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Impact of Shift Work and Occupational Fatigue on Clinical Performance and Patient Safety Among Paramedics a Systematic Review

تأثير العمل بنظام الورديات والإرهاق المهني على الأداء السريري وسلامة المرضى بين المسعفين: مراجعة منهجية

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Abstract:

Background: Paramedics work in a continuous emergency care environment that combines rapid clinical decision-making, physical demands, ambulance driving, communication, and exposure to unpredictable events. Night work, rotating schedules, extended shifts, and limited recovery between duties can disturb sleep and contribute to occupational fatigue. These effects are relevant because reduced alertness, concentration, and judgment may influence both clinical performance and safety.
Objective: To systematically synthesize evidence published from 2012 to 2024 on the relationship between shift work, occupational fatigue, clinical performance, and patient or occupational safety among paramedics and operational emergency medical services (EMS) personnel.
Methods: A systematic search was conducted for studies published between January 2012 and December 2024. PubMed, including MEDLINE-indexed records, and PubMed Central (PMC) were the primary bibliographic sources, supplemented by targeted searches of publisher websites, journal archives, and backward reference-list screening. Eligible studies involved paramedics, emergency medical technicians, or operational EMS clinicians and examined shift schedules, sleep, fatigue, recovery, clinical performance, errors, adverse events, occupational injuries, safety-compromising behaviors, or fatigue-management interventions. Fourteen primary studies met the eligibility criteria. Methodological quality was appraised using design-specific Joanna Briggs Institute (JBI) critical appraisal guidance, and findings were synthesized narratively because of substantial methodological and clinical heterogeneity.
Results: The 14 included studies showed that fatigue and disturbed sleep are common in EMS, particularly with rotating work, overnight duty, extended shifts, and insufficient recovery. Fatigued clinicians were more likely to report occupational injuries, medical errors or adverse events, and safety-compromising behaviors. Large observational evidence linked very long shifts with greater injury risk, while simulation research demonstrated reduced clinical decision accuracy across a night shift. However, not all 24-hour schedules produced measurable cognitive decline; findings indicated that workload and the opportunity to sleep during duty modify the effect of shift duration. Recovery between shifts and sleep regularity were also important determinants of fatigue. A cluster-randomized fatigue-education trial showed limited overall effects, suggesting that education alone is unlikely to address the problem.
Conclusion: Shift work contributes to occupational fatigue among paramedics, and fatigue is associated with clinically important safety outcomes. Risk is not determined by shift length alone. Workload, circadian timing, sleep opportunity, recovery between duties, and organizational scheduling practices interact to shape fatigue. EMS organizations should therefore manage fatigue as an operational and patient-safety risk through scheduling, adequate recovery time, opportunities for rest, monitoring of excessive workload, and supportive fatigue-management practices.

Keywords: paramedics; emergency medical services; shift work; occupational fatigue; sleep; clinical performance; patient safety; medical errors; night shift

الملخص:

الخلفية :يعمل المسعفون في بيئة مستمرة من الرعاية الطارئة، تجمع بين اتخاذ القرارات السريرية السريعة، والمتطلبات البدنية، وقيادة سيارات الإسعاف، والتواصل، والتعرض للأحداث غير المتوقعة. وقد يؤدي العمل الليلي، ونظام المناوبات المتناوبة، وساعات العمل الممتدة، وقلة فترات التعافي بين المناوبات إلى اضطراب النوم والإسهام في حدوث الإرهاق المهني. وتكتسب هذه التأثيرات أهمية خاصة، لأن انخفاض اليقظة والتركيز والقدرة على إصدار الأحكام قد يؤثر في كل من الأداء السريري والسلامة.

الهدف :التوليف المنهجي للأدلة المنشورة خلال الفترة من 2012 إلى 2024 بشأن العلاقة بين العمل بنظام المناوبات، والإرهاق المهني، والأداء السريري، وسلامة المرضى والسلامة المهنية لدى المسعفين والعاملين الميدانيين في خدمات الطوارئ الطبية.

