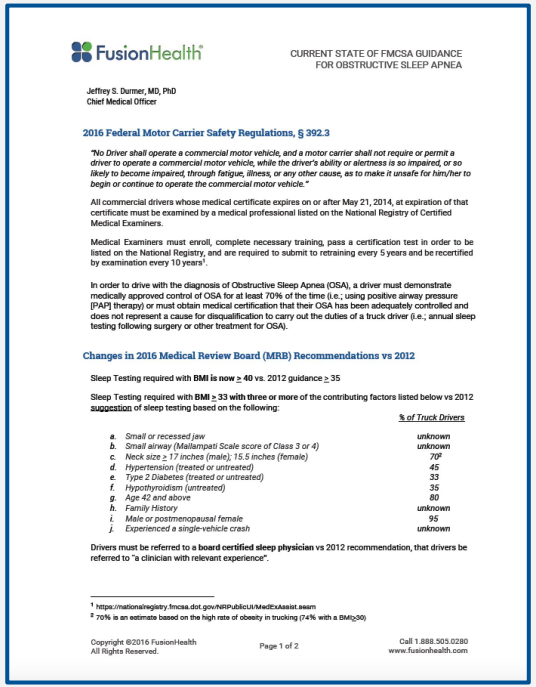
$250k

in Health Care System Expense Waste

Source: Confidential FusionHealth Client (unpublished data, 2015). Healthy Sleep and Fatigue Management Six Sigma Project

# APPENDIX

# 2016 FMCSA MRB OSA Recommendations



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CURRENT STATE OF FMCSA GUIDANCE FOR OBSTRUCTIVE SLEEP APNEA

Jeffrey S. Durmer, MD, PhD
Chief Medical Officer

**2016 Federal Motor Carrier Safety Regulations, § 392.3**

*"No Driver shall operate a commercial motor vehicle, and a motor carrier shall not require or permit a driver to operate a commercial motor vehicle, while the driver's ability or alertness is so impaired, or so likely to become impaired, through fatigue, illness, or any other cause, as to make it unsafe for him/her to begin or continue to operate the commercial motor vehicle."*

All commercial drivers whose medical certificate expires on or after May 21, 2014, at expiration of that certificate must be examined by a medical professional listed on the National Registry of Certified Medical Examiners.

Medical Examiners must enroll, complete necessary training, pass a certification test in order to be listed on the National Registry, and are required to submit to retraining every 5 years and be recertified by examination every 10 years[1].

In order to drive with the diagnosis of Obstructive Sleep Apnea (OSA), a driver must demonstrate medically approved control of OSA for at least 70% of the time (i.e.; using positive airway pressure [PAP] therapy) or must obtain medical certification that their OSA has been adequately controlled and does not represent a cause for disqualification to carry out the duties of a truck driver (i.e.; annual sleep testing following surgery or other treatment for OSA).

**Changes in 2016 Medical Review Board (MRB) Recommendations vs 2012**

Sleep Testing required with **BMI is now ≥ 40** vs. 2012 guidance ≥ 35

Sleep Testing required with **BMI ≥ 33 with three or more** of the contributing factors listed below vs 2012 suggestion of sleep testing based on the following:

| | | *% of Truck Drivers* |
|---|---|---|
| *a.* | *Small or recessed jaw* | ***unknown*** |
| *b.* | *Small airway (Mallampati Scale score of Class 3 or 4)* | ***unknown*** |
| *c.* | *Neck size ≥ 17 inches (male); 15.5 inches (female)* | ***70[2]*** |
| *d.* | *Hypertension (treated or untreated)* | ***45*** |
| *e.* | *Type 2 Diabetes (treated or untreated)* | ***33*** |
| *f.* | *Hypothyroidism (untreated)* | ***35*** |
| *g.* | *Age 42 and above* | ***80*** |
| *h.* | *Family History* | ***unknown*** |
| *i.* | *Male or postmenopausal female* | ***95*** |
| *j.* | *Experienced a single-vehicle crash* | ***unknown*** |

Drivers must be referred to a **board certified sleep physician** vs 2012 recommendation, that drivers be referred to "a clinician with relevant experience".

