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Fatigue in Emergency Medical Services Systems

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16. Abstract

This project produced five evidence-based guidelines (EBGs) for fatigue risk management tailored to Emergency Medical Services (EMS) operations using the National Prehospital EBG Model Process and the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) methodology.

1. Use fatigue/sleepiness survey instruments to measure and monitor fatigue in EMS personnel.
2. EMS personnel work shifts shorter than 24 hours long.
3. EMS personnel have access to caffeine as a fatigue countermeasure.
4. EMS personnel have opportunities to nap while on duty to mitigate fatigue.
5. EMS personnel receive education and training to mitigate fatigue and fatigue-related risks.

17. Key Words	18. Distribution Statement
Emergency Medical Services Fatigue Risk Management GRADE methodology evidence-based guidelines	This document is available to the public through the National Technical Information Service, www.ntis.gov.

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

Fatigue refers to *a subjective, unpleasant symptom, which incorporates total body feelings ranging from tiredness to exhaustion creating an unrelenting overall condition which interferes with an individual's ability to function to their normal capacity* (Ream & Richardson, 1996). Work-related fatigue affects greater than half of Emergency Medical Services (EMS) personnel. Fatigue affects the safety of EMS operations. The odds of injury, medical error, patient adverse events, and safety compromising behavior are higher among fatigued EMS personnel than non-fatigued personnel (Patterson et al., 2012). Work-related fatigue is a threat to the safety of EMS clinicians, their patients, and the public at large; yet there are no guidelines for fatigue risk management in the EMS setting (Patterson et al., 2017).

On January 30, 2013, the National EMS Advisory Council issued an advisory that recommended the National Highway Traffic Safety Administration (NHTSA) and Federal partners examine fatigue in EMS and disseminate evidence for fatigue mitigation (NEMSAC, 2013). NHTSA awarded a contract in 2015 that sought to develop evidence-based guidelines (EBGs) for fatigue risk management tailored to EMS operations.

The project followed the procedures and protocol for development of EBGs as prescribed by the National Prehospital EBG Model Process (Model Process) and the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) methodology. A panel of experts was assembled, as prescribed by the Institute of Medicine, to review the evidence and formulate recommendations. The panel convened in April 2016 to formulate research questions and select outcomes that would guide a comprehensive review of published evidence (Patterson et al., 2017). The project team used systematic reviews and meta-analyses to synthesize the evidence linked to seven research questions. Evidence from more than 38,000 pieces of literature was screened and synthesized into tables and figures (Patterson, Weaver, Fabio, et al., 2018; Patterson, Runyon, Higgins, et al., 2018; Temple et al., 2018; Martin-Gill, Barger, et al., 2018; Barger et al, 2018; James et al., 2018; Studnek et al., 2018; Patterson, Higgins, Van Dongen, et al., 2018). The panel reconvened in February 2017 to review the summary evidence and formulate recommendations prepared as a guideline for mitigating fatigue in the EMS setting.

The panel reached consensus on five recommendations (Patterson, Higgins, Van Dongen, et al., 2018).

- **Recommend using reliable and/or valid fatigue/sleepiness surveys to measure and monitor fatigue in EMS personnel.**
- **Recommend that EMS personnel work shifts shorter than 24 hours long.**
- **Recommend that EMS personnel have access to caffeine as a fatigue countermeasure.**
- **Recommend that EMS personnel have opportunities to nap while on duty to mitigate fatigue.**
- **Recommend that EMS personnel receive education and training to mitigate**

The panel then reached consensus on a set of performance measures linked to each of the five recommendations (Martin-Gill, Higgins, et al., 2018). The performance measures are intended to complement the recommendations and provide EMS administrators assistance with evaluating the impact and progress following adoption of one or more of the recommendations.

DESCRIPTION OF COMMONLY USED TERMS/PHRASES

Fatigue

There is no gold standard measure or consensus-based definition of fatigue. For purposes of this EMS project, fatigue is described as: *a subjective, unpleasant symptom that incorporates total body feelings ranging from tiredness to exhaustion, creating an unrelenting overall condition that interferes with a person's ability to function to normal capacity* (Ream & Richardson, 1996).

Evidence-Based Guidelines

EBGs are *statements that include recommendations intended to optimize patient care that are informed by a systematic review of evidence and an assessment of the benefits and harms of alternative care options* (R. Graham, Mancher, M., Wolman, D. M., Greenfield, S., & E. Steinberg, Eds. 2011). The process of guideline development is complex and time-consuming. The National Guideline Clearinghouse (www.guidelines.gov) maintains a record of hundreds of EBGs. Professional organizations, societies, and governing bodies promote: guideline adoption to reduce variability, adoption of best practice, and improvement of outcomes.

