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The Effects of Shift Work and Work-Related Fatigue on Paramedics' Clinical Performance and Patient Safety: A Systematic Review

تأثير العمل بنظام المناوبات والإرهاق المرتبط بالعمل في الأداء السريري للمسعفين وسلامة المرضى: مراجعة منهجية

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Abstract:

Background. Extended shifts, night work and insufficient recovery are common operational features of emergency medical services (EMS). Fatigue can plausibly affect vigilance, clinical judgement, communication and safety, although the strength of direct patient-outcome evidence is uncertain.
Objective. To examine published evidence linking paramedic shift patterns and occupational fatigue with clinical performance, clinician safety and patient safety, and to identify practical implications for EMS fatigue-risk management.
Methods. This systematic-review-style manuscript follows the organization of the supplied model article and provides a structured narrative synthesis of traceable primary studies and guidance published through November 2026. Evidence was organized by exposure, outcome and study design. The uploaded source did not include executed database searches, screening logs or a review protocol; accordingly, no PRISMA identification totals, formal pooled estimates or completed study-level JBI ratings are claimed.
Results. Evidence from EMS surveys, administrative records, shift-based cognitive studies, randomized interventions and a Saudi paramedic survey indicates that fatigue and sleep problems are common and that their consequences vary with workload, time of day, shift duration and opportunities for sleep. One cross-sectional EMS survey found that fatigued clinicians had adjusted odds ratios of 2.2 for self-reported medical error/adverse event and 1.9 for injury; a large schedule-linked cohort associated shifts exceeding 16–24 hours with higher occupational injury risk. Objective alertness studies emphasize night work, while behavioral interventions have produced mixed effects.
Conclusion. Occupational fatigue is an actionable EMS workforce and safety concern, but associations should not be confused with demonstrated causal effects on patient outcomes. A multifaceted strategy combining roster design, fatigue assessment, protected rest, reporting systems and prospective evaluation is justified. A fully auditable systematic review requires original search and appraisal records.
Keywords: paramedics; emergency medical services; shift work; fatigue; clinical performance; patient safety; occupational injury; sleep; systematic review

الملخص

الخلفية :تُعد المناوبات الممتدة، والعمل الليلي، وعدم كفاية فترات التعافي من السمات التشغيلية الشائعة في خدمات الطوارئ الطبية. ومن المحتمل أن يؤثر الإرهاق في اليقظة، والحكم السريري، والتواصل، والسلامة، رغم أن قوة الأدلة المباشرة المتعلقة بالنتائج الصحية للمرضى لا تزال غير مؤكدة.
الهدف :دراسة الأدلة المنشورة التي تربط بين أنماط المناوبات لدى المسعفين والإرهاق المهني من جهة، والأداء السريري وسلامة الممارسين وسلامة المرضى من جهة أخرى، مع تحديد التداعيات العملية لإدارة مخاطر الإرهاق في خدمات الطوارئ الطبية.
المنهجية :أُعدّت هذه المخطوطة وفق منهجية المراجعة المنهجية، مع اتباع التنظيم الوارد في المقالة النموذجية المقدمة، وتقديم توليف سردي منظم للدراسات الأصلية والإرشادات العلمية القابلة للتحقق، والمنشورة حتى نوفمبر 2026. ونُظّمت الأدلة وفقاً لطبيعة عوامل التعرض، والنتائج، والتصميم البحثي لكل دراسة. ولم يتضمن المصدر المرفق سجلات لعمليات البحث المنفذة في قواعد البيانات، أو سجلات فرز الدراسات، أو بروتوكولاً للمراجعة؛ وبناءً على ذلك، لم تُذكر أعداد سجلات تحديد الدراسات وفق مخططPRISMA ، أو تقديرات إحصائية مجمعة رسمية، أو تقييمات مكتملة للجودة المنهجية لكل دراسة باستخدام أداة معهد جوانا بريغز.(JBI)
النتائج :تشير الأدلة المستمدة من الاستبيانات الخاصة بخدمات الطوارئ الطبية، والسجلات الإدارية، والدراسات المعرفية المرتبطة بالمناوبات، والتدخلات العشوائية، واستبيان أُجري على المسعفين في المملكة العربية السعودية، إلى شيوع الإرهاق ومشكلات النوم، وإلى تفاوت آثارهما تبعاً لعبء العمل، ووقت أداء المناوبة، ومدتها، وفرص الحصول على النوم خلالها. وأظهرت إحدى الدراسات المسحية المقطعية التي شملت العاملين في خدمات الطوارئ الطبية أن الممارسين الذين يعانون من الإرهاق سجلوا نسب أرجحية معدلة بلغت 2.2 فيما يتعلق بالأخطاء الطبية أو الأحداث الضارة المُبلغ عنها ذاتياً، و1.9 فيما يتعلق بالإصابات المهنية. كما ربطت دراسة أترابية واسعة النطاق، استندت إلى بيانات جداول المناوبات، بين المناوبات التي تتجاوز مدتها 16–24 ساعة وارتفاع مخاطر الإصابات المهنية. وأكدت دراسات اليقظة الموضوعية أهمية العمل الليلي بوصفه عاملاً مؤثراً في مستويات الانتباه، في حين أظهرت التدخلات السلوكية نتائج متفاوتة من حيث الفاعلية.

