ZENPREXI
BIO-RISK™

Actuarial Foundation

Biometric Risk Assessment for Workers' Compensation

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The Category Gap

Workers' compensation carriers face $136 billion in annual fatigue-related losses with no systematic tools to address them. While telematics transformed auto insurance through continuous driving data, no equivalent exists for worker fatigue risk. Bio-Risk™ creates this category—the first platform providing continuous biometric risk visibility and automated intervention for workers' compensation carriers.

The Unaddressed Problem

Current State	Impact	Source
No fatigue monitoring tools for carriers	Reactive underwriting only	Industry gap
$136.4B annual fatigue productivity losses	Unmitigated carrier exposure	OSHA, NSC
97% of workers have fatigue risk factors	Systemic, not isolated	NSC Fatigue Reports
13% of injuries directly from fatigue	Preventable claims	NSC
70%+ false positive rate (camera systems)	Unusable alternatives	Industry data

Published Research Foundation

The scientific basis for HRV-based fatigue detection is well-established in peer-reviewed literature. Machine learning models trained on heart rate variability data have demonstrated consistent accuracy in detecting cognitive impairment:

- Mental fatigue detection: 84.3% AUC using HRV-trained ML models — Source: Matuz et al., Scientific Reports (Nature), 2022
- Physical fatigue classification: 85.5% accuracy using LightGBM — Source: Chen et al., PMC, 2022
- Systematic review: HRV confirmed as reliable autonomic fatigue marker (19 studies) — Source: ScienceDirect, 2023
- Sensor validation: Polar optical sensors ICC=0.99 correlation with ECG — Source: Gilgen-Ammann et al., PLoS ONE, 2019

Bio-Risk™ implements these validated methodologies using clinical-grade wearable sensors, providing carriers with fatigue risk visibility that has never before been available at scale.

The CARI™ Scoring System

The Cognitive Adherence Risk Index (CARI™) transforms continuous HRV data into actionable risk scores. Rather than claiming unvalidated accuracy improvements, CARI implements the published 84-86% baseline methodology with a focus on minimizing false positives through dual-threshold validation. Our federated learning architecture enables continuous model improvement as the platform scales.

CARI Score	Risk Level	Platform Response
75-100	Normal	Continue monitoring
50-74	Elevated	Increased monitoring frequency
35-49	High Risk	Supervisor notification triggered
0-34	Critical	PANT™ intervention protocol

PANT™ Intervention System

The core value proposition is not prediction alone—it's systematic intervention. The Proactive Automated Notification and Termination (PANT™) system provides graduated responses that carriers can require as part of policy terms:

- **Tier 1: Automated rest break reminders to worker device**
- **Tier 2: Supervisor notification with recommended actions**
- **Tier 3: Equipment interlock prevents operation until recovery confirmed**

This intervention capability—not just monitoring—is what differentiates Bio-Risk™ from any alternative approach. Carriers gain the ability to mandate fatigue management protocols.

Validation Roadmap

Rather than claim unvalidated accuracy improvements, Bio-Risk™ follows a rigorous validation path:

- Phase 1 (Pilot): Shadow mode deployment, CARI scores logged without intervention
- Phase 2 (Correlation): Compare logged CARI scores to actual incidents over 6-12 months
- Phase 3 (Validation): Statistical analysis of predictive lift vs. baseline
- Phase 4 (Publication): Peer-reviewed study submission with carrier partner data

Intellectual Property

Provisional Patent US 63/919,896 filed November 2025, covering the integrated biometric risk assessment system, CARI algorithm architecture, privacy-preserving federated learning approach, and PANT intervention protocols. PCT international filing planned within 12-month priority window.

References

1. Matuz, A., et al. (2022). Generalisable machine learning models trained on heart rate variability data to predict mental fatigue. Scientific Reports (Nature). doi:10.1038/s41598-022-24415-y

2. Chen, S., et al. (2022). Heart Rate Variability-Based Subjective Physical Fatigue Assessment. PMC. doi:10.3390/s22093199

3. Gilgen-Ammann, R., et al. (2019). Validation of the Polar OH1 optical heart rate sensor. PLoS ONE. doi:10.1371/journal.pone.0217547

4. OSHA. Long Work Hours, Extended or Irregular Shifts, and Worker Fatigue. osha.gov/worker-fatigue

5. National Safety Council. Fatigue in the Workplace. nsc.org/workplace/safety-topics/fatigue

6. NCCI. State of the Line 2024. National Council on Compensation Insurance.