Emergency Medical Services

EMS *is a system of coordinated response and emergency medical care, involving multiple people and agencies* (www.ems.gov). Personnel who work in EMS are certified or licensed to provide basic and/or advanced medical care in emergency situations. EMS personnel work in shifts, and in most communities, are available for response to emergencies 24 hours a day, 365 days per year.

METHODS

The project team followed the National Prehospital EBG Model Process as the framework for this project (Lang et al., 2012). The Model Process was developed in 2012 with support from NHTSA, and adopted as a structured approach for EBG development on topics germane to EMS care and delivery. The Model Process is comprised of four steps.

Step 1: External Inputs

The project team searched for and did not identify existing fatigue risk management guidelines for EMS personnel or related shift worker groups. The team identified numerous anecdotal reports of fatigue-related events such as ambulance crashes (Blau, 2015; "Medic falls asleep," 2013; Stevens, 2015) and received input from stakeholders and researchers that affirmed fatigue as a problem for the EMS industry as a whole.

Step 2: Guideline Initiation and Evidence Review

The project team formed a research team with expertise in sleep, fatigue, epidemiology, biostatistics, emergency medicine and prehospital care, library science, and development of EBGs using a structured process (Table 1).

Table 1: Project Team

Name	Institution
P. Daniel Patterson, Ph.D., NRP	University of Pittsburgh
Anthony Fabio, Ph.D.	
Patricia M. Weiss, MLIS	
Christian Martin-Gill, M.D., M.P.H.	
Charity G. Moore, Ph.D.	
Denisse J. Sequeira, B.S.	
Kate Flickinger, MS	
Joe Condle, MS	
Patrick Coppler, MSPAS, PA-C	
Ellen Teasley, LAT, ATC	
Megan Renn, B.S.	
Andrew Kroemer, B.S.	
Ayushi Divecha, MPT	
Maggie Matthews, B.S.	
Brett Curtis, B.S.	
Julia Han, B.S.	
Xiaoshuang Xun, B.S.	
Zhadyra Bizhanova, B.S.	
Kathy Robinson, RN, EMT-P	NASEMSO
Dia Gainor, M.P.H.	
J. Stephen Higgins, Ph.D.	NHTSA

Name	Institution
Eddy S. Lang, M.D.	University of Calgary
Matthew D. Weaver, Ph.D., EMT-P	Harvard University
Laura K. Barger, Ph.D.	
Jon Studnek, Ph.D., NRP	Mecklenburg County EMS Agency
Allison Infinger, MSPH	
Michael S. Runyon, M.D., M.P.H.	Carolinas HealthCare System
David Hostler, Ph.D., EMT-P	University of Buffalo, The State University of New York
Jennifer Templin, Ph.D.	
Francine O. James, Ph.D.	Institutes for Behavior Resources, Inc.
Lauren B. Waggoner, Ph.D.	

Next, the project team created an 11-person panel of experts, selected based on evidence of expertise in sleep medicine, fatigue or sleep health, public safety operations, risk management and administration, emergency medicine, and prehospital care. The panel was formed as prescribed by the Institute of Medicine (R. Graham, Mancher, M., Wolman, D. M., Greenfield, S., & E. Steinberg, Eds. 2011).

Table 2: Expert Panel

Name	Area of Expertise	Institution
Hans Van Dongen, Ph.D.	Sleep Medicine/Fatigue	Washington State University
John Violanti, Ph.D.	Fatigue in Public Safety Operations	University of Buffalo
Daniel Buysse, M.D.	Sleep Medicine/Sleep Health	University of Pittsburgh
Douglas Kupas, M.D.	Emergency Medicine	Geisinger Health System
Joe Penner, M.B.A.	EMS Leadership/Administration	Mecklenburg EMS Agency
Ron Thackery, J.D.	Risk Management in EMS	American Medical Response
Frank Guyette, M.D., M.P.H.	Air-Medical Systems	University of Pittsburgh
David Becker, M.A, EMT-P	Fire-Based EMS Operations	Columbia Southern University
Bradley Dean, MA., NRP	EMS Field Provider/Clinician	Rowan County EMS Agency
George Lindbeck, M.D.	State EMS Medical Direction	University of Virginia
Dennis Eisnach	Consumer Representative	Retired

Step 3: Evidence Appraisal

Step 3 focused on evaluating existing guidelines or evidence-based recommendations germane to the project's goals and determining if the existing EBGs or recommendations required updates. Findings from Step 1 revealed the absence of existing EBGs for fatigue risk management for EMS personnel and operations. Foundational work on EBG development in this area was required.