الاستنتاج :يمثل الإرهاق المهني قضية مهمة وقابلة للتدخل، تتعلق بالقوى العاملة والسلامة في خدمات الطوارئ الطبية، إلا أنه ينبغي عدم الخلط بين الارتباطات الإحصائية وبين إثبات التأثيرات السببية على النتائج الصحية للمرضى. وتُعد الاستراتيجية متعددة المحاور، التي تجمع بين تصميم جداول المناوبات، وتقييم مستويات الإرهاق، وتوفير فترات راحة محمية، وإنشاء أنظمة للإبلاغ عن حالات الإرهاق، وإجراء تقييم مستقبلي للنتائج، نهجاً مبرراً للتعامل مع هذه المشكلة. ومع ذلك، فإن إجراء مراجعة منهجية مكتملة وقابلة للتدقيق يتطلب توفير السجلات الأصلية لعمليات البحث والتقييم المنهجي للدراسات.

الكلمات المفتاحية :المسعفون؛ خدمات الطوارئ الطبية؛ العمل بنظام المناوبات؛ الإرهاق؛ الأداء السريري؛ سلامة المرضى؛ الإصابات المهنية؛ النوم؛ المراجعة المنهجية.

1. Introduction

Emergency medical services deliver time-critical assessment and treatment across unpredictable environments. Paramedics must integrate clinical observations, procedural skills, team communication and transport decisions while moving between stations, vehicles, accident scenes and hospitals. These demands are often sustained during irregular shifts, nights and prolonged periods of duty. Scheduling arrangements that preserve around-the-clock coverage may simultaneously reduce the opportunity for restorative sleep and increase circadian disruption.

Occupational fatigue is more than ordinary tiredness. It includes subjective exhaustion, diminished capacity to sustain attention and altered cognitive or psychomotor functioning. Sleep restriction and circadian misalignment can interact with workload, commuting, secondary employment and recovery opportunities. Consequently, two clinicians working shifts of identical duration may have very different fatigue exposure; a 24-hour duty period with predictable sleep opportunities is not equivalent to 24 hours of continuous high-acuity activity (Guyette et al., 2013; Patterson et al., 2019a).

The safety problem involves several linked but distinct outcomes. Staff injury and vehicle-related risk concern the workforce; vigilance and concentration concern performance; documentation, medication and assessment errors concern clinical processes; and preventable adverse events concern patients. Evidence demonstrating a shift-associated change in sleepiness cannot automatically establish an effect on patient mortality. Stronger causal conclusions require designs that connect staffing exposure to objectively measured care processes and patient outcomes.

An early EMS cross-sectional study by Patterson et al. (2012) found fatigue in more than half of surveyed clinicians and associations with perceived injury, medical errors and safety-compromising behaviors. Brachet et al. (2012), analyzing a large administrative EMS sample, reported poorer performance toward the end of long shifts and modelled a possible patient-mortality consequence. However, the latter calculation was an estimate rather than a direct randomized test of reduced shift length.

Later literature shows why a simple assumption that every longer shift is necessarily worse would be inadequate. Guyette et al. (2013) did not find a significant difference in cognitive test changes after 12- versus 24-hour air-medical shifts in a small, low-to-moderate workload sample. In contrast, large injury records indicate that longer shifts can be associated with clinician harm (Weaver et al., 2015). Prospective monitoring suggests that night work and timing of a nap can be more informative than nominal shift length alone (Patterson et al., 2019a).

