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REVIEWS

WHEN GUIDELINES MEET THE ROAD: A CFIR-INFORMED SYSTEMATIC REVIEW OF IMPLEMENTATION IN AMBULANCE SERVICES

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ABSTRACT

Introduction: Clinical practice guidelines are central to safe, consistent, and evidence-informed ambulance care, yet their implementation is rarely straightforward. Ambulance services operate across complex, time-sensitive, and geographically dispersed settings, where organizational capacity, local context, and workforce engagement can influence whether guidelines are adopted and sustained in practice. This review aimed to identify and synthesize the barriers and facilitators influencing the implementation of clinical practice guidelines in ambulance services, and to map these determinants using the Consolidated Framework for Implementation Research (CFIR).

Methods: This systematic review followed Joanna Briggs Institute methodology for mixed-methods systematic reviews and was registered with PROSPERO (CRD42024580204). Searches were conducted in MEDLINE (PubMed), CINAHL, EMBASE, Cochrane Library, JBI Database, Scopus, and Web of Science. Qualitative, quantitative, and mixed-methods studies published in English within the past 20 years were included. Data were extracted and mapped to the domains of the CFIR.

Results: Forty-two studies were included, revealing substantial variability in CPG implementation contexts and outcomes. Key barriers included resource limitations, protocol complexity, and organizational resistance, especially in rural and under-resourced areas. Facilitators identified included leadership engagement, effective communication, adaptable protocols, and targeted education. The most frequently reported determinants were within the CFIR's 'Inner Setting' and 'Process' domains.

Conclusion: The implementation of clinical practice guidelines in ambulance services depends on more than the quality of the guideline itself. Successful uptake requires organizational readiness, local adaptation, leadership support, workforce engagement and sustained implementation planning. By mapping implementation determinants to the CFIR, this review provides a structured evidence base to guide future implementation strategies, policy development and research in ambulance services.

INTRODUCTION

Clinical practice guidelines (CPGs) are important tools for promoting standardized, high-quality, and evidence-informed care across healthcare systems. In ambulance services, CPGs support clinical decision-making in dynamic, unpredictable, and often resource-limited environments. Paramedics deliver care across diverse emergency and non-emergency contexts, frequently with

limited personnel, equipment, and direct clinical oversight. Consistent application of CPGs is therefore important for supporting safe and reliable patient care (Maria, 2021).

Despite their recognized benefits, the implementation of CPGs in ambulance services is frequently challenged by significant contextual and organizational barriers. Ambulance services vary widely in their structures, workforce capacities, and available resources, contributing to marked differences in the adoption and application of CPGs (Maria et al., 2024). Barriers such as resource scarcity, limited training opportunities, and logistical constraints are especially acute in rural and underserved settings, where maintaining adherence to guidelines can be particularly difficult (McCaul et al., 2018). Additionally, the diversity within paramedic scope of practice levels, such as Advanced Life Support (ALS) and Basic Life Support (BLS), requires that guidelines often be adapted to match the skills and resources available within each service type (Wilkinson-Stokes et al., 2021).

Previous reviews have identified an unstructured range of barriers and facilitators to CPG implementation in out-of-hospital care. Commonly reported obstacles include insufficient inter-agency coordination, lack of dedicated funding, and inconsistent access to technology for disseminating and tracking guidelines (Lord et al., 2012; Maria et al., 2024; McCaul et al., 2019). To date, our understanding of the challenges remains limited, and there remains a need for a comprehensive synthesis that systematically maps the determinants of CPG implementation across different service contexts. Such synthesis can inform the development of targeted, context-sensitive interventions to improve guideline uptake and sustainability.

The Consolidated Framework for Implementation Research (CFIR) was selected because it provides a comprehensive structure for examining implementation determinants across intervention, organizational, individual and process-related domains (Damschroder et al., 2009). Its multidimensional structure is well suited to ambulance services, where guideline implementation is influenced by interactions between clinical protocols, workforce capability, organizational systems and external service contexts. This systematic review aimed to identify and synthesize the barriers and facilitators influencing CPG implementation in ambulance services, and to map these determinants across the five CFIR domains: Intervention Characteristics, Outer Setting, Inner Setting, Characteristics of Individuals, and Process.

The primary research question was: What are the main barriers and facilitators of clinical practice guideline implementation in ambulance services, and how do these map to the domains of CFIR?

METHODS

Study Design and Protocol Registration

This systematic review was conducted in accordance with the Joanna Briggs Institute (JBI) methodology for mixed methods systematic reviews (MMSR), as outlined in Chapter 8 of the JBI Manual for Evidence Synthesis (JBI, 2024). Studies of all designs, including qualitative, quantitative, and mixed methods studies, were included to address the review question comprehensively. A convergent integrated approach was used; whereby quantitative data were transformed into textual descriptions ("qualitized") and synthesized alongside qualitative findings to generate integrated categories and

findings (Joanna Briggs Institute, 2024b). The review was reported in accordance with PRISMA 2020 guidelines (Page et al., 2021). The protocol was registered in PROSPERO (CRD42024580204).

The CFIR guided data extraction and synthesis. CFIR identifies determinants of implementation across five domains: Intervention Characteristics, Outer Setting, Inner Setting, Characteristics of Individuals, and Process. Mapping findings to these domains supported structured synthesis of barriers and facilitators influencing CPG implementation in ambulance service settings.

Eligibility Criteria

Studies were eligible if they involved paramedics, ambulance clinicians, or other out-of-hospital care providers and examined implementation of clinical practice guidelines in ambulance service or out-of-hospital care settings. Outcomes of interest were barriers, facilitators, or other implementation determinants that could be mapped to CFIR domains. Studies of any design, including randomized controlled trials, quasi-experimental studies, observational studies, qualitative studies, and mixed-methods studies, were eligible if published in English within the last 20 years. Case reports, editorials, opinion pieces, studies involving non-EMS healthcare providers, and studies conducted solely in hospital-based settings were excluded.

Search Strategy

Searches were conducted in MEDLINE (PubMed), CINAHL, EMBASE, Cochrane Library, JBI Database, Scopus, and Web of Science. Search terms related to clinical practice guidelines, ambulance services and out-of-hospital care, and implementation determinants, including "clinical practice guidelines", "ambulance services", "implementation", "training", and "leadership support". Searches were limited to English-language publications from the previous 20 years. Additional records were identified through citation searching and supplementary Google Scholar searching. Google Scholar was searched using simplified keyword combinations based on the main database strategy, and the first 200 results were screened for potentially relevant studies. The full search strategy is available in Appendix 1.

Study Selection

Study selection was undertaken in Covidence (Veritas Health Innovation, 2024). After duplicate removal, three independent reviewers screened titles and abstracts against the inclusion and exclusion criteria. Full-text review was then undertaken in the same way to confirm eligibility. Disagreements were resolved through discussion. The PRISMA flow diagram was used to report the study selection process.

Data Extraction

Data was extracted in Excel (Microsoft Corporation, 2024) using a standardized template based on JBI methodology. Extracted items included study characteristics, participant details, intervention characteristics, reported barriers and facilitators, and implementation determinants relevant to CFIR domains. Two reviewers independently extracted data and mapped each reported barrier and facilitator to the most relevant CFIR domain and, where appropriate, construct. The two extracted and mapped datasets were then com-

pared, with discrepancies resolved through discussion and consensus. Where agreement could not be reached, a third reviewer adjudicated.