[1] https://nationalregistry.fmcsa.dot.gov/NRPublicUi/MedExAssist.aspx
[2] 70% is an estimate based on the high rate of obesity in trucking (74% with a BMI≥30)





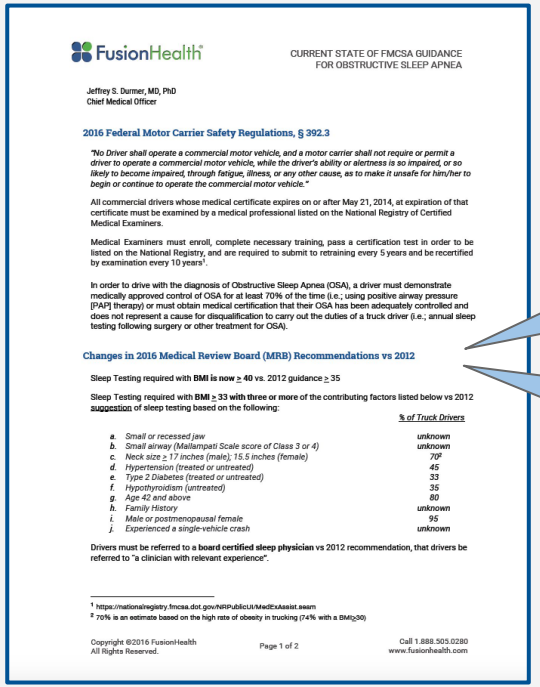
Call 1.888.505.0280
www.fusionhealth.com

## Testing Criteria

Individuals with a **BMI of 40** or greater, and
Individuals with a **BMI 33 to 40** with at least three or more:

- Hypertension (treated or untreated)
- Type 2 Diabetes (treated or untreated)
- History of stroke, coronary artery disease, or arrhythmias
- Micrognathia or retrognathia (receding chin)
- Loud Snoring or Witnessed apneas
- Small airway (Mallampati Classification of Class 3 or 4)
- **Neck Size of > 17 inches** (male), 15.5 inches (female)
- Hypothyroidism (untreated)
- **Age 42** and above
- **Male** or postmenopausal female

# 2016 FMCSA MRB OSA Recommendations



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www.fusionhealth.com

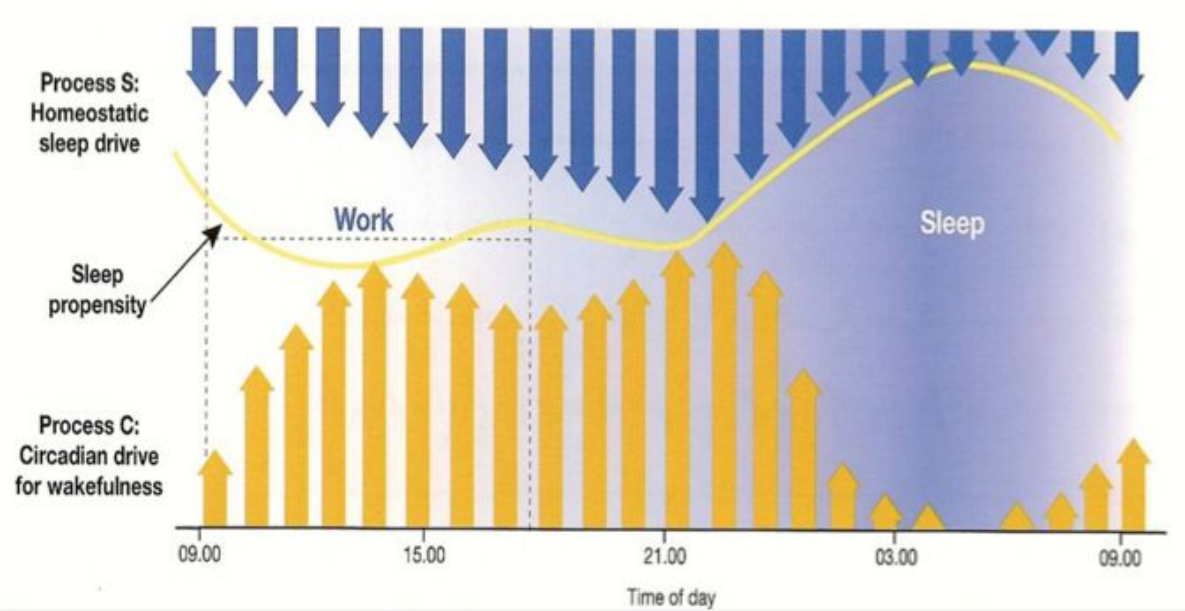
Given the Known Prevalence of Drivers with a **BMI ≥ 33** who are also:
**Male**
**Over 42**
**>17" Neck**