Step 4: Guideline Development

To develop EBGs for fatigue risk management, the team adopted the GRADE methodology. This methodology outlines a series of steps for purposes of reviewing the evidence, grading the quality of the evidence, and developing recommendations based on the evidence (Guyatt et al., 2008). The GRADE methodology is widely used by clinical investigators to develop EBGs germane to clinical care decisions. While GRADE has yet to be applied to operational questions related to fatigue risk management, experts in occupational medicine and epidemiology have supported GRADE as a tool for such purposes (Morgan et al., 2016). The GRADE methodology has been applied to numerous clinical questions specific to the delivery of EMS care and services (Shah et al., 2014; Gausche-Hill et al., 2014; Thomas et al., 2014). For these reasons, the team adhered to the steps outlined by the GRADE methodology as the basis for developing EBGs for fatigue risk management in the EMS setting.

The expert panel and project team were assembled in April 2016 to create the research questions that would guide the search of the evidence (the literature). Per guidance from GRADE, the team formulated research questions and selected outcomes of interest using an iterative process. Agreement was reached on seven research questions with overlapping outcomes (Table 3). The results of this process were published in the journal, *Prehospital Emergency Care* (Patterson et al., 2017).

Table 3: Research Questions

1	Are there reliable and valid instruments for measuring fatigue among EMS personnel?
2	Among EMS personnel, do shift-scheduling interventions mitigate fatigue, fatigue-related risks, and/or improve sleep?
3	Among EMS personnel, does the worker's use of fatigue countermeasures mitigate fatigue, fatigue-related risks, and/or improve sleep?
4	Among EMS personnel, does the use of sleep or rest strategies and/or interventions mitigate fatigue, fatigue-related risks, and/or improve sleep?
5	Among EMS personnel, does fatigue training and education mitigate fatigue, fatigue-related risks, and/or improve sleep?
6	Among EMS personnel, does implementation of model-based fatigue risk management mitigate fatigue, fatigue-related risks, and/or improve sleep?
7	Among EMS personnel, do task load interventions mitigate fatigue, fatigue-related risks, and/or improve sleep?

Next, the project team completed seven systematic reviews, and where feasible, pooled findings for meta-analyses. The inclusion/exclusion criteria for each systematic review appear in separate publications (Patterson, Higgins, Lang, et al., 2017; Patterson, Weaver, Fabio, et al., 2018; Patterson, Runyon, Higgins, et al., 2018; Temple et al., 2018; Martin-Gill, Barger, et al., 2018; Barger et al, 2018; James et al., 2018; Studnek et al., 2018). A research librarian searched five bibliographic databases and one website for potentially relevant literature. The literature was screened, and peer-reviewed journal articles that met inclusion criteria were retained for full-text

review. The findings from each of the seven systematic reviews appear in Table 4 in the Results section of this report.

Per guidance from GRADE, the panel of experts was assembled in April 2017 to review the evidence for each systematic review. The panel assessed the quality of evidence as determined by the project team's review of the literature and application of the GRADE methodology. The expert panel reflected on evidence quality, while simultaneously considering: (1) the balance of benefits and harms for a particular fatigue mitigation intervention; (2) the values and preferences of the target population; and (3) the costs associated with a particular intervention. The project team's GRADE methodologist, Dr. Eddy S. Lang, led the panel through a stepwise process of creating a recommendation.

Throughout all phases of the project, the project team and expert panel were focused on the population of interest, which was defined as: *EMS personnel or similar worker groups, defined as shift workers whose job activity requires multiple episodes of intense concentration and attention to detail per shift, with serious adverse consequences potentially resulting from a lapse in concentration* (Patterson et al., 2017).

The team collated the findings from each of the seven systematic reviews into manuscripts. Each manuscript was submitted in 2017 to the principal peer-reviewed journal for EMS, *Prehospital Emergency Care*. The full supplement was published online on January 11, 2018, and contained the 15 articles listed in the reference section at the end of this report.

RESULTS

The project team evaluated more than 38,000 records pulled from five bibliographic databases and one website (Table 4). The final number of records (studies) retained for inclusion and synthesis varied by systematic review (Table 4). (Patterson, Weaver, Fabio, et al., 2018; Patterson, Runyon, Higgins, et al., 2018; Temple et al., 2018; Martin-Gill, Barger, et al., 2018; Barger et al, 2018; James et al., 2018; Studnek et al., 2018; Patterson, Higgins, Van Dongen, et al., 2018).

Panel members reached consensus on five recommendations and agreed to not issue a recommendation for two of the systematic reviews given the sparse evidence and heterogeneity of retained literature. The recommendations and their assigned strength appear in Table 5 (Patterson, Higgins, Van Dongen, et al., 2018).

Panel members reached agreement on a set of goals and performance measures that local EMS agency administrators may utilize if they choose to adopt one or more recommendations (Martin-Gill, Higgins, et al., 2018). Goals and performance measures are shown in Table 6.