Critical Appraisal and Risk of Bias Assessment

Methodological quality was assessed using the JBI Critical Appraisal Checklists, with the checklist matched to each study design (Joanna Briggs Institute, 2024a). Two reviewers independently appraised included studies and assigned overall ratings of high, moderate, or low quality. Discrepancies were resolved through discussion or consultation with a third reviewer. The critical appraisal results were used to inform interpretation of the synthesis, particularly when considering the strength and consistency of findings within and across CFIR domains.

Data Synthesis

Data analysis followed the convergent integrated approach for mixed methods systematic reviews recommended by JBI (Joanna Briggs Institute, 2024b). Quantitative findings were transformed into textual descriptions ("qualitized") and synthesized alongside qualitative findings. All qualitative findings, qualitized quantitative results, and relevant findings from mixed-methods studies were pooled based on similarity of meaning.

Synthesis was undertaken using the meta-aggregative approach described in the JBI Manual for Evidence Synthesis, with findings examined and categorized into themes based on shared meaning. Categories were developed using both deductive and inductive coding. CFIR provided the deductive framework, with extracted findings initially organized according to the five CFIR domains: Intervention Characteristics, Outer Setting, Inner Setting, Characteristics of Individuals, and Process. Within each domain, recurring patterns in the extracted barriers and facilitators were then examined inductively to develop subthemes and categories based on shared meaning. This supported a structured and theory-informed synthesis of implementation determinants across diverse study types.

A formal certainty or confidence assessment was not undertaken. This review used a framework-based synthesis, mapping heterogeneous qualitative, quantitative, and mixed-methods evidence to CFIR domains rather than synthesizing it as discrete effect estimates or standalone qualitative findings. Methodological quality was therefore considered when interpreting the strength and consistency of findings within and across CFIR domains.

Given the heterogeneity of study designs, interventions, and reported outcomes, meta-analysis was not appropriate. Findings were therefore synthesized narratively and presented by CFIR domain. The frequency and nature of reported barriers and facilitators were described, including convergent, divergent, and complementary findings across study types.

RESULTS

Study Selection and Characteristics

A total of 42 studies were included following screening and eligibility assessment (Figure 1). The database search identified 940 records, with a further 13 references located

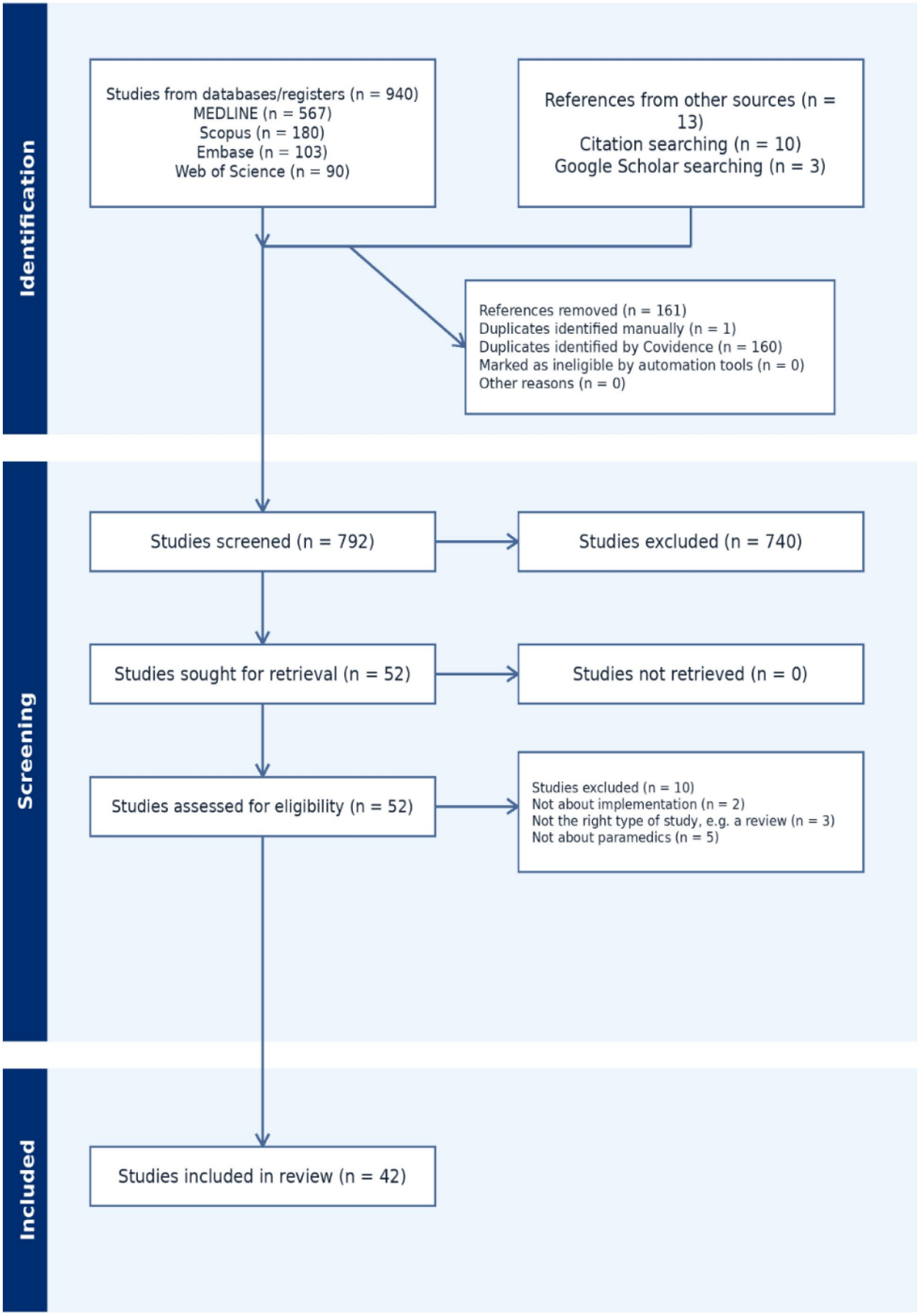

Figure 1. PRISMA.

through manual citation searching and Google Scholar. After removal of 161 duplicates, 792 records were screened. Fifty-two full-text articles were assessed for eligibility, of which 10 were excluded because they focused on non-paramedic populations, lacked an implementation focus, or were review or commentary papers.

A summary of included study characteristics is provided in Table 1, with detailed study-level characteristics provided in Appendix 2.