Regional relevance is considerable. Alruwaili and Alanazy (2024) surveyed 1,076 paramedics in Saudi Arabia and identified relationships between shift characteristics and insomnia. Although the study does not show that a particular Saudi ambulance service had a given error rate, it emphasizes the local importance of sleep health and the need to evaluate roster arrangements within the Saudi healthcare context.

The present review brings together these strands of evidence to examine fatigue as an operational exposure, performance as an intermediate outcome, and patient safety as the final clinical concern. It also distinguishes directly measured outcomes from self-reported events, indirect indicators and policy recommendations.

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1.1 Research Objectives

The objectives were to:

describe the association of shift duration, night duty and recovery periods with fatigue and sleep quality;

examine available evidence concerning vigilance, concentration, cognitive performance and clinical work quality;

assess links between fatigue, clinician injury, self-reported error and patient safety indicators;

compare findings from observational studies and fatigue-mitigation interventions; and

identify evidence limitations and actionable EMS operational priorities.

1.2 Research Questions

The overarching question was: How do shift work and occupational fatigue relate to clinical performance and patient safety among paramedics?

Which shift characteristics are most consistently linked to fatigue or impaired sleep?

Which outcomes have been directly observed, and which are indirect or self-reported?

What management strategies have been evaluated and what is their demonstrated effect?

2. Methodology

2.1 Study Design

The manuscript is a structured evidence synthesis written in the systematic-review reporting format of the supplied reference document. Its evidence statements were developed from identifiable published studies and established methodological guidance. PRISMA 2020 is used as the reporting framework (Page et al., 2021), while the JBI critical appraisal framework identifies design-appropriate risks of bias. However, an original executed database search and complete independent screening were not supplied. Thus, the current evidence set should be understood as a verified candidate corpus, not a demonstrably exhaustive PRISMA-included set.

2.2 Search Strategy and Sources

The bibliographic verification for this draft focused on PubMed-indexed articles, accessible full texts and journal publication records addressing fatigue, paramedics, EMS shift patterns, performance, patient safety and intervention effectiveness. Appendix B supplies reproducible example searches for PubMed, Scopus, Web of Science, CINAHL and Embase. Those strings describe an appropriate future full search; they are not retrospective assertions that all five databases were systematically searched or that their yields were recorded. Primary studies available up to 3 November 2026 were considered, and foundational studies before 2019 were retained where directly relevant.

The conceptual search combines an EMS population term, a shift/fatigue term and a clinical, occupational or safety outcome. English-language published primary studies were prioritized for synthesis; review articles and guidelines informed context but were not treated as primary outcome datasets.

2.3 Eligibility Criteria

The target population comprised paramedics, emergency medical technicians, flight paramedics and mixed EMS clinicians where paramedic-relevant findings could be interpreted. Eligible exposures included shift duration, night/rotating shifts, workload, sleep deficiency, fatigue or an intervention designed to reduce fatigue. Relevant outcomes included objective vigilance, cognitive testing, work-related injury, insomnia, perceived error, recorded clinical performance or patient outcomes. Randomized trials, controlled studies, observational cohorts, cross-sectional studies and prospective service evaluations were appropriate designs.

Reports involving exclusively in-hospital workers, opinion pieces without primary data, and studies with no meaningful relationship to EMS fatigue or shifts were outside primary synthesis. An older primary study could be retained where it provides important direct performance or safety outcomes. Review articles were cited separately for comparison and recommended interventions.

2.4 Study Selection

Study titles, designs, sample characteristics and headline outcomes were checked against identifiable publication records for the current narrative corpus. Because the original bibliographic export, deduplication records, independent reviewer decisions, full-text exclusion log and protocol were not available, the number of records identified, screened, excluded or formally included cannot be reconstructed. A numerical PRISMA chart would therefore risk presenting invented research activity. Appendix A records the required PRISMA fields as not documented, without assigning artificial values.

2.5 Data Extraction

For each primary publication summarized in Table 1, the synthesis records the study citation, setting and design, available sample or observation units, exposure/measurement strategy and principal reported findings. Outcome units are retained as originally reported. Reported odds ratios, relative risks, p-values and proportions are not pooled across incompatible designs. Where papers describe multi-professional EMS or air-medical teams, the applicable population is identified rather than presented as paramedics alone.

2.6 Methodological Quality and Risk of Bias

Risk of bias was considered using the JBI approach appropriate to each design: analytical cross-sectional studies, cohort studies, quasi-experimental evaluations and randomized controlled trials. Table 2 maps specific design risks, including self-reporting, residual confounding, selection, missingness and outcome measurement. This mapping is a cautious appraisal narrative. It is not an independently completed, two-reviewer, item-by-item JBI checklist and cannot support numerical JBI scores. A criterion-level audit worksheet is supplied in Appendix D.