The manuscripts related to this project were published in a special supplemental issue of the journal, *Prehospital Emergency Care,* on January 11, 2018 (Patterson, Weaver, Fabio, et al., 2018; Patterson, Runyon, Higgins, et al., 2018; Temple et al., 2018; Martin-Gill, Barger, et al., 2018; Barger et al, 2018; James et al., 2018; Studnek et al., 2018; Patterson, Higgins, Van Dongen, et al., 2018; Hersman & Whitcomb, 2018; Buysse, 2018; Patterson & Martin-Gill, 2018; Van Dongen, 2018; Myers et al., 2018). This supplement, approved by the editor, included 15 papers that incorporated the seven systematic reviews, editorials/commentaries from experts in the field of sleep health and fatigue, a methodology paper, statements from stakeholders, a paper that summarizes the EBGs, and a paper that summarizes a set of performance measures that EMS agencies may use if they choose to adopt one or more of the recommendations. See Table 7 for a summary of the papers included and the total number of pages for the supplemental issue (printed pages and online supplemental material).

Table 4: Summary of findings for seven systematic reviews

(Table from Patterson, Higgins, Weiss, Lang, & Martin-Gill, 2018, IPEC-A-1380096-O)

PICO	PROSPERO# Dates searched	[P] Population [I] Intervention [C] Comparison [O] Outcome	Study designs included	Records screened	Kappa on initial screening	Percent agreement with P.I.	Total studies retained
1	CRD42016040097 1/1/1980-9/30/2017	[P] EMS personnel or similar shift worker groups [I] Use of fatigue and/or sleepiness survey instruments [C] Comparison to a gold standard or indirect measure of standard [O] Reliability, validity, sensitivity, and specificity	Observational and experimental	1,257	.63	90%	34
2	CRD42016040099 1/1/1980-9/30/2017	[P] EMS personnel or similar shift worker groups [I] Change in shift duration [C] Comparisons of outcomes by shift duration [O] Patient safety, personnel safety, personnel performance, acute fatigue, sleep and sleep quality, retention/turnover, long-term health, burnout/stress, cost to system	Observational and experimental	21,674	.49	100%	100
3	CRD42016040101 1/1/1980-9/30/2017	[P] EMS personnel or similar shift worker groups [I] Use of caffeine [C] Caffeine versus placebo or other study arms [O] Patient safety, personnel safety, personnel performance, acute fatigue, sleep and sleep quality, long-term health	Experimental	1,401	.55	100%	8
4	CRD42016040107	[P] EMS personnel or similar shift worker groups [I] Napping/sleeping during shift work [C] Napping/sleeping during shift work versus no nap	Experimental	4,660	.78	100%	13

PICO	PROSPERO# Dates searched	[P] Population [I] Intervention [C] Comparison [O] Outcome	Study designs included	Records screened	Kappa on initial screening	Percent agreement with P.I.	Total studies retained
	1/1/1980-9/30/2017	[O] Patient safety, personnel safety, personnel performance, acute fatigue, sleep and sleep quality, retention/turnover, long-term health, cost to system					
5	CRD42016040110 1/1/1980-9/30/2017	[P] EMS personnel or similar shift worker groups [I] Fatigue education/training [C] Impact of fatigue/sleep education/training on outcomes [O] Patient safety, personnel safety, personnel performance, acute fatigue, sleep and sleep quality, long-term health, burnout/stress	Observational and experimental	3,817	.88	100%	18
6	CRD42016040112 1/1/1980-9/30/2017	[P] EMS personnel or similar shift worker groups [I] Implementation of biomathematical fatigue modeling [C] Impact of biomathematical fatigue modeling on outcomes [O] Patient safety, personnel safety, personnel performance, acute fatigue, sleep and sleep quality, long-term health, cost to system	Experimental	2,777	.80	n/a*	1
7	CRD42016040114 1/1/1980-9/30/2017	[P] EMS personnel or similar shift worker groups [I] Modifying task load during shift work [C] Impact of task load interventions on outcomes [O] Patient safety, personnel safety, personnel performance, acute fatigue, cost to system	Observational and experimental	3,394	.66	92%	5

Table Notes: PICO=population, intervention, comparison, outcome. P.I.=Principal investigator. *=The percentage agreement between the principal investigator and screeners was not calculated for one systematic review (PROSPERO 2016:CRD42016040112), given that the assigned screeners are experts in the field of biomathematical fatigue modeling.