Characteristic	Summary
Number of included studies	42
Publication years	2004–2024
Countries/regions represented	USA, Canada, Australia, New Zealand, England, Northern Ireland, Netherlands, Germany, Finland, Sweden, Norway, South Africa, Europe, and multi-country studies across Asia, Latin America and Europe
Study designs	Qualitative studies, surveys, mixed-methods studies, retrospective and prospective observational studies, before-and-after studies, quasi-experimental studies, interrupted time series, process mining, and implementation/evaluation reports
Population/setting	Paramedics, ambulance clinicians, EMS leaders, EMS agencies, emergency response organizations, helicopter emergency medical services, and related out-of-hospital care settings
Guideline/protocol focus	Pain management, cardiac arrest and resuscitation, trauma and traumatic brain injury, pediatric care, referral pathways, thrombolysis, prehospital anesthesia, transport safety, quality improvement, and evidence-based guideline implementation
Implementation focus	Barriers and facilitators to CPG uptake, protocol adherence, training and education, leadership, organizational readiness, audit and feedback, implementation strategies, and sustainability
Detailed study-level characteristics	Provided in Appendix 2

Table 1. Summary characteristics of included studies.

Included studies used a range of designs, including mixed methods, retrospective and prospective observational studies, cross-sectional surveys, quasi-experimental studies, and qualitative research. Some also used cohort, controlled before-and-after, national evaluation, or longitudinal designs. Studies were conducted across the USA, Canada, Australia, Europe, and South Africa (Figure 2). Interventions included training programs, leadership strategies, and technological supports, with outcomes relating to clinical care, documentation, guideline adherence, and paramedic knowledge. Full study characteristics are provided in Appendix 2.

Critical Appraisal and Risk of Bias Results

Overall, studies were of moderate to high methodological quality. Of the 42 included studies, 22 were rated as high quality and 20 as moderate quality; no studies were rated as low quality. Appraisal considered study design, sampling and recruitment, appropriateness of data collection methods, and management of potential confounding. Common limitations included reliance on self-reported data, incomplete reporting of sampling or recruitment, limited reporting of researcher positioning or reflexivity in qualitative studies, and limited control for confounding in observational and survey-based studies. Detailed study-level appraisal notes are provided in Appendix 3. Given the heterogeneity of study designs and outcomes, risk of bias assessments were used to inform interpretation of the findings rather than to exclude or weight studies.

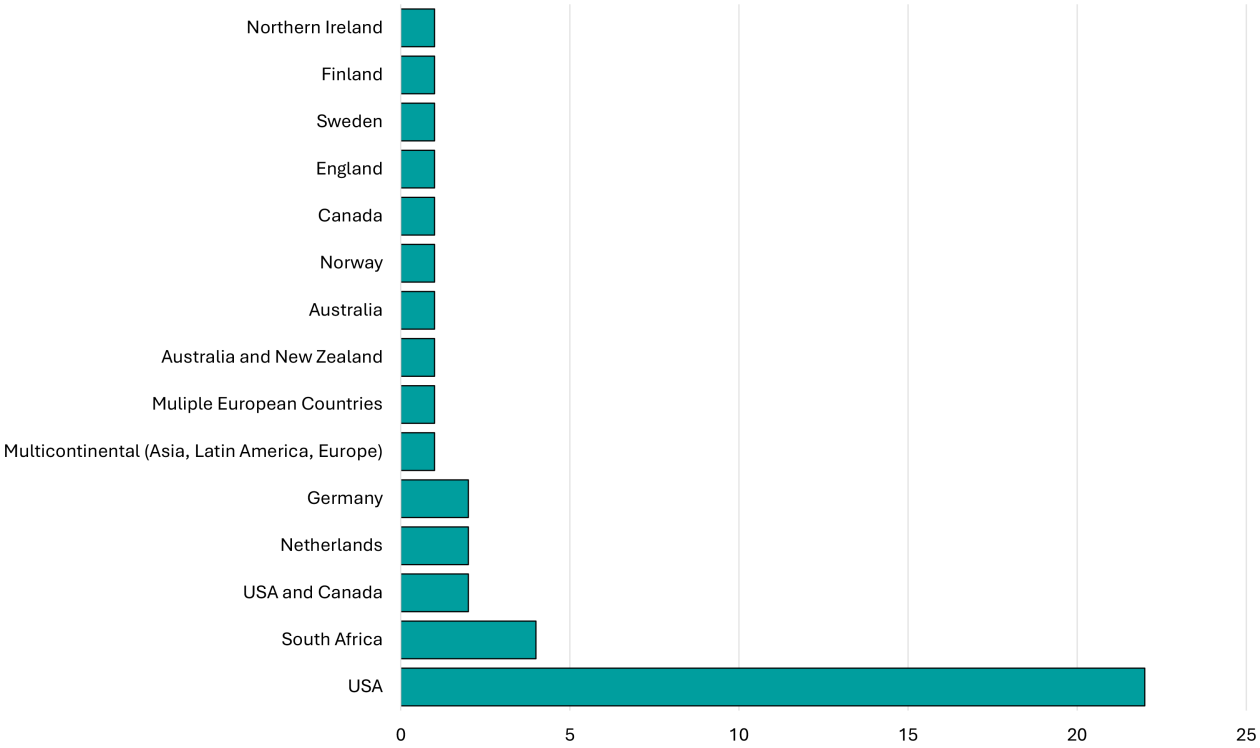

Figure 2. Distribution of studies by country.

Synthesis of Results Organized by CFIR Domains

Findings were extracted and organized using CFIR as the framework for synthesis. The full study-level CFIR extraction is provided in Appendix 4. Each included study was examined against the five CFIR domains: Intervention Characteristics, Inner Setting, Outer Setting, Characteristics of Individuals, and Process. Therefore, the domain summary should be interpreted as a framework-based organization of extracted determinants rather than as mutually exclusive frequency counts. Some determinants were mapped across more than one domain, reflecting the interaction between intervention, organizational, individual and system-level factors. For example, resource constraints appeared as both an Inner Setting issue, relating to staffing, equipment, training capacity and organizational infrastructure, and an Outer Setting issue, relating to broader funding, geography and service-system variation. Similarly, rural and under-resourced contexts influenced implementation across multiple domains, including workforce capacity, access to training, inter-agency coordination, and availability of alternative care pathways. Table 2 summarizes the recurring implementation determinants identified within each CFIR domain.

Intervention Characteristics

Implementation of CPGs in ambulance services was influenced by guideline complexity, adaptability, and the extent to which protocols depended on resources available in the local service context.

Complexity was a consistent barrier to implementation. Lengthy protocols, high cognitive demands, and poor fit with prehospital practice reduced uptake, particularly in stressful or time-critical situations (Adelgais et al., 2019; Bosse et al., 2011; Hagiwara et al.,

CFIR Domain	Role in Synthesis	Recurring Determinants Identified
Intervention Characteristics	Captured features of the guideline, protocol, pathway, checklist, training package or implementation intervention that influenced uptake.	Complexity, adaptability, clarity, accessibility, evidence alignment, compatibility with clinical workflow, format, need for local contextualization.
Inner Setting	Captured organizational conditions within ambulance services and related agencies.	Organizational readiness, leadership support, available resources, staffing, training infrastructure, communication, organizational culture, feedback systems, local governance.
Outer Setting	Captured external system, policy, regulatory and service-environment factors influencing implementation.	Funding, regulation, policy mandates, geography, rurality, inter-agency coordination, hospital feedback, community needs, system fragmentation.
Characteristics of Individuals	Captured clinician, leader and stakeholder factors influencing engagement with guidelines.	Knowledge, confidence, attitudes to change, professional autonomy, perceived risk, motivation, prior experience, comfort with new skills or protocols.
Process	Captured how implementation was planned, delivered, monitored and sustained.	Education and training, phased implementation, champions, stakeholder engagement, audit and feedback, monitoring, reinforcement, quality improvement, sustainability planning.