2.7 Data Synthesis

A qualitative narrative approach was chosen because exposures ranged from scheduling records to self-reported fatigue, and outcomes ranged from psychomotor vigilance to occupational injuries and patient-mortality models. Findings were grouped into sleep/fatigue burden, cognitive and clinical performance, safety outcomes and fatigue-management interventions. Contradictory findings were preserved and interpreted against workload, rest opportunities and study design. No meta-analysis was attempted.

2.8 Ethical Considerations

This article is based on published literature and did not recruit patients or staff or analyze confidential clinical records. Research integrity therefore rests on accurate attribution, transparent methodological status and avoidance of false study counts or invented appraisals.

2.9 Reporting Limitations

The manuscript can be assessed as a substantive evidence synthesis and a foundation for a registered systematic review. It should not be represented as a completed PRISMA-auditable systematic review until database searches, eligibility decisions, final included-study list and appraisal forms have been independently completed and documented. This distinction is especially important because the study-selection numbers in the supplied model article concern a different research question and cannot be transferred to this topic.

3. Results

3.1 Identification of Evidence

Eleven traceable primary publications were summarized as a relevant evidence sample spanning 2012–2026. This number describes the papers summarized below, not an exhaustive or PRISMA-derived count of formally included studies. The reports represent large EMS administrative datasets, cross-sectional surveys, cognitive-performance assessments, a prospective HEMS evaluation and randomized behavioral trials. Study settings include the United States, the United Kingdom and Saudi Arabia.

Table 1. Characteristics and findings of verified topic-relevant primary publications

Study	Setting / design	Sample	Exposure / focus	Principal finding
Brachet et al. (2012)	USA; administrative performance analysis	~743,000 incidents; 2,381 paramedics	Shift structure, end-of-shift performance	Performance worsened toward the end of long shifts; estimated mortality implication is model-based.
Patterson et al. (2012)	USA; cross-sectional EMS survey	547 responses from 30 agencies	Sleep, fatigue, perceived safety	55% classified as fatigued; adjusted OR 2.2 for error/adverse event and 1.9 for injury.
Guyette et al. (2013)	USA; air-medical pre/post cognitive study	34 flight nurses/paramedics	12- vs 24-hour shifts	No between-group difference in cognitive test changes; 24-hour workers had on-shift sleep opportunities.
Weaver et al. (2015)	USA; retrospective multi-agency cohort	966,082 shifts; 4,382 employees	Shift duration, OSHA injury/illness	>16 to ≤24-hour shifts: adjusted RR 1.60 versus >8 to ≤12-hour shifts.
Patterson et al. (2015)	USA; SleepTrackTXT randomized trial	99 analyzed; 2,621 shifts	Text-based fatigue feedback	Lower self-rated fatigue/sleepiness on 12-hour shifts in intervention group.
Patterson et al. (2019a)	USA; prospective air-medical cohort	112 clinicians	PVT alertness, night work, napping	Night shifts had more PVT lapses/false starts; no clear difference by <24 vs 24-hour duration.
Patterson et al. (2019b)	USA; SleepTrackTXT2 randomized trial	83 randomized; 2,828 shifts	Fatigue messaging, sleep health	Short-term fatigue benefit in 12-hour shifts; no sustained sleep-quality improvement.
Rose et al. (2023)	UK; HEMS prospective service evaluation	8 clinicians; five-week cycle	PVT and Samn–Perelli fatigue scores	Night shifts showed within-shift worsening; overall five-week trends were not statistically significant.

Study	Setting / design	Sample	Exposure / focus	Principal finding
Alruwaili & Alanazy (2024)	Saudi Arabia; cross-sectional survey	1,076 paramedics	Shift patterns and insomnia	47.67% met the Athens Insomnia Scale cutoff; shift characteristics associated with insomnia.
Patterson et al. (2025)	USA; repeated shift reports in trial cohort	388 clinicians; 4,573 shifts	Intrashift fatigue and concentration	Highest fatigue/concentration difficulties on 24-hour shifts near 03:00–04:00.
Patterson et al. (2026)	USA; cluster randomized trial	108 agencies; 708 workers	Behavioral fatigue messages	Severe fatigue fell over time in both arms, with no significant between-arm difference.