It is Expected that **56-64%** of All Current Truck Drivers **May Require Sleep Testing**
&
As Many as **54% May Require Treatment**

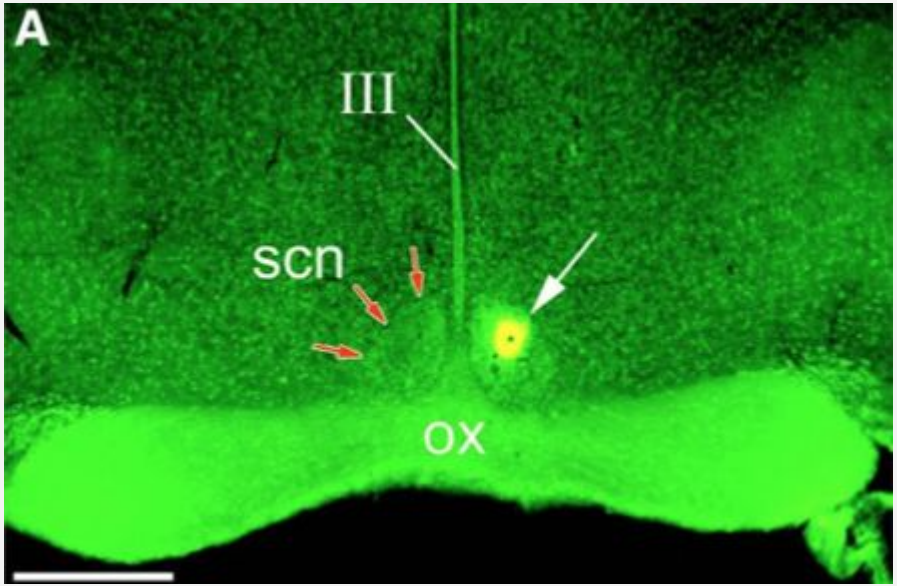
# Life on Earth Follows a Universal Rhythm

Circadian means “around the day”. All life on Earth has adapted to the regular 24 hour circadian pattern of our environment.