Table 2. Summary of recurring implementation determinants by CFIR domain.

2013; Sarmiento et al., 2013). This was evident in areas such as weight-based opioid dosing and advanced life support protocols, where adherence was often delayed and clinicians reverted to simpler approaches under pressure (Bigham, Koprowicz, et al., 2010).

Adaptability facilitated implementation. Guidelines tailored to local resources, equipment, and service context were associated with greater uptake and clinician confidence (Adelgais et al., 2019; Ciarletta et al., 2024; McManus et al., 2023). Locally adapted protocols and training were particularly useful in complex areas such as pediatric transport, asthma care, STEMI, and traumatic brain injury (Gaither et al., 2024; Kothari et al., 2021; Spaite et al., 2019).

Resource dependency remained a barrier where guidelines required staffing, equipment, funding, or implementation structures that were not consistently available (Angerman et al., 2023; Mai et al., 2023; Mould-Millman et al., 2023). This was particularly evident in rural, low-income, and volunteer-based services, where uptake was more variable and adherence was lower (Adelgais et al., 2019; McCaul et al., 2020; Spaite et al., 2019).

Inner Setting

Implementation of CPGs was influenced by organizational readiness, leadership engagement, and workplace culture.

Organizational readiness shaped implementation. Larger EMS agencies were generally better prepared due to stronger infrastructure, established training systems, and access to digital decision-support tools, supporting smoother implementation and higher compliance than less-resourced services (Angerman et al., 2023). Smaller or volunteer-based services faced greater implementation barriers, including limited staffing, funding, and access to training, contributing to less consistent uptake (Adelgais et al., 2019).

Leadership engagement also influenced implementation. Services with visible leadership support, protocol development activities, and performance review processes reported stronger adherence and greater accountability (Angerman et al., 2023; Feder et al., 2006). Where leadership was inconsistent, implementation was more variable and services appeared less able to support change effectively (Adelgais et al., 2019).

Workplace culture further shaped implementation. Collaborative cultures that supported shared decision-making and team-based learning were better positioned to embed new CPGs, while resistance to change remained a barrier, particularly where clinicians were reluctant to move away from established practices (Bosse et al., 2011; Carey et al., 2019; Kothari et al., 2021). Qualitative evidence also suggested that transport-focused organizational norms could limit uptake of referral pathways and alternative care options, while recognizing paramedics as autonomous clinicians supported practice change (Bloomer et al., 2024).

Outer Setting

Implementation of CPGs was shaped by regulatory requirements, external partnerships, and system-level resourcing.

Regulatory frameworks influenced adherence, with EMS services operating under national or regional mandates generally reporting stronger uptake than those without formal external requirements (Brown et al., 2014; Spaite et al., 2019). In the absence of such mandates, implementation was more variable and depended more heavily on internal leadership and organizational priorities, although strong leadership and training could partly offset this (Guerrier et al., 2023).

External relationships also affected implementation. Public awareness initiatives, such as CPR and AED campaigns, were associated with stronger alignment with evidence-based practice (Ezem et al., 2024). Collaboration with hospitals and other health services supported adoption of time-critical protocols, particularly in areas such as stroke, STEMI, and cardiac arrest care (Angerman et al., 2023; Carey et al., 2019; Jones Rhodes et al., 2016; Spaite et al., 2019). However, logistical and coordination challenges could limit the effectiveness of these partnerships.

System-level resource disparity was a major barrier. Rural agencies often had less access to equipment, trained personnel, funding, and implementation supports, contributing to lower adherence, particularly for complex protocols such as pediatric and trauma care (Mai et al., 2023; McCaul et al., 2020). Limited uptake of adhesive defibrillation pads, restricted access to video laryngoscopes and ePCRs, delays in software updates, and local protocol modifications further illustrate the effect of external resource constraints and operational misalignment on implementation (Bigham, Aufderheide, et al., 2010; Ebben et al., 2014; Krawczyk et al., 2016).

Characteristics of Individuals

Implementation of CPGs was influenced by paramedics' knowledge, beliefs, confidence, and attitudes towards guideline use.

Knowledge and skill deficits were a recurring barrier, particularly for complex protocols such as weight-based opioid dosing and pediatric trauma care, where clinicians reported uncertainty in high-pressure or resource-constrained environments (Adelgais et al., 2019; Angerman et al., 2023). Generational differences also contributed to variation in adherence, with younger paramedics more likely to adopt structured evidence-based guidelines, while more experienced clinicians were more likely to rely on established practice or personal judgement (Guerrier et al., 2023).

Beliefs and attitudes towards CPGs shaped implementation. Resistance to change was commonly reported, particularly among experienced clinicians, alongside concerns regarding medication dosing errors, adverse effects, reduced autonomy, and restrictions on clinical judgement (Bosse et al., 2011; Carey et al., 2019; Feder et al., 2006). In contrast, clinicians were more likely to adopt guidelines when they perceived clear clinical benefit, such as improved treatment accuracy or reduced medication error (McManus et al., 2023). Fear of complaints or regulatory scrutiny could also discourage use of alternative care pathways even when clinically appropriate (Bloomer et al., 2024).

Confidence and self-efficacy supported adherence, particularly where clinicians felt organizationally supported and protocols were embedded within routine practice (Ebben et al., 2015; Feder et al., 2006). However, experience could also contribute to deviation from protocols where feedback and monitoring were limited (Bosse et al., 2011).

Process

Implementation of CPGs was influenced by how guidelines were planned, introduced, reinforced, and evaluated.

Structured planning supported implementation. Evidence appraisal, stakeholder collaboration, phased rollouts, pilot programs, and staggered adoption schedules reduced uncertainty and supported adherence during transition to new guidelines (Angerman et al., 2023; Feder et al., 2006; Lang et al., 2012; McCaul et al., 2020; Spaite et al., 2019).

Engagement of frontline clinicians was also important. Passive dissemination limited confidence and uptake, whereas involving paramedics in implementation processes improved buy-in and alignment with operational realities (Thorvaldsen et al., 2019). Pre-implementation strategies that included clinician input and targeted training were associated with higher adherence and greater confidence in applying guidelines (Adelgais et al., 2019; Kothari et al., 2021).

Education and reinforcement strategies strengthened execution. Structured education, simulation-based training, checklists, interactive learning methods, provider prompts, and feedback improved familiarity, confidence, and adherence, particularly for complex protocols such as traumatic brain injury, opioid safety, seizure management, and pediatric airway care (Angerman et al., 2023; Carey et al., 2019; Kelleher et al., 2014; Siriwardena et al., 2014; Tomasone et al., 2014; Watts et al., 2004).

Ongoing monitoring and feedback supported sustained implementation. Regular audit processes, feedback sessions, ePCRs, and clinical audit systems improved documentation, reduced deviation from protocols, and helped maintain guideline use over time (Bosse et al., 2011; Feder et al., 2006; Kothari et al., 2021).