Table 5: Recommendations from the panel of experts

(Table from Patterson, Higgins, Van Dongen, et al., 2018, IPEC-A-1376137-O)

PICO	Recommendation statement with justification
1	We recommend using fatigue/sleepiness survey instruments to measure and monitor fatigue in EMS personnel. (Strong recommendation, very low certainty in evidence).
	Justification: The panel perceived little downside with measurement and monitoring of fatigue and/or sleepiness. Findings from the evidence review provide introductory support for use of 14 different survey instruments. The panel believed the benefits of measurement and monitoring with these instruments outweigh the costs.
	Why Strong Recommendation with Low Certainty in Evidence? In this context, the level of certainty in evidence is based upon research that specifically relates to EMS or other types of shift workers. There is evidence for this recommendation, but not directly from studies of EMS or shift workers.
2	We recommend that EMS personnel work shifts shorter than 24 hours long. (Weak recommendation in favor, very low certainty in effect). The panel does not have a recommendation regarding 8-hour versus 12-hour shifts or other shift comparisons that are less than 24 hours.
	Justification: The ratio of favorable versus unfavorable outcomes classified as critical or important was 16 to 1 in studies comparing shift durations <24 hours versus shifts >=24 hours.
3	We recommend that EMS personnel have access to caffeine as a fatigue countermeasure. (Weak recommendation in favor, low certainty in effect).
	Justification: The assessment of certainty in effect (also referred to as quality of evidence) ranged from moderate to very low.
4	We recommend that EMS personnel have the opportunity to nap while on duty to mitigate fatigue. (Weak recommendation in favor, very low certainty in effect).
	Justification: The assessment of certainty in effect (also referred to as quality of evidence) ranged from low to very low.
5	We recommend that EMS personnel receive education and training to mitigate fatigue and fatigue-related risks. (Weak recommendation in favor, low certainty in evidence).
	Justification: The panel concluded that there was significant potential benefit and few potential risks to sleep health and/or fatigue education and/or training. Findings from the review of evidence support the intervention and the benefits were perceived to outweigh the harm and/or costs.
6	No recommendation: The confidence in effect estimates is insufficient to make a recommendation at this time. (Reference to GRADE Handbook 6.1.4).
7	No recommendation: The confidence in effect estimates is insufficient to make a recommendation at this time. (Reference to GRADE Handbook 6.1.4).

Table 6: Proposed performance measures and goals
(Table from Martin-Gill, Higgins, Van Dongen, et al., 2018, IPEC-A-1381791)

Recommendation	Performance Measures
1 – We recommend using fatigue/sleepiness survey instruments to measure and monitor fatigue in EMS personnel (strong recommendation, very low certainty in evidence).	• Performance Measure: Demonstrated use of reliable/valid fatigue and/or sleepiness survey instruments to measure and monitor fatigue in EMS personnel on at least a quarterly basis. o Goal: Assess fatigue/sleepiness of EMS personnel with reliable/valid survey instruments quarterly (4 out of 4 quarters annually). o Numerator: Number of quarters in previous year when reliable/valid fatigue/sleepiness survey instruments was used to assess fatigue/sleepiness. o Denominator: Four quarters over same time period selected for numerator. • Notes: o Assessing fatigue/sleepiness for a random sample of scheduled shifts (rather than all shifts) may reduce respondent burden and improve the rate of participation by EMS personnel. o Targeted assessments are recommended. Specifically, the assessment of fatigue/sleepiness is recommended with reliable/valid survey instruments for any shift schedule (pattern/structure) suspected of elevating the risk of fatigue, such as extended duration shifts (e.g., ≥12 hours).
2 - We recommend that EMS personnel work shifts shorter than 24 hours (weak recommendation in favor, very low certainty in effect).	• **Performance Measure:** Percent of all shifts that are <24 hours. o Goal: 100 percent of shifts are <24 hours. o Numerator: Number of shifts that are <24 hours. o Denominator: Number of all shifts. • Notes: o Shifts performed contiguously should be counted as a single shift period with a total duration (e.g. two 12-hour shifts performed contiguously by a single provider should be counted as a 24-hour shift).
3 - We recommend that EMS workers have access to caffeine as a fatigue countermeasure (weak recommendation in favor, low certainty in effect).	• **Performance Measure:** Percent of all shifts where EMS personnel have access to caffeine. o Goal: 100 percent of shifts with access to caffeine. o Numerator: Number of shifts with access to caffeine. o Denominator: Number of all shifts. • Notes: o Example of access to caffeine includes availability of caffeinated beverages for free or for purchase while on duty within reasonable access to on-duty EMS personnel.
4 - We recommend that EMS personnel have the opportunity to nap while on duty to mitigate fatigue (weak recommendation in	• **Performance Measure:** Percent of all shifts where EMS personnel are provided with access to and permission to take a nap while on duty.