المنهجية :أُجري بحث منهجي عن الدراسات المنشورة خلال الفترة من يناير 2012 إلى ديسمبر 2024. واستُخدمت قاعدة بيانات PubMed، بما في ذلك السجلات المفهرسة ضمنMEDLINE ، ومستودع(PubMed Central (PMC ، بوصفهما المصدرين البيليوغرافيين الأساسيين، مع استكمال البحث بعمليات استقصاء موجهة في مواقع الناشرين، وأرشيفات المجلات العلمية، وفحص قوائم المراجع في الدراسات ذات الصلة. وشملت الدراسات المؤهلة المسعفين، وفنيي الطوارئ الطبية، والممارسين السريريين العاملين ميدانياً في خدمات الطوارئ الطبية، وتناولت جداول المناوبات، والنوم، والإرهاق، والتعافي، والأداء السريري، والأخطاء، والأحداث الضارة، والإصابات المهنية، والسلوكيات التي تهدد السلامة، أو التدخلات الرامية إلى إدارة الإرهاق. واستوفت أربع عشرة دراسة أصلية معايير الإدراج. كما جرى تقييم الجودة المنهجية باستخدام إرشادات التقييم النقدي الصادرة عن معهد جوانا بريغز(JBI) ، بما يتناسب مع تصميم كل دراسة، وتم توليف النتائج سردياً نظراً لوجود تباين منهجي وسريري كبير بين الدراسات.

النتائج :أظهرت الدراسات الأربع عشرة المشمولة أن الإرهاق واضطرابات النوم شائعان بين العاملين في خدمات الطوارئ الطبية، ولا سيما مع المناوبات المتناوبة، والعمل الليلي، وساعات العمل الممتدة، وعدم كفاية فترات التعافي. وكان الممارسون الذين يعانون من الإرهاق أكثر عرضة للإبلاغ عن الإصابات المهنية، والأخطاء الطبية أو الأحداث الضارة، والسلوكيات التي تهدد السلامة. كما ربطت أدلة رصدية واسعة النطاق بين المناوبات الطويلة جداً وارتفاع مخاطر الإصابات، في حين أظهرت أبحاث المحاكاة انخفاضاً في دقة القرارات السريرية على مدار المناوبة الليلية. ومع ذلك، لم تؤدِ جميع جداول العمل الممتدة إلى تراجع معرفي قابل للقياس؛ إذ أشارت النتائج إلى أن حجم عبء العمل وإمكانية الحصول على قسط من النوم أثناء المناوبة يؤثران في طبيعة العلاقة بين مدة المناوبة والإرهاق. كذلك، تبيّن أن فترات التعافي بين المناوبات وانتظام مواعيد النوم يمثلان عاملين مهمين في تحديد مستويات الإرهاق. وأظهرت تجربة عشوائية عنقودية لتقييم التثقيف بشأن إدارة الإرهاق آثاراً إجمالية محدودة، مما يشير إلى أن التثقيف وحده لا يُرجح أن يكون كافياً لمعالجة هذه المشكلة.

الاستنتاج :يسهم العمل بنظام المناوبات في حدوث الإرهاق المهني لدى المسعفين، ويرتبط هذا الإرهاق بنتائج مهمة تتعلق بالسلامة السريرية والمهنية. ولا تتحدد المخاطر بطول المناوبة وحده، بل تتفاعل عوامل متعددة، تشمل حجم عبء العمل، والتوقيت المرتبط بالإيقاع اليومي للجسم، وإمكانية الحصول على النوم، وفترات التعافي بين المناوبات، وممارسات تنظيم جداول العمل، لتشكيل مستويات الإرهاق. وبناءً على ذلك، ينبغي لمؤسسات خدمات الطوارئ الطبية التعامل مع الإرهاق بوصفه خطراً تشغيلياً ومصدراً محتملاً لتهديد سلامة المرضى، وذلك من خلال تنظيم جداول المناوبات، وتوفير فترات تعافٍ كافية، وإتاحة فرص للراحة، ومراقبة أعباء العمل المفرطة، وتطبيق ممارسات داعمة لإدارة الإرهاق المهني.

الكلمات المفتاحية :المسعفون؛ خدمات الطوارئ الطبية؛ العمل بنظام المناوبات؛ الإرهاق المهني؛ النوم؛ الأداء السريري؛ سلامة المرضى؛ الأخطاء الطبية؛ المناوبات الليلية.

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1. Introduction

Paramedics deliver emergency care in situations where assessment and treatment decisions often need to be made within minutes. Their work includes patient assessment, medication administration, airway management, resuscitation, ambulance driving, communication with hospitals, and coordination with other emergency personnel. Much of this work takes place outside controlled clinical environments, where noise, traffic, weather, emotionally difficult cases, and physical demands may occur during the same shift.

EMS systems operate continuously, so night shifts, rotating schedules, weekends, and extended duties are common. Twelve-hour and 24-hour shifts remain in use in many services. These schedules can provide operational advantages and longer periods away from work, but they can also interfere with normal sleep and circadian rhythms. The effect is especially relevant when long shifts are combined with high call volume, repeated night work, short recovery periods, or limited opportunity to rest.