# Light Activates Our Circadian Rhythm

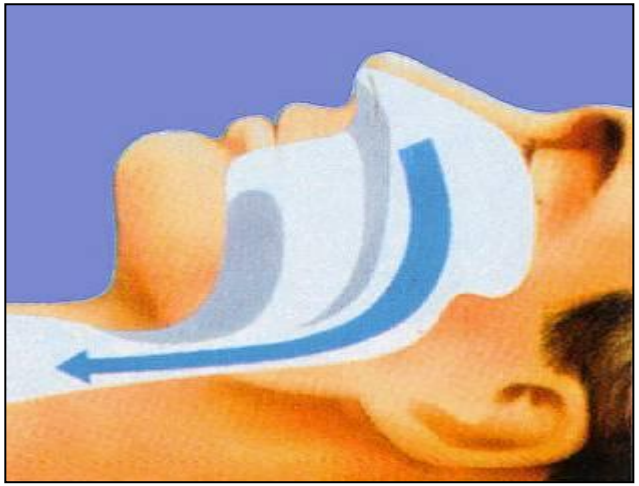


# Our Brain Has Adapted to Create Sleep and Wake

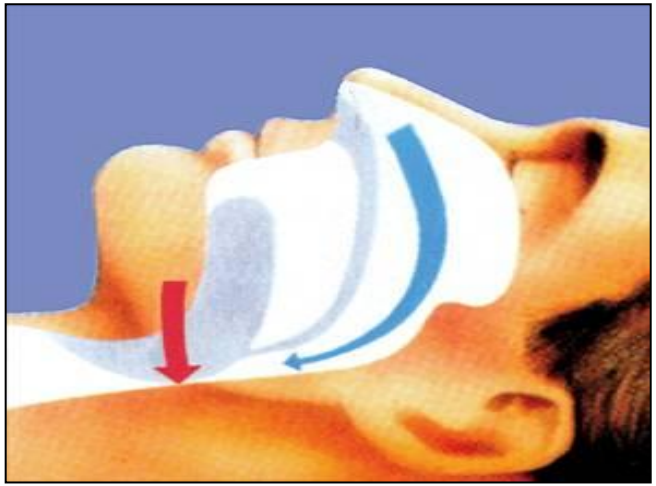



In the human brain, 10,000 neurons fire together every 23.8 to 24.6 hours and drive us into wake and stop sleep. This intrinsic pattern is our Circadian Rhythm.

# Obstructive Sleep Apnea (OSA)



OPEN

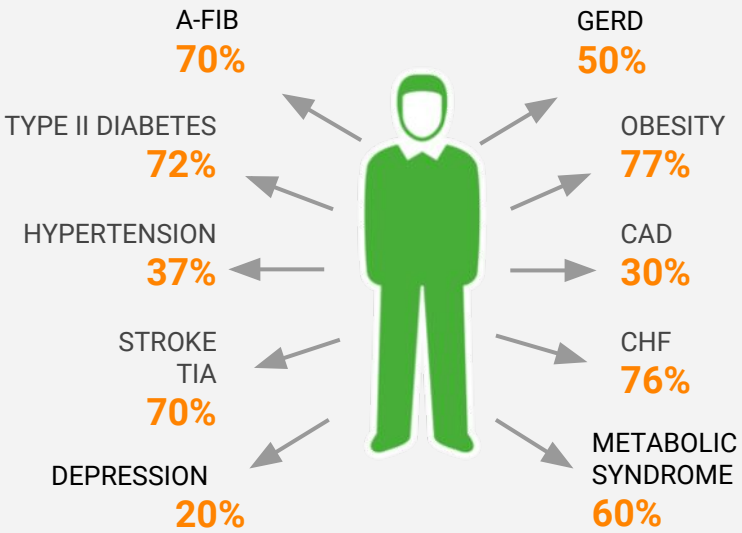


OBSTRUCTED

Apneas + Hypopneas / Hours of Sleep = **Apnea Hypopnea Index** (AHI)
(Normal ≤ 5/hr)  (Mild = 5.1-14.9/hr)  (Moderate 15-29.9/hr)  (Severe ≥ 30/hr)

# OSA is a SILENT KILLER

## OSA PREVALENCE IN CHRONIC DISEASES




## PREVALENCE OF CHRONIC DISEASES IN OSA POP

| Prevalence of Sleep Disorder Related Conditions | Sleep Apnea Multiplier |
|---|---|
| Obesity | 6.4x |
| **Hypertension (HTN)** | **3.2x** |
| **Coronary artery disease (CAD)** | **4.1x** |
| Peripheral vascular disease (PVD) | 3.0x |
| Cardiac dysrhythmias | 4.0x |
| Cerebrovascular disease, ischemic (eg., ischemic stroke) | 4.1x |
| Cerebrovascular disease, hemmorhagic (eg., hemmorhagic stroke) | 1.2x |
| Congestive Heart Failure (CHF) | 6.3x |
| **Diabetes mellitus (DM)** | **3.8x** |
| **Hyperlipidemia** | **2.8x** |
| Pulmonary heart disease | 6.0x |
| Gastroesophageal reflux disease | 3.7x |
| Iron deficiency anemia | 2.8x |
| Depression | 1.6x |
| Headache, migraine/vascular type | 2.0x |
| Headache, non-migraine type | 2.8x |