Recommendation	Performance Measures
favor, very low certainty in effect).	○ Goal: EMS personnel are provided with access to and permission to take a nap while on duty in 100 percent of extended shifts (e.g., >=12 hours) and shifts taking place overnight. ○ Numerator: Number of extended shifts (e.g., ≥12 hours) or shifts taking place overnight where EMS personnel are provided with access to and permission to take a nap while on duty. ○ Denominator: Number of all shifts ≥12 hours or taking place overnight. • Notes: ○ We define a nap as a short period of sleep (duration is not specified). ○ The EMS agency that permits EMS personnel the opportunity to nap on duty is best demonstrated with a written policy. ○ To ensure reasonable access to take a nap while on duty, there should be a scheduled time to take a nap or an unrestricted opportunity to take a nap throughout the shift, and an appropriate place to take an uninterrupted nap. ○ Agencies may wish to consider the napping strategy regardless of shift duration and include shifts <12 hours as part of the performance measure if personnel work contiguous shifts and/or consecutive shifts with limited recovery between shifts (including combinations of shifts involving different agencies).
5 - We recommend that EMS personnel receive education and training to mitigate fatigue and fatigue-related risks (weak recommendation in favor, low certainty in evidence).	• **Performance Measure:** Percent of EMS personnel who have: (1) received education and training to mitigate fatigue and fatigue-related risks during new employee orientation/training; and (2) received education and training to mitigate fatigue and fatigue-related risks in the previous two years. ○ Goals: (1) 100 percent of EMS personnel have received fatigue education and training as part of new employee orientation/training; and (2) 100 percent of EMS personnel have received fatigue education and training in the previous two years. ○ Numerator: Number of EMS personnel who have received fatigue education and training (1) during new employee orientation/training, or (2) in the previous two years. ○ Denominator: All EMS personnel • Notes: ○ Functional memory, knowledge, and skill can decay rapidly after initial education and training. Education and training every two years is recommended to address decay in memory, knowledge, and skills in dealing with fatigue in the workplace.

Table 7: Outline for Supplemental Issue "NHTSA Fatigue in EMS Project"
***Prehospital Emergency Care*, published online January 11, 2018**

TITLE/Authors	Pages (main article)	Supplemental Material and Pages
Title: *Fatigue Risk Management in High-Risk Environments: A Call to Action* Authors: Deborah A. P. Hersman, M.S., Emily A. Whitcomb, M.P.H. PEC ID: IPEC-A-1380097 Available at http://tandfonline.com/doi/full/10.1080/10903127.2017.1380097	2	0
Title: *Evidence-Based Guidelines for Fatigue Risk Management in Emergency Medical Services: A Step in the Right Direction Toward Better Sleep Health* Author: Daniel J. Buysse, M.D. PEC ID: IPEC-A-1380099 Available at http://tandfonline.com/doi/full/10.1080/10903127.2017.1380099	3	0
Title: *Absence and Need for Fatigue Risk Management in Emergency Medical Services* Authors: P. Daniel Patterson, Ph.D., NRP, Christian Martin-Gill, M.D., M.P.H. PEC ID: IPEC-A-1380101-O Available at http://tandfonline.com/doi/full/10.1080/10903127.2017.1380101	3	0
Title: *Systematic Review Methodology for the Fatigue in Emergency Medical Services Project* Authors: P. Daniel Patterson, Ph.D., NRP, J. Stephen Higgins, Ph.D., Patricia M. Weiss, MLIS, Eddy S. Lang, MDCM, CCFP (EM), Christian Martin-Gill, M.D., M.P.H. PEC ID: IPEC-A-1380096-O Available at http://tandfonline.com/doi/full/10.1080/10903127.2017.1380096	8	0
Title: *Reliability and Validity of Survey Instruments to Measure Work-Related Fatigue in the Emergency Medical Services Setting: A Systematic Review* Authors: P. Daniel Patterson, Ph.D., NRP, Matthew D. Weaver, Ph.D., EMT-P, Anthony Fabio, Ph.D., Ellen M. Teasley, LAT, ATC, Megan L. Renn, B.S., Brett R. Curtis, B.S., Margaret E. Matthews, B.S., Andrew J. Kroemer, B.S., Xiaoshuang Xun, B.S., Zhadyra Bizhanova, B.S., Patricia M. Weiss, MLIS, Denisse J. Sequeira, B.S., Patrick J. Coppler, MSPAS, PA-C, Eddy S. Lang, MDCM, CCFP, (EM), J. Stephen Higgins, Ph.D. PEC ID: IPEC-A-1376134-O Available at http://tandfonline.com/doi/full/10.1080/10903127.2017.1376134	11	Table 1: 9 Table 2: 7 Appendix A: 8 Appendix B: 38 Appendix C: 36 Appendix D: 12 Appendix E: 7 TOTAL = 118