Occupational fatigue is more than a feeling of tiredness. It can include reduced alertness, slower information processing, difficulty concentrating, lower motivation, and impaired physical or mental performance. In EMS, even modest reductions in attention or judgment may affect medication preparation, driving, interpretation of vital signs, patient assessment, communication, or recognition of clinical deterioration.

Evidence published since 2012 indicates that fatigue is common among EMS clinicians. In a multicenter study of 547 EMS clinicians, Patterson et al. (2012) found that approximately 55% met the study definition of fatigue. Fatigued clinicians had higher odds of occupational injury, medical errors or adverse events, and safety-compromising behaviors. Canadian research later reported a similarly high prevalence of fatigue among paramedics and again linked fatigue with adverse safety outcomes (Donnelly et al., 2019, 2020).

The relationship between scheduling and fatigue is not explained by shift duration alone. A long shift may be more tolerable in a low-volume service where clinicians can obtain meaningful sleep, whereas a shorter overnight shift with continuous calls may produce substantial fatigue. Research comparing shift duration, recovery, sleep opportunity, and transition into shift work suggests that workload, circadian timing, prior sleep, and intershift recovery should be considered together (Betson et al., 2022; Guyette et al., 2013; Harris et al., 2024; Patterson et al., 2015; Weaver et al., 2015).

The present systematic review therefore examines the evidence published from 2012 through 2024 on how shift work and occupational fatigue affect clinical performance and safety among paramedics and operational EMS personnel. It also considers factors that may increase or reduce fatigue-related risk and the evidence for fatigue-management interventions.

1.1 Review Question

Among paramedics and operational EMS clinicians, how do shift work and occupational fatigue affect clinical performance and patient or occupational safety, and what factors increase or reduce fatigue-related risk?

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1.2 Objectives

Examine the relationship between shift-work patterns and occupational fatigue among paramedics.

Assess the effect of fatigue on clinical decision-making, concentration, cognitive performance, and related measures of clinical functioning.

Examine associations between fatigue and safety outcomes, including medical errors, adverse events, occupational injuries, and safety-compromising behaviors.

Identify work-related factors that increase or reduce fatigue, including shift duration, workload, sleep opportunity, and recovery between shifts.

Review evidence concerning interventions designed to reduce fatigue among EMS personnel.

2. Methods

2.1 Review Design

A systematic-review approach was used to identify and synthesize primary research on shift work, sleep, fatigue, clinical performance, and safety among paramedics and EMS clinicians. Reporting was organized in accordance with the principles of the PRISMA 2020 statement (Page et al., 2021). Because the included studies were heterogeneous in design, fatigue measurement, shift exposure, and outcome assessment, narrative synthesis was selected rather than meta-analysis.

2.2 Search Strategy

The search covered publications from January 2012 through December 2024. PubMed was the primary bibliographic database, including MEDLINE-indexed records, and PubMed Central (PMC) was used to identify accessible full-text reports. Searches were supplemented by targeted checks of publisher websites and journal archives and by backward reference screening of eligible articles and relevant reviews. Search terms were organized around four concepts: the EMS population, work schedules, fatigue or sleep, and clinical performance or safety. The core Boolean structure was:

(“paramedic” OR “emergency medical services” OR “EMS personnel” OR “emergency medical technician”) AND (“shift work” OR “night shift” OR “extended shift” OR “24-hour shift” OR “work schedule”) AND (“fatigue” OR “sleep” OR “sleepiness”) AND (“clinical performance” OR “decision making” OR “medical error” OR “patient safety” OR “injury” OR “adverse event”).

Backward reference checking was used to identify additional potentially eligible publications. Where multiple bibliographic records referred to the same publication, they were treated as one study record. The review was limited to English-language primary empirical reports published within the defined 2012–2024 period.

2.3 Eligibility Criteria

Studies were eligible when they involved operational paramedics, emergency medical technicians, EMS clinicians, or comparable prehospital emergency personnel and examined shift work, working hours, sleep, sleepiness, occupational fatigue, intershift recovery, or fatigue-management strategies. Eligible studies were required to report at least one outcome related to fatigue, sleep, concentration, cognitive or clinical performance, medical errors, adverse events, occupational injury, safety-compromising behavior, or another relevant safety outcome.

Observational, cross-sectional, cohort, prospective, experimental, simulation, randomized, case-based, and comparative primary studies were eligible. Studies involving only hospital physicians or nurses were excluded unless EMS-specific results were reported separately. Editorials, commentaries, reviews, and papers without primary empirical data were not counted among the included studies.