Abbreviations: EMS, emergency medical services; HEMS, helicopter EMS; OR, odds ratio; RR, relative risk; PVT, psychomotor vigilance test; OSHA, Occupational Safety and Health Administration. Numerical values refer to the original study, not to a combined patient sample.

3.2 Methodological Quality and Risk of Bias

The studies offer complementary levels of evidence rather than a single uniform estimate. Administrative records provide large samples but often lack case-level sleep, mission intensity and patient covariates. Self-report surveys capture fatigue and perceived errors but are vulnerable to common-method and recall bias. Small air-medical test studies provide objective performance measures but have limited statistical power and may not represent high-volume ground ambulance operations. Randomized messaging trials provide intervention evidence, although self-rated outcomes and follow-up attrition still constrain interpretation.

Table 2. Design-specific JBI appraisal mapping and limitations

Study	Relevant appraisal approach	Observable bias considerations / required checks
Brachet 2012	Observational / analytic	Potential time-of-shift and patient-acuity confounding; modeled mortality is not direct observation.
Patterson 2012	Analytical cross-sectional	Convenience sample; self-reported fatigue and errors; temporality not established.
Guyette 2013	Repeated-measures observational	Small sample; mixed professions; variable workload and rest opportunities.
Weaver 2015	Retrospective cohort	Large administrative sample; no complete dispatch volume/fatigue exposure; observational confounding.

Study	Relevant appraisal approach	Observable bias considerations / required checks
Patterson 2015	Randomized trial	Self-rated fatigue endpoints; intervention exposure and generalizability need verification.
Patterson 2019a	Prospective cohort	Objective PVT strength; setting-specific selection, nap timing and residual confounding.
Patterson 2019b	Randomized trial	Follow-up attrition; benefits limited to selected shifts; no demonstrated patient outcome.
Rose 2023	Prospective service evaluation	n=8; incomplete readings; trends often nonsignificant; mixed professional roles.
Alruwaili 2024	Analytical cross-sectional	Convenience online recruitment; extreme stratum estimates and possible confounding; no direct errors measured.
Patterson 2025	Longitudinal repeated measurements	Data derived from a trial cohort; response noncompletion and repeated-measure dependence.
Patterson 2026	Cluster randomized trial	Cluster-level design; outcomes based on reports; null between-arm effect limits causal benefit claims.

The judgments above flag appraisal domains only; no formal overall low/moderate/high category or numerical JBI rating is assigned without full criterion-level assessment.

3.3 Main Findings of the Review

3.3.1 Shift Work, Sleep Deficiency and Fatigue

The burden of fatigue is evident in EMS populations. Patterson et al. (2012) surveyed 547 employees across 30 agencies and reported that 55% met their fatigue classification. This represents fatigue within the respondents and is not a census prevalence estimate for all paramedics. In Saudi Arabia, Alruwaili and Alanazy (2024) found that 513 of 1,076 surveyed paramedics (47.67%) met the Athens Insomnia Scale threshold for insomnia. Shift schedule, work patterns and reported occupational stress were associated with sleep problems, but the cross-sectional design cannot establish that any one shift factor caused insomnia.

More recent repeated assessments refine these patterns. Patterson et al. (2025) analyzed 4,573 reported shifts and found greater self-reported fatigue, sleepiness and difficulty concentrating during 24-hour shifts, with peaks around 03:00–04:00. Mean sleep before shifts was 6.2 hours, and sleep during shifts varied substantially by duration. These observations underscore circadian timing, rather than shift length alone, as an important operational variable.

3.3.2 Attention, Cognitive Performance and Clinical Quality

Objective performance data are mixed. In a small air-medical comparison, Guyette et al. (2013) found no between-group difference in changes across cognitive tests after 12-hour and 24-hour duties. Participants working 24-hour shifts reported substantially more opportunity to sleep during

duty than those on 12-hour shifts; the result therefore should not be extended to very busy ground ambulance systems with little protected rest.

In a 112-clinician prospective cohort, Patterson et al. (2019a) found no significant psychomotor vigilance difference by the simple split of shifts under 24 hours versus 24 hours, but selected vigilance measures were worse at night. Nap timing also mattered. Rose et al. (2023), monitoring eight HEMS clinicians, observed a significant within-shift rise in PVT response time during night shifts, although overall five-week increases were not statistically significant. Together these findings favor measurement of actual alertness and mission workload rather than reliance on roster duration alone.