Einhorn et al. Endocrine Prac 2007; O'Keefe and Patterson Obes Surgery 2004; Tasali E et al., OSA and type 2 diabetes. Chest 2008;133:496-506; Sjostron et al.Thorax 2002, Bassetti et al. Sleep; 1999, Schafer et al. Cardiology 1999; Oldenburg et al. Eur J Heart Failure, 2007; Harvard Med School & McKinsey Co.The Price of Fatigue Report: the surprising economic costs of unmanaged sleep apnea, December, 2010; National Institute of Health, Centers for Disease Control and Prevention; Lee J. et al. Poor-quality sleep is associated with metabolic syndrome in Korean adults, Tohoku J Exp Med 2013;231:281-91; Tasali E et al., OSA and metabolic syndrome. Proc Am Thorac Soc 2008;5:207-17; Parish JM et al., Relationship of metabolic syndrome and OSA. J Clin Sleep Med 2007;3(5):467-72; Goyal SK and Sharma A, atrial fibrillation in OSA. World J of Cardiol 2013;5(6):157-63; Kanagala R et al., OSA and the recurrence of AFib. Circulation 2003;107:2589-94; Jung H et al., GERD and sleep disorders. J Neurogastroenterol Motil 2010;16(1):22-29; Basoglu OK et al., OSA and GERD-the importance of obesity and gender. Sleep Breath 2015;19(2):585-92; Sharafkhaneh A et al., Association of psychiatric disorders and OSA in large cohort. Sleep 2005;28(11):1405-11; Gupta MA et al., OSA and psychiatric disorders-a systematic review. JCSM 2015;11(2):165-75.