2.4 Study Selection

Titles and abstracts were screened against the review question, followed by full-text assessment of potentially eligible articles using the predefined population, exposure, outcome, publication-year, and study-design criteria. Study selection followed the identification, screening, eligibility, and inclusion logic of PRISMA 2020 (Page et al., 2021). Fourteen primary studies published between 2012 and 2024 met all eligibility criteria and were included in the narrative synthesis. Donnelly et al. (2019) and Donnelly et al. (2020) were retained as separate publications because they addressed different analytical questions, although both used the same Ontario paramedic survey cohort (n = 717); this cohort was therefore treated as one participant dataset when interpreting sample independence.

2.5 Data Extraction

For each included study, data were extracted on author and year, country or setting, study design, sample size, participant characteristics, shift-work or fatigue exposure, outcome measures, and principal findings. Particular attention was given to whether fatigue, clinical performance, and safety outcomes were measured objectively or by self-report and whether studies adjusted for relevant occupational or scheduling factors.

2.6 Methodological Quality Assessment

Methodological quality was appraised using design-specific Joanna Briggs Institute (JBI) critical appraisal guidance (Aromataris & Munn, 2020). Analytical cross-sectional studies were assessed with the JBI analytical cross-sectional framework; cohort and prospective studies with the JBI cohort framework; the cluster-randomized trial with the JBI randomized controlled trial framework; the case report with the JBI case report framework; and the simulated night-shift study with the closest applicable quasi-experimental framework. Appraisal considered sampling, clarity and validity of exposure and outcome measurement, control of confounding, completeness of follow-up where relevant, and appropriateness of statistical analysis. No numerical summary score was used; appraisal findings were used to weight interpretation of the evidence rather than as an automatic exclusion rule.

2.7 Data Synthesis

Meta-analysis was not undertaken because the studies differed substantially in shift length, work setting, fatigue measures, sleep variables, and clinical or safety outcomes. Findings were therefore synthesized narratively in five areas: shift work and occupational fatigue; shift duration, workload, and sleep opportunity; clinical performance; safety outcomes; and recovery or fatigue-management strategies.

3. Results

3.1 Characteristics of Included Studies

Fourteen primary studies met the eligibility criteria. These 14 publications represented 13 independent participant datasets because Donnelly et al. (2019) and Donnelly et al. (2020) analyzed the same Ontario cohort of 717 paramedics for different research questions. The evidence included multicenter

observational studies, cross-sectional surveys, retrospective and prospective cohorts, simulation research, a cluster-randomized trial, a comparative study, and a case report. Sample sizes ranged from a single paramedic in a schedule-change case report to 4,382 employees contributing 966,082 shifts in a large occupational cohort. The included studies were conducted primarily in the United States, Canada, Australia, and Saudi Arabia.

Table 1. Summary of the 14 Included Primary Studies (2012–2024)

Study	Design and sample	Main exposure/area	Main finding
Patterson et al. (2012)	Multicenter observational study; 547 EMS clinicians	Sleep and fatigue	Approximately 55% were fatigued. Fatigue was associated with occupational injury, medical errors/adverse events, and safety-compromising behavior.
Guyette et al. (2013)	Prospective air-medical study; 34 clinicians	12-hour vs. 24-hour shifts	No significant difference in cognitive decline between schedules. Considerable on-shift sleep occurred during 24-hour shifts.
Patterson et al. (2015)	Observational study; 450 EMS workers	Intershift recovery	Recovery was related to shift characteristics, sleep quality, fatigue, daytime sleepiness, and schedule satisfaction.
Weaver et al. (2015)	Retrospective cohort; 4,382 employees; 966,082 shifts	Shift duration	Shifts >16–24 hours were associated with higher occupational injury/illness risk than shifts >8–12 hours.
Patterson et al. (2016)	Case report	Change from 24-hour to 8-hour shifts	Fatigue, alertness, and sleep measures improved after the schedule changed to shorter shifts.
Donnelly et al. (2019)	Cross-sectional survey; 717 paramedics	Fatigue and safety	About 55% reported fatigue; fatigue was associated with injury, errors/adverse outcomes, and safety-compromising behaviors.
Donnelly et al. (2020)	Further cross-sectional analysis of the same 717-paramedic Ontario cohort reported by Donnelly et al. (2019)	Stress, fatigue, and safety	Fatigue remained associated with injury, medication error, and safety-compromising behavior after considering other occupational factors.