TITLE/Authors	Pages (main article)	Supplemental Material and Pages
Title: *Shorter Versus Longer Shift Duration to Mitigate Fatigue and Fatigue Related Risks in Emergency Medical Services: A Systematic Review.* Authors: P. Daniel Patterson, Ph.D., NRP, Michael S. Runyon, M.D., M.P.H., J. Stephen Higgins, Ph.D., Matthew D. Weaver, Ph.D., EMT-P, Ellen M. Teasley, LAT, ATC, Andrew J. Kroemer, B.S., Margaret E. Matthews, B.S., Brett R. Curtis, B.S., Katharyn L. Flickinger, B.S., Xiaoshuang Xun, B.S., Zhadyra Bizhanova, Patricia M. Weiss, Joseph P. Condle, Megan L. Renn, Denisse Sequeira, Patrick J. Coppler, Eddy S. Lang, Christian Martin-Gill PEC ID: IPEC-A-1376135-O Available at http://tandfonline.com/doi/full/10.1080/10903127.2017.1376135	9	Table 1: 23 Table 2: 1 Table 3: 46 Appendix A: 10 Appendix B: 100 Appendix C: 122 Appendix D: 104 Appendix E: 40 TOTAL = 446
Title: *Systematic Review and Meta-Analysis of the Effects of Caffeine in Fatigued Shift Workers: Implications for Emergency Medical Services Personnel* Authors: Jennifer L. Temple, Ph.D., David Hostler, Ph.D., EMT-P Christian Martin-Gill, M.D., M.P.H., Charity G. Moore, Ph.D., Patricia M. Weiss, MLIS, Denisse J. Sequeira, B.S., Joseph P. Condle, M.S., Eddy S. Lang, MDCM, CCFP (EM), J. Stephen Higgins, Ph.D., P. Daniel Patterson, Ph.D., NRP PEC ID: IPEC-A-1382624 Available at http://tandfonline.com/doi/full/10.1080/10903127.2017.1382624	10	Table 2: 3 Appendix A: 13 Appendix B: 8 Appendix C: 10 Appendix D: 8 TOTAL = 42
Title: *Effects of Napping During Shift Work on Sleepiness and Performance in Emergency Medical Services Personnel and Similar Shift Workers: A Systematic Review and Meta-Analysis* Authors: Christian Martin-Gill, M.D., M.P.H., Laura K. Barger, Ph.D., Charity G. Moore, Ph.D., J. Stephen Higgins, Ph.D., Ellen M. Teasley, LAT, ATC, Patricia M. Weiss, MLIS, Joseph P. Condle, M.S., Kathryn L. Flickinger, M.S., Patrick J. Coppler, MSPAS, PA-C, Denisse J. Sequeira, B.S., Ayushi A. Divecha, MPT, Margaret E. Matthews, B.S., Eddy S. Lang, MDCM, CCFP (EM), P. Daniel Patterson, Ph.D., NRP PEC ID: IPEC-A-1376136-O Available at http://tandfonline.com/doi/full/10.1080/10903127.2017.1376136	10	Table 3: 3 Appendix A: 11 Appendix B: 13 Appendix C: 27 Appendix D: 13 TOTAL = 67

TITLE/Authors	Pages (main article)	Supplemental Material and Pages
Title: *Effect of Fatigue Training on Safety, Fatigue, and Sleep in Emergency Medical Services Personnel and Other Shift Workers: A Systematic Review and Meta-Analysis* Authors: Laura K. Barger, Ph.D., Michael S. Runyon, M.D., M.P.H., Megan L. Renn, B.S., Charity G. Moore, Ph.D., Patricia M. Weiss, MLIS, Joseph P. Condle, M.S., Katharyn L. Flickinger, M.S., Ayushi A. Divecha, MPT, Patrick J. Coppler, MSPAS, PA-C, Denisse J. Sequeira, B.S., Eddy S. Lang, MDCM, CCFP, (EM), J. Stephen Higgins, Ph.D., P. Daniel Patterson, Ph.D., NRP PEC ID: IPEC-A-1362087-O Available at http://tandfonline.com/doi/full/10.1080/10903127.2017.1362087	11	Table 3: 8 Appendix A: 12 Appendix B: 19 Appendix C: 13 Appendix D: 22 TOTAL = 74
Title: *Does Implementation of Biomathematical Models Mitigate Fatigue and Fatigue Related Risks in Emergency Medical Services Operations? A Systematic Review* Authors: Francine O. James, Ph.D., Lauren B. Waggoner, Ph.D., Patricia M. Weiss, MLIS, P. Daniel Patterson, Ph.D., J. Stephen Higgins, Ph.D., Eddy S. Lang, MDCM, CCFP, (EM), Hans P. Van Dongen, Ph.D. PEC ID: IPEC-A-1384875 Available at http://tandfonline.com/doi/full/10.1080/10903127.2017.1384875	12	Appendix A: 8 Appendix B: 1 Appendix C: 17 Appendix D: 1 TOTAL = 27
Title: *Effect of Task Load Interventions on Fatigue in Emergency Medical Services Personnel and Other Shift Workers: A Systematic Review* Authors: Jon R. Studnek, Ph.D., NRP, Allison Infinger, MSPH, Megan L. Renn, B.S., Patricia M. Weiss, MLIS, Joseph P. Condle, M.S., Katharyn L. Flickinger, M.S., Andrew J. Kroemer, B.S., Brett R. Curtis, B.S., Xiaoshuang Xun, B.S., Ayushi A. Divecha, MPT, Patrick J. Coppler, MSPAS, PA-C, Zhadyra Bizhanova, B.S., Denisse J. Sequeira, B.S., Eddy S. Lang, MDCM, CCFP (EM), J. Stephen Higgins, Ph.D., P. Daniel Patterson, Ph.D., NRP PEC ID: IPEC-A-1384874 Available at http://tandfonline.com/doi/full/10.1080/10903127.2017.1384874	8	Table 3: 17 Appendix A: 11 Appendix B: 5 Appendix C: 40 Appendix D: 5 TOTAL = 78