Across studies, determinants related to planning, clinician engagement, and early training appeared most relevant to initial implementation, while audit, feedback, monitoring, and integration into routine systems were more closely aligned with sustained practice.

The following figure visually represents the key determinants of CPG implementation in ambulance services identified across the five CFIR domains. Figure 3 provides a concise visual overview of the main guideline, clinician, organizational, process, and system-level influences discussed in the Results and Discussion.

Figure 3. CFIR determinants of clinical practice guidelines implementation in ambulance services.

DISCUSSION

This review identified multiple interacting determinants of CPG implementation in ambulance services, with barriers and facilitators evident across all CFIR domains. Implementation was shaped not only by the quality of the guideline, but by whether it could be applied in mobile, time-critical, geographically dispersed, and resource-variable care environments. Ambulance clinicians often make decisions with limited personnel, variable equipment access, minimal immediate clinical support, and little control over the physical or social environment. In this context, guideline usability, operational fit, training, feedback, and organizational support become central to implementation.

The CFIR mapping showed that implementation challenges were rarely confined to one level of influence. Protocol complexity, training access, workforce confidence, leadership support, resource availability, inter-agency coordination, and rurality frequently interacted across domains. For example, a clinically appropriate guideline may still be difficult to implement if it requires equipment that is inconsistently available, training that cannot be delivered across dispersed teams, or coordination with receiving services that varies by region.

Adaptability and usability emerged as central influences. Guidelines were more likely to be adopted when they were clear, operationally relevant, and adaptable to local service conditions. Complex protocols, high cognitive demands, and heavy resource requirements created barriers, particularly in rural and under-resourced settings. This aligns with wider implementation literature showing that intervention design and contextual fit are critical where workflow, staffing, and infrastructure constraints affect feasibility (Dev et al., 2020; Roldan et al., 2022; Tuyisenge et al., 2021). In ambulance care, these pres-

sures are intensified by mobile practice, time-critical decision-making, variable scope of practice, and uneven access to equipment and training.

Inner setting and process factors were also prominent. Leadership engagement, organizational readiness, supportive workplace culture, practical training, and ongoing feedback were associated with stronger uptake of CPGs. Services that involved clinicians in implementation and reinforced expectations through education, audit, and review appeared better positioned to embed guideline use into routine practice. Conversely, inconsistent leadership, limited organizational support, and resistance to change were linked with more variable adherence. This is consistent with broader healthcare evidence that leadership visibility, collaborative culture, and structured implementation processes support practice change and guideline compliance (Blok et al., 2021; Orangi, 2023; Stokes et al., 2016).

Determinants also appeared to differ between initial implementation and sustained practice. Initial uptake was most closely linked to protocol clarity, clinician awareness, early training, leadership communication, and resource availability. Sustained adherence relied more on refresher training, audit and feedback, access to outcome data, ongoing leadership support, protocol updates, and integration into routine organizational systems. This suggests that strategies used to introduce CPGs may not be sufficient to maintain their use over time.

Individual-level influences included knowledge gaps, lack of confidence with complex protocols, cognitive overload, and reliance on established routines. Practical and repeated training, particularly when linked to real-world application, helped clinicians build confidence, rehearse application, and receive reinforcement over time. This supports broader healthcare literature suggesting that education is more effective when active, iterative, and integrated into practice rather than delivered as one-off information transfer (Flynn et al., 2016; Stokes et al., 2016).

Outer setting factors, particularly regulation, inter-organizational collaboration, and resource disparity, further shaped implementation. Stronger regulatory or collaborative frameworks appeared to support guideline uptake, while rural and low-resource settings faced additional barriers related to equipment, training access, and specialist support. This reinforces that implementation is not solely a clinician-level issue; it is also shaped by service capability, geography, receiving hospital relationships, and broader system conditions. Broader health systems literature similarly shows that external partnerships, organizational linkages, and equitable access to resources influence whether evidence-based practices can be implemented consistently across settings (Luo et al., 2021; Perry et al., 2017; Valaitis et al., 2018).

Implications for Practice and Policy

Improving CPG implementation in ambulance services requires more than guideline publication alone. Services should assess local readiness and barriers before implementation, adapt guidelines to local workflows, identify local champions, and support uptake through practical education, simulation, audit, and feedback. These strategies align with the Expert Recommendations for Implementing Change (ERIC) taxonomy, which provides a structured set of approaches for supporting evidence uptake in healthcare (Powell et al., 2015; Waltz et al., 2015).

For guideline developers and educators, the findings highlight the importance of usability, clarity, and operational fit. Guidelines should be designed for mobile, time-critical, and resource-variable care environments, with education that helps clinicians apply recommendations in realistic practice conditions. For implementation leads, ongoing reinforcement, feedback systems, and decision-support tools may help move guideline use from initial adoption to sustained practice.

At a policy and service-planning level, the level at which CPGs are developed and implemented requires careful consideration. National CPGs can support consistency, reduce duplication, and provide a common minimum standard across services, but may be too broad to account for local workforce, geography, equipment, digital systems, or referral pathways. State or regional CPGs may better reflect jurisdictional legislation, scope of practice, governance, and service configuration, although this can create variation between jurisdictions. Local implementation allows services to tailor training, decision-support, equipment use, and referral processes to their own context, but may also increase inconsistency, duplication, and reliance on local implementation capacity.

Greater attention is also needed to rural and resource-related inequities. Implementation planning should include investment in training, digital infrastructure, essential equipment, feedback systems, and access to clinical support where appropriate. Overall, implementation is likely to be strongest when core standards are supported at national or jurisdictional levels, while allowing local adaptation of implementation processes to fit operational conditions.

LIMITATIONS

This review has several limitations. The included studies were heterogeneous in design, context, and outcome measures, which precluded meta-analysis and required narrative synthesis. Some studies relied on self-reported data, introducing the possibility of reporting bias. In addition, only English-language studies were included, which may limit the transferability of findings to non-English-speaking settings.

CONCLUSION

This systematic review synthesized barriers and facilitators influencing CPG implementation in ambulance services, using CFIR as the organizing framework. Findings indicate that effective implementation depends on more than guideline publication. Mapping these determinants to CFIR domains provides a structured basis for planning implementation strategies that are responsive to local ambulance service conditions.

Future research should evaluate implementation strategies in specific ambulance service contexts, including rural and under-resourced settings, and examine how sustained CPG adherence influences patient care and service outcomes.