Study	Design and sample	Main exposure/area	Main finding
Khan et al. (2020a)	Cross-sectional study; 136 Australian paramedics	Shift work and sleep	Rotating shift workers showed substantial sleep and fatigue problems together with poorer mental health.
Khan et al. (2020b)	Comparative study; Australian and Saudi paramedics	Sleep, work duration, and fatigue	Differences in sleep and fatigue between groups were influenced by working duration and driving duration.
Bartlett et al. (2022)	Simulated night-shift study; 24 paramedic students	Sleepiness and clinical decisions	Clinical decision accuracy declined across a 13-hour simulated night shift as sleepiness increased.
Betson et al. (2022)	Prospective study; 28 graduate paramedics	Transition to shift work	Sleep became more fragmented and perceived sleep quality worsened after transition into operational shift work.
Patterson et al. (2023)	Cluster-randomized trial; 678 EMS personnel	Sleep/fatigue education	No significant intention-to-treat effect on major sleep outcomes; greater module exposure was associated with some improvement.
Alruwaili & Alanazy (2024)	Cross-sectional study; 1,076 Saudi paramedics	Shift work and insomnia	Working hours, scheduling, days off, sleep duration, and occupational stress were associated with insomnia.
Harris et al. (2024)	Prospective cohort; 105 recruit paramedics	Transition to shift work	Sleep regularity decreased after entry into shift work; sleep and psychological factors influenced shift-work tolerance.

Note. Donnelly et al. (2019) and Donnelly et al. (2020) used the same Ontario survey cohort (n = 717). They were retained as distinct publications because they reported different analyses, but they were not treated as independent participant samples.

3.2 Methodological Quality of Included Studies

Overall, methodological quality was mixed. The strongest design-level evidence came from the very large retrospective cohort and the multi-agency cluster-randomized trial, while several cross-sectional studies provided consistent but less temporally informative associations. The most frequent appraisal concerns were reliance on self-reported fatigue and safety outcomes, cross-sectional designs, small samples in several prospective or simulation studies, and limited generalizability from specialized or early-career populations. These considerations were incorporated into the narrative interpretation rather than converted into a numerical quality score. Table 2 summarizes the design-specific appraisal.

Table 2. Design-Specific Methodological Appraisal of Included Studies

Study design group	Included studies	JBI framework	Main appraisal considerations
Analytical cross-sectional / observational surveys	Patterson et al. (2012); Donnelly et al. (2019); Donnelly et al. (2020); Khan et al. (2020a); Khan et al. (2020b); Alruwaili & Alanazy (2024)	JBI Analytical Cross-sectional	Generally clear populations and relevant fatigue/safety measures, but self-report and cross-sectional exposure-outcome assessment limit temporal and causal inference. The two Donnelly papers share one cohort.
Prospective / cohort studies	Guyette et al. (2013); Patterson et al. (2015); Weaver et al. (2015); Betson et al. (2022); Harris et al. (2024)	JBI Cohort	Prospective or longitudinal follow-up and, in Weaver et al., very large administrative data strengthen inference. Main concerns include nonrandom scheduling, residual confounding, small samples in some cohorts, and setting-specific generalizability.
Simulation / quasi-experimental study	Bartlett et al. (2022)	JBI Quasi-experimental	Repeated clinical testing across a simulated night shift supports within-shift comparison, but the small student sample and simulated setting limit generalizability to experienced operational paramedics.
Cluster-randomized trial	Patterson et al. (2023)	JBI Randomized Controlled Trial	Multi-agency randomization strengthens intervention inference; interpretation is influenced by variation in exposure/adherence to the educational modules and by reliance on sleep/fatigue outcomes.
Case report	Patterson et al. (2016)	JBI Case Report	Detailed within-person pre/post schedule comparison, but the single-participant design has very limited generalizability and cannot isolate schedule effects from all competing influences.

Note. The appraisal is qualitative and design-specific; no numerical JBI summary score was assigned.

3.3 Shift Work and Occupational Fatigue

Fatigue was common across the included literature. Patterson et al. (2012) reported that about 55% of participating EMS clinicians met the study definition of fatigue. A later Canadian study reported a very similar prevalence, with approximately 55% of paramedics describing significant workplace fatigue (Donnelly et al., 2019).

Night and rotating work can contribute to fatigue through repeated disruption of normal sleep timing. In Australia, Khan et al. (2020a) found substantial sleep and fatigue problems among paramedics, most of whom worked rotating shifts. The pattern was accompanied by poor sleep quality and poorer mental-health indicators. A comparative study of Australian and Saudi paramedics further showed that working and driving duration were important contributors to differences in sleep and fatigue (Khan et al., 2020b).