TITLE/Authors	Pages (main article)	Supplemental Material and Pages
Title: *Evidence-Based Guidelines for Fatigue Risk Management in Emergency Medical Services* Authors: P. Daniel Patterson, Ph.D., NRP, J. Stephen Higgins, Ph.D., Hans P. A. Van Dongen, Ph.D., Daniel J. Buysse, M.D., Ronald W. Thackery, JD, Douglas F. Kupas, M.D., David S. Becker, MA, EMT-P, Bradley E. Dean, MA, NRP, George H. Lindbeck, M.D., Francis X. Guyette, M.D., M.P.H., Josef H. Penner, MBA, John M. Violanti, Ph.D., Eddy S. Lang, MDCM, CCFP (EM), Christian Martin-Gill, M.D., M.P.H. PEC ID: IPEC-A-1376137-O Available at http://tandfonline.com/doi/full/10.1080/10903127.2017.1376137	13	Appendix A: 15 Appendix B: 9 Appendix C: 8 Appendix D: 7 Appendix E: 7 Appendix F: 8 Appendix G: 8 Appendix H: 7 TOTAL = 69
Title: *Proposed Performance Measures and Strategies for Implementation of the Fatigue Risk Management Guidelines for Emergency Medical Services* Authors: Christian Martin-Gill, M.D., M.P.H., J. Stephen Higgins, Ph.D., Hans P. A. Van Dongen, Ph.D., Daniel J. Buysse, M.D., Ronald W. Thackery, JD, Douglas F. Kupas, M.D., David S. Becker, MA, EMT-P, Bradley E. Dean, MA, NRP, George H. Lindbeck, M.D., Francis X. Guyette, M.D., M.P.H., Josef H. Penner, MBA, John M. Violanti, Ph.D., Eddy S. Lang, MDCM, CCFP (EM), P. Daniel Patterson, Ph.D., NRP PEC ID: IPEC-A-1381791 Available at http://tandfonline.com/doi/full/10.1080/10903127.2017.1381791	8	0
Title: *Evidence-Based Guidelines for Fatigue Risk Management in Emergency Medical Services: A Significant Step Forward and a Model for Other High-Risk Industries* Author: Hans P. A. Van Dongen, Ph.D. PEC ID: IPEC-A-1380098 Available at http://tandfonline.com/doi/full/10.1080/10903127.2017.1380098	3	0

TITLE/Authors	Pages (main article)	Supplemental Material and Pages
Title: *What an Evidence-Based Guideline for Fatigue Risk Management Means for Us: Statements From Stakeholders* Authors: J. Brent Myers, M.D., M.P.H., FACEP, R. Keith Wages, B.S., Dennis Rowe, EMT-P, Chris Nollete, EdD, NRP, LP, Michael Touchstone, B.S., EMT-P, FACPE, John Sinclair, NREMT-P (Ret), Edward L. Mund, Justin M. Eberly, B.S., EMT, John D. Montes, B.S., NREMT, Richard J. Sherlock, Laura K. Barger, Ph.D., Sean P. A. Drummond, Ph.D., Indira Gurubhagavatula, M.D., M.P.H. PEC ID: IPEC-A-1380100 Available at http://tandfonline.com/doi/full/10.1080/10903127.2017.1380100	6	0
	Total Printed Pages 117	Total Online Supplemental Material 921

CONCLUSIONS

Fatigue is a threat to safety for EMS personnel, their patients, and the public. There is no equivalent effort from any other high-risk industry/occupation to improve worker fatigue. This project created guidelines for fatigue mitigation based on the best available evidence. The project findings have the potential to bring about positive change for the EMS community. This body of work may also inform other high-risk industries that deploy workers in shifts and struggle to address fatigue with strategies based on evidence.

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