The most direct work-performance evidence in the candidate literature includes Brachet et al. (2012), who examined approximately 743,000 emergencies attended by 2,381 paramedics. Their analysis indicated performance deterioration toward the end of long shifts. The publication estimated a possible 0.76% increase in 30-day mortality from modeled deterioration. Because this is a model-based inference, it should not be reported as an observed mortality effect of experimentally assigning longer shifts.

3.3.3 Occupational Injury, Errors and Patient Safety

In Patterson et al. (2012), 41.1% of respondents reported a medical error or adverse event over the specified recall period and fatigue was associated with 2.2-fold adjusted odds of this composite outcome. Adjusted odds of injury were 1.9-fold, and adjusted odds of perceived safety-compromising behavior were 3.6-fold among fatigued versus non-fatigued respondents. These associations are clinically important signals, while self-reporting and cross-sectional exposure/outcome measurement leave causality uncertain.

A separate administrative study by Weaver et al. (2015) linked 966,082 EMS work shifts with occupational reporting across 14 agencies. After adjustment, shifts longer than 16 and up to 24 hours were associated with 60% greater injury/illness risk than shifts over 8 and up to 12 hours (RR 1.60, 95% CI 1.22–2.10); shifts of 8 hours or less were associated with lower risk (RR 0.70, 95% CI 0.51–0.96). The endpoint was clinician injury/illness, not patient harm. Confounding by agency practices, mission activity and safety reporting remains possible.

Across all reports, objective patient-level harms such as medication-related complications, unexpected deterioration or preventable death were much less frequently measured than fatigue, insomnia, cognition or employee injury. For that reason, the evidence is stronger for a fatigue–performance/occupational-risk relationship than for a precise effect estimate on patient morbidity or mortality.

3.3.4 Effects of Fatigue-Mitigation Interventions

A randomized feasibility trial of 99 emergency clinician participants by Patterson et al. (2015) reported reduced self-rated fatigue and sleepiness with a text-based intervention during 12-hour shifts. The later SleepTrackTXT2 air-medical trial randomized 83 participants and found a short-term fatigue benefit near the end of 12-hour shifts, but no significant improvement in overall sleep quality after 120 days (Patterson et al., 2019b). These studies suggest that communication and behavior prompts may be helpful under certain conditions, without establishing durable sleep or patient-safety improvements.

A larger cluster-randomized study enrolled 108 EMS agencies and 708 shift workers (Patterson et al., 2026). Severe fatigue declined in both the intervention and attention-control groups during follow-up, but the between-group difference was not statistically significant. The trial tempers claims that fatigue messaging alone solves fatigue risk, and reinforces the need to evaluate broader scheduling and workplace interventions.

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3.4 Summary of Key Outcomes

Table 3. What the evidence can and cannot establish

Domain	Observed signal	Inference boundary
Sleep / insomnia	High fatigue and insomnia burden in cross-sectional EMS and Saudi paramedic samples.	Cannot determine population prevalence or causal shift effects from convenience surveys.
Vigilance / cognition	Night-shift deficits and time-of-night peaks; some small studies find null duration effects.	PVT and concentration are performance proxies, not measured clinical error rates.
Employee safety	Extended shifts associated with higher recorded occupational injury/illness in large cohort.	Agency practices and workloads may confound exposure–outcome relationships.
Patient safety	Self-reported medical error association; modeled mortality implication in administrative analysis.	Direct causal patient-harm evidence remains limited.
Interventions	Selected short-term symptom improvements with text prompts; mixed or null sustained benefits.	No demonstrated uniform effectiveness across EMS systems or patient outcomes.

4. Discussion

4.1 Interpretation of Main Findings

The candidate literature supports a plausible and important safety pathway: irregular duty patterns and constrained recovery contribute to poor sleep or fatigue; fatigue may reduce sustained attention and task reliability; and reduced reliability can create opportunities for occupational injury and clinical error. Evidence is not equally strong at every link. Fatigue and sleep are measured frequently, vigilance is measured in several smaller studies, and direct patient outcomes are comparatively uncommon. A careful synthesis must therefore avoid collapsing fatigue indicators, self-reported error, and actual patient harm into one endpoint.

The apparently discordant shift-duration findings can be understood through operational context. In some air-medical services, 24-hour duty may include meaningful periods of rest, whereas 12-hour work in a high-volume ambulance setting can provide little relief. Conversely, long hours combined with active workload and nighttime calls may create especially high risk. The frequency of nighttime exposure, rest opportunities, mission acuity and personnel recovery can influence both measured fatigue and safety outcomes. Fixed schedule duration alone is an incomplete measure of physiological exposure.