Saudi evidence shows that the problem is also relevant in Middle Eastern EMS systems. Alruwaili and Alanazy (2024) studied 1,076 Saudi paramedics and found that insomnia was associated with work-related factors including working hours, scheduling, days off, sleep duration, and occupational stress.

Prospective evidence suggests that the transition into shift work itself changes sleep behavior. Betson et al. (2022) observed more fragmented sleep and poorer perceived sleep quality among early-career paramedics after beginning operational shift work. Harris et al. (2024) similarly found that sleep regularity declined as recruit paramedics transitioned into shift work, although individual tolerance varied. Together, these findings indicate that fatigue may accumulate through repeated sleep disruption and incomplete recovery rather than arising only from a single long shift.

3.4 Shift Duration, Workload, and Sleep Opportunity

Shift duration was associated with safety risk in the largest included scheduling study. Weaver et al. (2015) analyzed 966,082 shifts involving 4,382 EMS employees. Compared with shifts lasting more than 8 but no more than 12 hours, shifts lasting more than 16 and up to 24 hours were associated with an approximately 60% higher risk of occupational injury or illness. Shifts of eight hours or less showed lower risk.

However, a different pattern was observed in an air-medical service. Guyette et al. (2013) compared 12-hour and 24-hour shifts and found no significant difference in cognitive performance decline between the two groups. A key contextual finding was that personnel on 24-hour shifts obtained substantially more on-shift sleep, averaging about 6.8 hours, while the 12-hour group obtained about one hour. The service also had relatively low-to-moderate utilization.

These studies suggest that shift duration should not be interpreted without considering workload and sleep opportunity. A 24-hour shift in a lower-volume service where meaningful sleep is possible may produce a different fatigue profile from a long shift with continuous calls. The case report by Patterson et al. (2016) also supports the potential value of shorter schedules, as fatigue, alertness, and sleep measures improved after one paramedic moved from a 24-hour to an 8-hour schedule.

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4. Occupational Fatigue and Clinical Performance

Direct evidence on clinical performance was less extensive than evidence on fatigue and safety. Bartlett et al. (2022) examined paramedic students during a 13-hour simulated night shift. Participants completed repeated clinical scenarios as the night progressed. Clinical decision accuracy declined while subjective sleepiness increased and motivation decreased. Not every cognitive measure worsened, indicating that fatigue may affect some aspects of clinical functioning more strongly than others.

These findings are clinically relevant because paramedic decisions often require continuous attention, integration of incomplete information, recognition of subtle change, and rapid prioritization. A fatigued clinician may still perform a familiar technical task but have more difficulty sustaining attention or making complex judgments under pressure.

At the same time, Guyette et al. (2013) did not identify significant objective cognitive deterioration after 24-hour air-medical shifts when substantial on-shift sleep was available. The contrast between these studies reinforces the importance of work context. It is therefore more accurate to interpret fatigue-related performance risk as the result of interacting factors such as circadian timing, sleep opportunity, workload, and recovery rather than shift duration alone.

5. Occupational Fatigue and Safety

The association between fatigue and safety was one of the most consistent findings in the included evidence. Patterson et al. (2012) reported that 17.8% of EMS clinicians had experienced an injury, 41.1% reported a medical error or adverse event, and 89.6% reported at least one safety-compromising behavior during the study period. After adjustment for relevant factors, fatigued clinicians had approximately 1.9 times the odds of injury, 2.2 times the odds of a medical error or adverse event, and 3.6 times the odds of safety-compromising behavior compared with clinicians who were not classified as fatigued.

Canadian findings were broadly consistent. Donnelly et al. (2019) found that fatigued paramedics were more than twice as likely to report injury and approximately three times as likely to report safety-compromising behaviors; errors and adverse outcomes were also more frequent among fatigued respondents. Donnelly et al. (2020) conducted a further analysis of the same 717-paramedic Ontario cohort and found significant relationships between fatigue and occupational injury, medication error, and safety-compromising behavior after accounting for occupational stress and other factors. Because the two publications used the same cohort, their findings were interpreted as complementary analyses rather than independent replication.

These findings indicate that fatigue is relevant to both patient safety and clinician safety. The mechanisms are plausible across many routine EMS tasks, including ambulance driving, lifting and moving patients, preparing medication, communicating clinical information, and making treatment decisions. Nevertheless, several safety outcomes were self-reported. The associations are therefore important for risk management but should not be interpreted as precise estimates of fatigue-caused patient harm.