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APPENDIX 1: CHARACTERISTICS TABLE

Study ID (author, year and country)	Study Design	Population and Setting	Intervention	Barriers to Implementation	Enablers of Implementation	Implementation Strategies	Outcomes	Key Findings
Adelgais et al., 2019, USA	Mixed-methods observational study	EMS agencies across five U.S. states	Implementation of statewide EBG for traumatic pain management	Lack of mandatory state protocols, delay in guideline publication, technical challenges with LMS	Local EBG champions, availability of toolkits, state-level champions for dissemination	State-specific implementation plans, dissemination toolkits, training modules	Increased pain score documentation, no significant increase in opioid use	EBG implementation requires local champions, robust training systems, and tailored state-level strategies
Ångerman et al., 2023, Finland	Retrospective observational study	2115 adult patients from helicopter emergency medical services (HEMS) in Finland	Implementation of a new prehospital anesthesia (PHEA) protocol that standardizes the process, including the use of mechanical ventilation, esketamine, and rocuronium	Challenges in sustaining protocol adherence over time and ensuring continuous team training across multiple EMS systems	Use of workshops, skill stations, lectures and simulations, and ongoing simulation training to support long-term sustainability of the protocol	A multifaceted approach with tailored training methods, team involvement, use of cognitive aids, and regular feedback loops	Significant improvements in on-scene time (OST), first-pass intubation success rate, and compliance with key indicators (use of mechanical ventilation and medications)	The systematic approach to implementing the PHEA protocol resulted in sustained improvements in clinical performance over a five-year period
Bigham et al., 2010, (a) USA and Canada	Survey of 176 EMS agencies	EMS agencies in the USA and Canada participating in the Resuscitation Outcomes Consortium (ROC)	Implementation of the 2005 American Heart Association (AHA) guidelines for CPR and ECC	Smaller agencies, non-transport agencies, and BLS-only agencies took longer to implement guidelines	Larger agencies with more vehicles and ALS services implemented guidelines more quickly	Survey conducted to determine implementation delays and investigate EMS system factors affecting speed	Mean implementation time was 416 days; large variability across agencies	Smaller agencies, BLS-only services, and non-transport agencies faced longer delays; larger, ALS agencies implemented more quickly
Bigham et al., 2010, (b) USA and Canada	Qualitative survey using semi-structured interviews and a grounded theory approach	EMS agencies in the USA and Canada participating in the Resuscitation Outcomes Consortium (ROC)	Implementation of the 2005 American Heart Association (AHA) guidelines for CPR and ECC	Delays in scheduling/accessing instructors, training materials, defibrillator upgrades, coordination with regulatory bodies and medical directors	Overcoming administrative and coordination barriers	Better coordination, timely development of training materials, collaboration with device manufacturers, engaging local champions	Variability in implementation timing, with agencies identifying multiple factors contributing to delays	Ten barriers identified across training, defibrillator reprogramming, and decision-making delays; proactive measures needed for timely future guideline implementation
Bloomer et al., 2024, Northern Ireland	Qualitative study using semi-structured interviews and thematic analysis	11 operational paramedics from the Northern Ireland Ambulance Service (NIAS); single-service study exploring clinician perspectives on referral pathway use	Use of patient care pathways (PCPs) that allow paramedics to refer patients to alternative services such as general practitioners, minor injury units, or community care rather than transporting all patients to emergency departments	Perceived clinical risk and fear of patient deterioration; concern about complaints or professional accountability; organizational culture historically focused on transport to hospital; variability in referral pathway availability across regions; communication challenges with receiving healthcare providers	Clear referral criteria within pathways; improved inter-professional communication; education and training on pathway use; cultural shift recognizing paramedics as autonomous clinical decision-makers; motivation to achieve better patient outcomes	Development and use of structured referral pathways; embedding referral decision-making and pathway education within paramedic training and professional development	Identification of key organizational and cultural factors influencing referral pathway utilization	Five themes were identified influencing pathway use: perceived risk, organizational culture, person-centered care, inter-professional communication, and operational infrastructure. Paramedics supported the use of referral pathways but described barriers including risk aversion, communication challenges, and inconsistent pathway availability across regions

Study ID (author, year and country)	Study Design	Population and Setting	Intervention	Barriers to Implementation	Enablers of Implementation	Implementation Strategies	Outcomes	Key Findings
Bosse et al., 2011, Germany	Prospective cohort study	1000 EMS patient care reports in Germany (pre/post SOP introduction for aeCOPD)	SOP for pre-hospital treatment of COPD based on national guidelines	Insufficient knowledge among emergency physicians, resistance to changing routine practices	Availability of SOP in printed and electronic formats	Introduction of SOP through staff meetings, access to printed/electronic versions	Adherence to guidelines increased from 34.6% to 53.8%, but not statistically significant	SOP improved specific therapies but full guideline adherence remained suboptimal without further training
Brown et al., 2014, USA	Quasi-experimental, pre-post design	EMS agencies in Maryland, USA; focus on trauma and burn patients	Implementation of an evidence-based prehospital pain management protocol including weight-based morphine dosing and repeat dosing. And naloxone as rescue medication post opiate.	Challenges in pain score documentation, baseline high rate of morphine use, transition to new electronic medical record system during study	Statewide adoption, online training programs, use of the National Prehospital EBG Model Process, collaboration with Maryland EMS systems	Weight-based dosing protocols, online learning management systems for EMS provider training, inclusion in annual protocol updates	Increase in total morphine dosage (18.1% higher total dose, 14.9% greater mg/kg dose), no change in percentage of patients receiving morphine or pain score documentation	Evidence-based protocol adoption led to increased morphine dosing but no change in narcotic administration rate or pain score documentation. Evidence-based guidelines improve patient care for regional EMS
Browne et al., 2016, USA	Retrospective observational study using patient records	Children under 18 years from three EMS agencies: Charlotte (NC), Houston (TX), Milwaukee (WI)	Changes to pain management protocols: age-appropriate pain scales, decreased minimum age for opioids, fentanyl dosage updates. Frequency of pain severity assessments.	Inconsistent pain severity documentation, training gaps, provider reluctance, operational barriers, no quality improvement process	Mandatory in-person and online training on protocol changes. Access to continuing education through video sessions and resources.	Protocol development by local medical experts. Use of different training approaches across the three EMS agencies (e.g., in-service sessions, video education).	Minimal increase in opioid administration, no significant change in pain severity documentation. Intranasal fentanyl administration decreased from 27% to 17%.	Opioid administration remained low despite protocol updates, indicating further barriers to effective prehospital pain management in children
Carey et al., 2019, USA	Multicenter, qualitative study	Paramedics from Charlotte, Houston, and Milwaukee EMS systems caring for pediatric patients	Implementation of pediatric seizure protocols based on EBG	Equipment availability issues, respiratory depression concerns, infrequent pediatric training, protocol ambiguity	Point-of-care decision support tools, availability of multiple midazolam administration routes, online medical control for guidance	Semi-structured interviews, use of decision support tools	Identified multiple barriers and enablers to pediatric seizure protocol adherence	System improvements suggested, including dose standardization and more frequent pediatric-specific training
Ciarletta et al., 2024, USA	Qualitative study (focus groups and interviews)	EMS clinicians and leadership from Level I pediatric trauma center in Buffalo, NY	Evaluation of adherence to NHTSA guidelines for pediatric ground transport	Low knowledge of guidelines, equipment unavailability and incompatibility, lack of hands-on training	Organizational support for training, leadership engagement	Focus groups, interviews, pediatric restraint training	Low familiarity with pediatric transport guidelines, organizational and external barriers to safety standards	EMS clinicians require more hands-on training and knowledge reinforcement to improve adherence
Ebben et al., 2014, Netherlands	Qualitative (Semi-structured interviews)	Ambulance and emergency nurses, and EMS and emergency physicians in the Netherlands	Interviews exploring factors influencing protocol adherence	Lack of awareness of national protocols, preference for local protocols, limited involvement in development	Integration of ATLS, embedding protocols in training, and physician support	Tailoring strategies to individual, organizational, and protocol-related factors	Adherence is influenced by clinical experience, organizational support, and external factors, acting as barriers or facilitators	Multifaceted strategies and user involvement in development are essential to improve adherence
Ebben et al., 2015, Netherlands	Cross-sectional survey	248 ambulance nurses from four EMS services in the Netherlands	Adherence to National Protocol Ambulance Care (NPAC)	Complexity of protocol, frequent updates, professional autonomy	Colleague expectations, perception of improved patient outcomes, trust in protocol	NPAC distribution, questionnaire for measuring adherence	Self-reported adherence high (83.4%), but professional autonomy and protocol complexity limited full adherence	Adherence influenced by protocol complexity/support for diagnosis and treatment, and social factors