4.2 Comparison with Previous Reviews and Guidance

The 2018 evidence-based fatigue risk management recommendations for EMS, developed by Patterson et al. (2018a), favored organizational attention to fatigue measurement, scheduling, breaks/naps and related countermeasures. A companion systematic review concluded that shifts of 24 hours or more tended to show unfavorable outcomes relative to shorter shifts in several worker-health and performance domains, while comparisons between 8-hour and 12-hour shifts lacked a consistent winner (Patterson et al., 2018b). These guideline-level findings support cautious policy development, but they should not be mistaken for direct evidence that any specific shift limit will eliminate patient harm in every service.

The selected primary evidence largely aligns with the guidelines on the need for proactive fatigue management. Newer results reinforce specific uncertainty: Patterson et al. (2025) shows marked variation over the clock cycle, whereas Patterson et al. (2026) reports no statistically significant superiority of a messaging intervention. Thus, multi-component operational controls are more defensible than reliance on a single educational or text-message tool.

4.3 Implications for Saudi Red Crescent Authority and EMS Systems

For EMS organizations, scheduling should be viewed as a patient and staff safety control rather than solely an administrative staffing decision. Roster reviews could track consecutive shifts, actual hours awake, overnight workload, overtime and minimum recovery periods. Fatigue reporting should be non-punitive and paired with access to operational adjustments for high-risk duty periods. The measures must be evaluated locally because the evidence does not identify one universally optimal duty length for all settings.

The Saudi survey provides a local reason to prioritize sleep-health screening and to investigate roster patterns among paramedics, but its results should not be directly generalized to all employees of the Saudi Red Crescent Authority. Prospective local evaluations could link duty rosters to operational data such as dispatch volume, time spent driving, medication administration, case documentation, handover quality, near misses and unplanned follow-up. Any patient-level analysis would need suitable governance, anonymization and confounder adjustment.

Practical safeguards may include documented fatigue checks before high-risk driving, protected rest where operationally feasible, structured handovers during long duty periods, review of overtime and consecutive nights, and post-shift access to safe travel options. Education on sleep practices is useful as a supporting measure, but it cannot compensate fully for insufficient time available for sleep.

4.4 Strengths and Limitations

Strengths of this manuscript include a clearly specified fatigue-to-safety framework, differentiation between direct and proxy outcomes, incorporation of objective and subjective performance measures, and attention to an original Saudi paramedic study. The evidence is not limited to one study design: large cohorts, randomized trials and small physiological studies provide different forms of insight.

The primary limitation is review-process documentation. No full export of database records, eligibility log, reviewer agreement data, dated search history or protocol accompanied the user-supplied title. Therefore, the primary study table is illustrative of verified relevant literature, not proof of exhaustive retrieval. A formal PRISMA count and reproducible JBI rating would be fabricated if presented as completed. At the study level, substantial heterogeneity, convenience sampling, lack of objective patient outcomes, mixed-professional populations, and overlap among some research programs also limit generalizability.

A further limitation concerns causal interpretation. Self-reported errors can be affected by recall and willingness to disclose; observational injury data may be affected by assignment patterns and workplace reporting; and psychomotor tests may not predict a specific clinical mistake. The effect of fatigue is also plausibly modified by task complexity and alertness countermeasures. Any combined numerical effect would need harmonized outcome definitions and validated independent datasets.

4.5 Future Research Priorities

Future investigations should use prospective multi-agency designs with objectively captured roster schedules, actigraphy or validated sleep measures, mission intensity, PVT or equivalent performance tasks, and independently adjudicated clinical/process safety outcomes. When appropriate, stepped-wedge or cluster-randomized implementation studies could test roster changes, protected breaks, fatigue reporting and education in combination. Saudi-based research should distinguish ground ambulance and air-medical operations and assess practical feasibility alongside patient safety, clinician wellbeing and ambulance coverage.

5. Conclusion

Shift work and occupational fatigue are relevant to paramedic clinical performance and the safety of both patients and EMS personnel. Published EMS surveys associate fatigue with self-reported medical error and injury; objective studies show important night-time and workload patterns; and large administrative datasets identify increased occupational injury risk during extended duty. However, direct evidence that a specific shift schedule causes a particular patient outcome is less secure, and fatigue-mitigation interventions have shown mixed results.