6. Recovery Between Shifts and Adaptation to Shift Work

Recovery between duties is an important part of the fatigue process. Patterson et al. (2015) found that recovery between EMS work shifts was related to shift duration, sleep quality, daytime sleepiness, fatigue, work setting, and satisfaction with scheduling. A clinician may complete one shift without

severe fatigue but begin the next shift insufficiently recovered if the interval between duties does not allow adequate sleep.

Commuting, family responsibilities, secondary employment, and difficulty sleeping during the day may further reduce effective recovery time. The early-career evidence is consistent with this interpretation. Betson et al. (2022) documented increased sleep fragmentation and poorer perceived sleep quality after paramedics entered operational shift work. Harris et al. (2024) found a decline in sleep regularity during the same type of transition and reported substantial individual differences in shift-work tolerance.

Together, these studies support viewing fatigue across the entire work-rest cycle. Scheduling decisions should therefore consider not only the duration of a single shift but also consecutive duties, night work, time available for recovery, and the predictability of sleep opportunities.

7. Fatigue-Management Interventions

Fatigue-management strategies in EMS include schedule design, protected rest opportunities, fatigue education, strategic napping, monitoring, and organizational fatigue-risk management. Within the 2012–2024 evidence set, the strongest intervention evidence came from the Emergency Medical Services Sleep Health Study.

Patterson et al. (2023) conducted a cluster-randomized trial across 36 EMS agencies involving 678 personnel. The intervention delivered structured online education on sleep and fatigue. In the intention-to-treat analysis, the program did not significantly improve the main sleep outcomes at three months compared with control conditions. However, participants with greater exposure to the educational modules showed some improvement in sleep quality and fatigue.

This finding suggests that education can contribute to fatigue awareness but may be insufficient when the underlying problem is related to staffing, call volume, repeated night duties, long shifts, or inadequate recovery. Fatigue-management programs are therefore likely to be more useful when individual education is combined with organizational changes to work scheduling and recovery opportunities.

8. Discussion

8.1 Main Findings

This review of 14 primary studies published from 2012 to 2024 shows that occupational fatigue is common among paramedics and is closely related to the way EMS work is scheduled and organized. Across different EMS systems, fatigue was repeatedly associated with injuries, medical errors or adverse events, and safety-compromising behaviors (Donnelly et al., 2019, 2020; Patterson et al., 2012). The two Donnelly publications were derived from the same Ontario cohort and were therefore treated as complementary analyses of one participant dataset rather than independent replications. Large scheduling data also linked very long shifts with increased occupational injury risk (Weaver et al., 2015).

The evidence on direct clinical performance was smaller but pointed in a similar direction. During simulated night work, increased sleepiness was accompanied by reduced clinical decision accuracy (Bartlett et al., 2022). In contrast, one air-medical study did not identify significant cognitive decline during 24-hour shifts when clinicians had substantial opportunity to sleep (Guyette et al., 2013).

The overall pattern therefore does not support a simple rule that every long shift produces poor performance. Rather, the effect of a shift depends on the conditions in which it occurs. Duration, workload, time of day, opportunity to sleep, previous sleep, and intershift recovery interact. This interpretation is also supported by studies of recovery and the transition into shift work, which demonstrate that disrupted sleep can persist across successive duties (Betson et al., 2022; Harris et al., 2024; Patterson et al., 2015).

8.2 Why Night Work Matters

Night work places clinicians on duty during a biological period when alertness normally falls and sleep pressure rises. Rotating schedules can further prevent stable sleep routines. The combined effect can reduce the quality and regularity of sleep even when the total number of scheduled hours appears acceptable.

This helps explain why a 12-hour overnight shift cannot automatically be considered low risk and why a 24-hour shift with genuine sleep opportunity may sometimes be better tolerated than expected. The evidence therefore supports workload-sensitive scheduling rather than a one-size-fits-all interpretation of shift length.

8.3 Patient and Clinician Safety Implications

Patient safety in paramedicine depends on sustained attention, accurate memory, medication calculation, interpretation of vital signs, effective communication, and rapid selection among treatment options. Fatigue can interfere with several of these processes. The included evidence repeatedly associated fatigue with reported medical errors, adverse events, and safety-compromising behaviors.

Clinician safety is equally relevant. Fatigue may increase risk during ambulance driving, manual handling, lifting, and other physically demanding tasks. The large shift-duration cohort and repeated associations between fatigue and injury indicate that fatigue should be considered an occupational safety issue as well as a patient-safety concern (Patterson et al., 2012; Weaver et al., 2015).