Study ID (author, year and country)	Study Design	Population and Setting	Intervention	Barriers to Implementation	Enablers of Implementation	Implementation Strategies	Outcomes	Key Findings
Ezem et al., 2024, USA	Semi-structured qualitative interviews	Emergency response agencies in North Carolina, USA; 7 counties (high- and low-performing)	Implementation of community-based OHCA interventions (RACE-CARS trial)	Resistance from teams, difficulties building foundational relationships, financial challenges, approval requirements in hospital systems	Engaging content experts, relevant data, relationship building, regular feedback mechanisms	Focus on relationship building, clear communication, engaging local experts, providing updates and feedback	Differences in readiness between high- and low-performing counties	Engaging local experts, focusing on relationships, and providing feedback are effective for gaining support for interventions
Feder et al., 2006, USA	Observational study for one year	16 of 35 local EMS agencies in King County participated in the study, Washington, USA, involving 2770 patients with EMS-attended cardiac arrest	New guidelines allowing EMS personnel to withhold resuscitation in terminally ill patients based on verbal or written requests from patients or caregivers. Implemented by two of the authors.	Legal and risk management concerns from non-participating agencies, inconsistency in honoring verbal requests, and difficulty implementing guidelines across all agencies	Support from local physicians, EMS administrators, and legal consultants; involvement of multiple EMS personnel in developing and training for the new guidelines	A voluntary program with written manuals, 2-hour lectures, competency quizzes, and support from legal and medical professionals	Resuscitation was withheld in 11.8% of cases for participating agencies, compared to 5.3% in non-participating agencies; verbal requests accounted for the majority of withheld resuscitations in the intervention group	The guidelines led to more frequent honoring of verbal requests to withhold resuscitation, suggesting the potential for expanding EMS discretion in end-of-life decisions
Fishe et al., 2024, USA	Cross-sectional survey using Discrete Choice Experiments (DCEs)	183 paramedics registered with the National Registry of Emergency Medical Technicians (NREMT) in the USA	Preferences for implementation of Evidence-Based Guidelines (EBGs) in EMS (sepsis alerts, bag-valve mask devices, pain medication protocols)	Lack of hospital and agency feedback, reliance on email/online education, mismatch between preferences and current practices	In-person simulation/ classroom-based education, individualized feedback, hospital feedback on outcomes	Focus on individualized feedback, incorporating hospital and agency feedback, providing in-person training over online options	EMS clinicians preferred in-person education and feedback on performance, but agency practices did not match these preferences	Agencies should adjust implementation practices to align with EMS clinicians' preferences for hands-on training and feedback
Gaither et al., 2021, USA	Multisystem, before/after controlled study (secondary analysis of EPIC Study)	2,801 children with major TBI transported by EMS in Arizona (2007-2015)	Implementation of Prehospital Pediatric TBI Guidelines, focused on preventing hypoxia, hypotension, and hyperventilation	Variation in EMS agency participation and training schedules, limited sample size	Participation by over 130 EMS agencies, broad guideline implementation	Train-the-trainer model, focused on guideline-based care for TBI	Improvement in survival to hospital admission for severe TBI, but not moderate or critical cases	Guidelines improved care and survival in severe pediatric TBI cases, no significant change in moderate or critical TBI cases
Gaither et al., 2024, USA	Multisystem, intention-to-treat before/after controlled design	EMS patients with severe TBI in Arizona, USA	Prehospital TBI guidelines focused on preventing hypoxia, hyperventilation, and hypotension	Resistance to guideline adherence, variability in EMS agency training	Comprehensive guideline training, use of various airway interventions	Intensive training on preventing hypoxia, hyperventilation, and hypercapnia	Improved survival to hospital admission in severe TBI cases, no significant improvement in overall survival to discharge	Guidelines improved survival in severe TBI with PPV, highlighting the importance of early intervention in prehospital care
Guerrier et al., 2023, USA	Qualitative study using focus groups with EMS leaders, EBG authors, EMS medical directors	EMS leadership in the USA, including EMS EBG authors, medical directors, and professional organization leaders	Implementation of prehospital evidence-based guidelines (EBGs)	Data access issues, resource constraints, variations in EMS systems, lack of training in data analytics, mixed opinions on CFIR	Strong leadership engagement, consistent messaging, in-person and frequent training, trust between EMS clinicians and leadership	Frequent hands-on training, CFIR to guide implementation, standardized protocol design, fostering culture of change and trust	Varied success in EBG implementation, challenges in data analytics and outcomes evaluation	Leadership engagement and communication are key, but systematic barriers like cost and resource constraints persist