# Integrated Pathways Create the Solution

## GUIDANCE

**Resourceful™**
Tech & Materials

**Mindful™**
Thoughts
& Behaviors

**Powerful™**
Physical Performance

**Newton™**
Guidance Logic

## INTERVENTIONS

**Breathing**

**Mind**

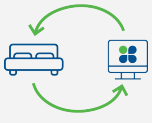
**Body**

**Rhythms**

Connected

**Restful™**
Pathway Solutions

## MANAGEMENT



Tracking

**Sleep Coaching**

**Therapy Support**

**Multi-Level Telemedicine**

Connected

**Restful™**
Continuous Care

# Diagnosing OSA

HOME

MOBILE

LABORATORY

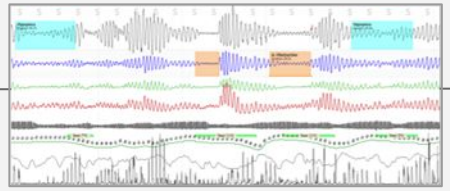
SUPPORT

TEST TYPE

INTERPRETATION

*RESULTS*

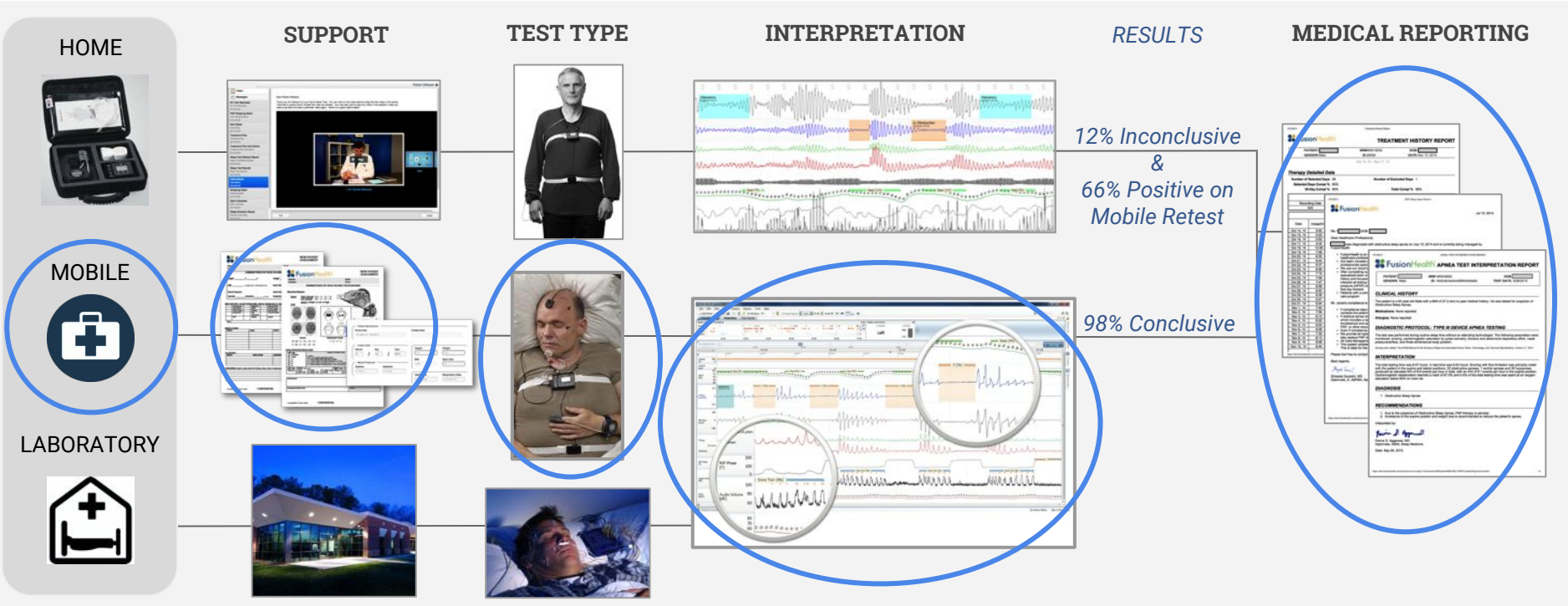
MEDICAL REPORTING



*12% Inconclusive & 66% Positive on Mobile Retest*

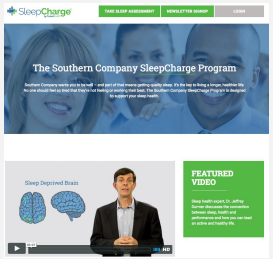
*98% Conclusive*

# Diagnosing OSA for Professional Drivers

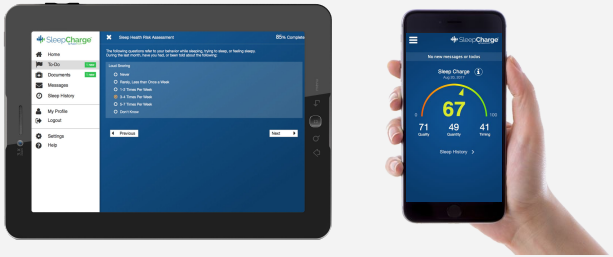


# User-Centered Engagement

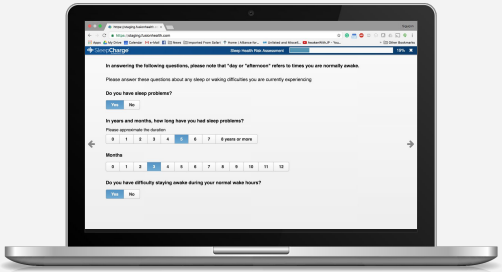
## SleepCharge Client Website




## SleepCharge Mobile Platform App



## SleepCharge Web App



**= SEAMLESS EXPERIENCE + CONTINUOUS SUPPORT**