However, causation should be interpreted carefully. Much of the existing evidence is observational, and several safety outcomes depend on self-report. The most defensible conclusion is that fatigue is a significant and modifiable risk factor that increases the conditions under which errors, unsafe behavior, and injury are more likely.

9. Implications for EMS Practice

The findings indicate that fatigue management should not rely only on individual paramedics being responsible for obtaining enough sleep. EMS organizations influence many of the conditions that shape fatigue, including shift duration, consecutive duties, overtime, workload, staffing, rest opportunity, and recovery time between shifts.

Where extended shifts are used, workload should be considered when deciding whether a schedule is sustainable. A schedule that is workable in a lower-volume service may not be appropriate in a continuously active urban setting. Protected rest or sleep opportunities may also be relevant during extended overnight duties, particularly when the service design allows safe coverage during rest periods.

Minimum recovery periods between duties and monitoring of repeated night work or excessive overtime should be considered. The findings on early-career paramedics also suggest that new staff

may benefit from support during the transition into shift schedules, especially where sleep regularity becomes difficult to maintain (Betson et al., 2022; Harris et al., 2024).

Fatigue education can remain one part of a broader strategy, but the cluster-randomized evidence indicates that education alone has limited effect (Patterson et al., 2023). Organizational scheduling, staffing, rest opportunities, and a non-punitive approach to fatigue reporting should be addressed together.

10. Strengths and Limitations

This review brings together evidence across several stages of the fatigue-safety pathway, including shift scheduling, sleep, fatigue, recovery, clinical decision-making, injury, medical error, and safety-compromising behavior. It also includes evidence from different EMS systems and incorporates studies ranging from large occupational datasets to prospective and experimental designs.

Several limitations should be considered. Fatigue was defined and measured differently across studies, which limits direct comparison. Many studies were observational or cross-sectional, so associations cannot establish causation with certainty. Several important outcomes, including errors and unsafe behaviors, were self-reported and may be affected by recall or reporting bias. Direct objective measurements linking fatigue with independently verified patient harm were uncommon. Two included publications (Donnelly et al., 2019, 2020) analyzed the same participant cohort; they were retained because they addressed different analytical questions, but they were not treated as independent samples when the overall evidence was interpreted.

The evidence was concentrated in a limited number of countries, particularly the United States, Canada, Australia, and Saudi Arabia, and EMS scheduling systems differ considerably between settings. In addition, one clinical decision-making study involved paramedic students rather than experienced operational paramedics (Bartlett et al., 2022). Methodological heterogeneity in exposure and outcome measurement also prevented meaningful statistical pooling.

11. Recommendations for Future Research

Future research should link fatigue measurements collected during real operational shifts with objective clinical and safety outcomes. Electronic patient-care records, medication-error reporting systems, ambulance-driving data, validated sleep measures, and operational workload data could provide stronger evidence than self-report alone.

Studies comparing shift arrangements should account for call volume and actual sleep opportunity. Comparing 12-hour and 24-hour schedules without measuring workload or rest may produce misleading conclusions because the same scheduled duration can represent very different levels of wakefulness and task demand.

More evidence is needed from Middle Eastern EMS systems. Saudi studies have added useful information on insomnia, sleep, and work patterns, but regional research directly linking fatigue with objective performance and safety outcomes remains limited. Intervention research should also examine organizational strategies such as protected rest periods, workload-sensitive scheduling, limits on consecutive night shifts, and minimum intershift recovery periods.

12. Conclusion

Shift work is a necessary feature of emergency medical services, but it can disrupt normal sleep and recovery and contribute to occupational fatigue. Across the 14 primary studies included in this review, fatigue was common and was consistently associated with important safety outcomes, including occupational injury, medical errors or adverse events, and safety-compromising behavior.

The effect of shift work is not determined by shift duration alone. Workload, circadian timing, sleep opportunity, previous sleep, recovery between duties, and individual tolerance all influence the fatigue experienced by paramedics. Direct evidence linking fatigue with objectively verified patient harm remains less extensive than evidence based on self-report, so causal estimates should remain cautious.

Overall, the evidence supports treating fatigue as an operational and patient-safety risk rather than solely as an individual problem. Scheduling that allows adequate recovery, workload-sensitive use of extended shifts, opportunities for rest, monitoring of repeated night work and overtime, and supportive fatigue-management practices provide a more appropriate response than relying on education or personal sleep behavior alone.

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