An evidence-informed response should combine thoughtful roster design, recovery opportunities, fatigue monitoring, supportive reporting and locally evaluated safety measures. The manuscript provides a carefully sourced synthesis in the structure of the supplied reference article, but original systematic searching, documented study selection and design-specific full JBI appraisal remain prerequisites for a fully reproducible systematic review.

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Appendix A. PRISMA 2020 Documentation Status

The source files contained a title/author sheet for this topic and a model systematic-review manuscript on a different EMS subject. They did not provide search exports, database yield counts or study-level eligibility decisions for the present topic. The model manuscript's numeric PRISMA flow must not be carried over to a new review.

Table A1. Selection fields requiring source documentation

PRISMA field	Current status	Documentation required
Records identified by database	Not supplied	Date-stamped exports and database-specific counts
Records identified from other sources	Not supplied	Citation chasing and registry logs
Duplicates removed	Not supplied	Deduplication log and software method
Titles/abstracts screened	Not supplied	Screening set with record IDs and decisions
Full texts sought / not retrieved	Not supplied	Retrieval attempts and non-retrieval reasons
Full texts assessed / excluded	Not supplied	Reasons linked to each excluded report
Included studies	Not established	Auditable included-citation list and screening decisions

Appendix B. Example Search Strategies (for Reproducible Execution)

The expressions below are prospective example strategies and were not presented as previously executed searches. A completed review must record the exact search date, field limits, filters, interface and retrieved counts for each database.

PubMed/MEDLINE

("Emergency Medical Services"[MeSH] OR paramedic*[tiab] OR ambulance*[tiab] OR prehospital[tiab]) AND ("Shift Work Schedule"[MeSH] OR fatigue[tiab] OR sleepiness[tiab] OR "night shift"[tiab] OR "shift length"[tiab] OR "work hours"[tiab]) AND ("Patient Safety"[MeSH] OR "occupational injur*"[tiab] OR performance[tiab] OR "medical error*"[tiab] OR vigilance[tiab] OR insomnia[tiab])

Scopus

TITLE-ABS-KEY (paramedic* OR ambulance OR "emergency medical services") AND TITLE-ABS-KEY ("shift work" OR fatigue OR sleepiness OR "shift duration" OR insomnia) AND TITLE-ABS-KEY ("patient safety" OR "clinical performance" OR errors OR injury OR vigilance)

Web of Science

TS=(paramedic* OR ambulance OR "emergency medical services") AND TS=("shift work" OR fatigue OR "night shift" OR sleep deprivation) AND TS=("patient safety" OR performance OR errors OR injury OR cognition)

CINAHL / Embase

Map EMS, paramedic, shift work, fatigue, sleep disorders, medical errors and occupational injury to each database's controlled terms; combine concept sets with AND and synonyms with OR. Save the executed platform-specific syntax.

Appendix C. Study-Level Extraction Template

Table C1. Minimum fields for auditable study extraction

Field	Required documentation
Citation and identifier	Author, year, title, DOI/PMID, screening ID
Study design and setting	Country, recruitment, prehospital system, calendar period
Population	Professional role, sample, age/workload and eligibility criteria
Fatigue exposure	Shift duration, nights, sleep, fatigue scale, measurement timing
Outcomes	Clinical error definition, patient safety event, PVT score, injury/illness and follow-up
Numerical effect	Adjusted estimate, 95% CI, denominator and model covariates
Risk of bias	JBI item-level answers with quoted/located supporting passage
Verification	Independent reviewer, reconciliation date and conflict resolution

Appendix D. JBI Assessment Audit Guide

- Use the full JBI checklist matching each study design. A criterion should be marked Yes, No, Unclear or Not Applicable only after inspecting the complete paper. Recommended record fields: study ID, reviewer 1 judgment, reviewer 2 judgment, supporting page/paragraph, discrepancy note and final consensus.
- Analytical cross-sectional reports: evaluate inclusion criteria, participant and setting description, valid and reliable fatigue measurement, confounding identification and management, outcome validity and analysis appropriateness.
- Cohort and administrative studies: examine baseline comparability, valid exposure classification, reliable outcomes, confounders, completeness and duration of follow-up, and the analytic treatment of follow-up.
- Randomized trials: document randomization sequence, allocation concealment, comparable baseline groups, blinding where feasible, deviations from assignment, attrition, intention-to-treat and appropriate statistical analysis.
- Small prospective service evaluations: evaluate consistent recruitment, repeated-measure independence, missing readings, appropriate time-series analysis and transferability to ground EMS practice.