Study ID (author, year and country)	Study Design	Population and Setting	Intervention	Barriers to Implementation	Enablers of Implementation	Implementation Strategies	Outcomes	Key Findings
Hagiwara et al., 2013, Sweden	Single-case study using realistic evaluation methodology. Four phases	Ambulance organization in Sweden (urban and rural stations)	Use of prehospital guidelines and protocols for various emergency conditions	Physical format of guidelines, lack of context knowledge during development, need to memorize guidelines, implicit use in patient care	Positive view of guidelines by ambulance personnel, local implementation strategies including lectures and simulation	Development of guidelines based on informal consensus, use of simulations and manikin training for local adaptation	Implicit use of large guidelines (physically too large to carry on person), request for better formats and context-sensitive guidelines	Guidelines were indispensable, but the format needed improvement; personnel often developed their own homemade guidelines
Haley et al., 2016, USA	Retrospective before-and-after study	Adult patients transported by EMS with trauma or burn injuries in Milwaukee County, USA	System-wide interventions: pediatric-specific pain management education and protocol implementation	Poor pain score documentation over time, limited focus on feedback and quality improvement	Systematic pain management protocols, education improved opioid administration	Multi-day educational interventions, case-based scenarios, protocol adoption	Increased opioid administration but inconsistent pain score documentation	Education and protocol improved opioid administration; efforts needed to sustain pain score documentation
Jones Rhodes et al., 2016, USA	Qualitative study (semi-structured interviews)	EMS providers, educators, and hospital decision-makers in two counties in Colorado, USA	Implementation of spinal immobilization guideline with selective immobilization and vacuum splints	Resistance to change, challenges maintaining shared equipment (vacuum splints)	Strong leadership, community collaboration, EMS providers seeing themselves as 'on the cutting edge'	Intensive face-to-face education, collaborative workshops	Successful community-wide guideline adoption with strong provider buy-in	Education and leadership were crucial for overcoming challenges and implementing collaborative EMS initiatives
Kelleher et al., 2014, USA	Quantitative (Process Mining)	Pediatric trauma resuscitations at a Level I trauma center (Children's National Medical Center, Washington, DC)	Implementation of a pediatric trauma resuscitation checklist to improve adherence to ATLS protocol	Lack of pre-arrival notification, smaller initial teams, increased workload for providers	Checklist improved task completion and reduced variability in care	Use of a standardized checklist for trauma resuscitation tasks	Improved ATLS protocol adherence and reduced variability in task performance	Checklist standardized care and reduced impact of lack of pre-arrival notification
Kerner et al., 2017, Germany	Prospective, controlled, monocentric study	740 emergency missions by a mobile emergency response unit in Berlin, Germany	Introduction of checklists (general prehospital care, acute coronary syndrome, asthma/COPD)	Slight increase in time (approx. 1 minute), but generally well accepted	Checklists improved documentation, diagnostics, and treatment adherence with high staff acceptance	Training seminars to introduce checklists, monitored compliance	Significant improvement in guideline adherence, particularly in patient history documentation, diagnostics, and emergency treatment	Checklists significantly improved guideline adherence and documentation quality in prehospital emergency care
Kothari et al., 2021, USA	Longitudinal, prospective study with simulation-based training	EMS professionals in a single urban fire-based EMS system in the USA	Repetitive pediatric emergency simulation training over 6 months	Difficulty maintaining competency between training sessions, limited exposure to pediatric emergencies	High fidelity simulations, structured debriefing with video playback, practice of key interventions	Serial high-fidelity simulations, structured debriefing focusing on airway management, shock treatment, team skills	Improved team performance in managing pediatric emergencies, timely interventions, increased competence	Repetitive simulation improved team-based pediatric emergency care and cognitive/psychomotor skills in EMS professionals
Krawczyk et al., 2016, Europe	Cross-sectional survey	Healthcare providers from 27 European countries	Evaluation of defibrillation techniques and barriers to ERC guideline implementation	Economic constraints on adhesive pad availability, resistance to change and manual paddles use	Growing awareness and use of adhesive pads in prehospital settings	National surveys on defibrillation techniques, discussions with ERC representatives	Mixed adherence to guidelines, with economic and traditional factors influencing technique	Economic and cultural resistance hinder adhesive pad adoption despite guideline recommendations

Study ID (author, year and country)	Study Design	Population and Setting	Intervention	Barriers to Implementation	Enablers of Implementation	Implementation Strategies	Outcomes	Key Findings
Lang et al., 2012, USA	National model development and evaluation with a qualitative and consensus-based approach	EMS systems across the USA, involving various EMS stakeholders, including federal agencies and EMS professionals	Development and implementation of a national evidence-based guideline (EBG) model for prehospital care	Resource limitations, lack of common governance, challenges in standardizing care, and difficulties integrating EBGs into varied systems	Support from federal organizations, multidisciplinary expert involvement, structured consensus-building efforts	Eight-step model: evidence review, GRADE methodology, EMS protocol contextualization, multimedia dissemination, certification/recertification linkage	Development of a comprehensive national EBG model, improving patient outcomes and EMS care consistency and efficiency	National EBG model has potential to improve EMS care but needs to address resource constraints and challenges in local adaptation
Lynch et al., 2020, South Africa	Qualitative single-case study design using semi-structured interviews	Emergency Medical Services (EMS) in South Africa, focusing on a private EMS provider	Implementation of prehospital thrombolysis (PHT) for ST-segment elevation myocardial infarction (STEMI)	Cost of equipment, lack of medical coding for reimbursement, logistical issues, inadequate inter-professional collaboration, lack of cardiologists, organizational resistance to change, and leadership disengagement	Leadership engagement, inter-professional collaboration	Stage implementation scale-up, leadership commitment, network collaboration, dynamic training partnerships	PHT is underutilized in South Africa despite evidence of safety and effectiveness. A lack of strategic implementation has resulted in a poor introduction of EBP for cardiac care	Key barriers include high costs, logistical complexities, lack of coding, inadequate leadership, and skepticism about PHT in urban areas with PCI access
Mai et al., 2023, Asia, Latin America, Europe	Multicenter site survey study	24 emergency departments across 14 countries in Asia, Latin America, and Europe	Evaluation of pediatric TBI management practices in DTCs and NTCs	Lack of centralized prehospital services in low- and middle-income countries, variation in guideline implementation	Presence of formal TBI protocols, availability of neuroimaging and pediatric ICU services	Site-specific surveys on prehospital and ED TBI management practices	Limited differences between DTCs and NTCs in TBI management, variations in guideline adherence	Need for improved guideline adoption and prehospital trauma care in low-resource settings
Manson et al., 2018, USA	Mixed methods (surveys of paramedics and surgeons)	Paramedics and general surgeons in urban and rural Kentucky	Surveys assessing perceptions of trauma readiness and guideline implementation	Lack of trauma centers, discrepancy between paramedic perception of surgical readiness and surgeon willingness to operate	Trauma center proximity increased medic confidence in surgeons' willingness to operate	Enhancing communication and collaboration, developing destination determination protocols	Medics farther from trauma centers were less confident in surgical readiness and more likely to transport to nearest hospital regardless of surgical capabilities	Discordance between paramedic perception and surgeon willingness affects guideline implementation, especially in rural areas
Maria et al., 2024, Australia and New Zealand	Qualitative descriptive analysis using thematic analysis of interviews	Jurisdictional ambulance services in Australia and New Zealand	Development of paramedic clinical practice guidelines (CPGs) in jurisdictional ambulance services	Lack of formal training, over-reliance on existing guidance, consultation challenges, limited research capacity, resource constraints, lack of formal project management approaches	Collaboration between services, interest in inter-service cooperation, evidence evaluation tools, gradual expertise development	Adoption of project management frameworks, multidisciplinary teams, GRADE framework for evidence synthesis, targeted training programs, improved resource allocation	Significant variation in CPG development across services due to resource and expertise limitations	Need for formalized training, project management, national collaboration, and enhanced funding to improve CPG consistency and effectiveness
Martin-Gill et al., 2016, USA	Summary report on national strategy for EMS stakeholders	EMS organizations and stakeholders in the United States	Development of a National Prehospital Evidence-Based Guidelines (EBG) Strategy	Limited collaboration between national projects, implementation challenges	Collaborative efforts of 57 organizations, financial support from NHTSA and EMS for Children program	Creation of Prehospital Guidelines Consortium (PGC), promotion of research and collaboration, improved education	Facilitated EBG implementation by improving guideline dissemination and incorporation into protocols	Strategy supports sustainable relationships among stakeholders to facilitate EBG development and implementation

Study ID (author, year and country)	Study Design	Population and Setting	Intervention	Barriers to Implementation	Enablers of Implementation	Implementation Strategies	Outcomes	Key Findings
McCaul et al., 2019, South Africa	Descriptive qualitative research using nine focus groups with thematic analysis	56 operational emergency care providers from public and private sectors in South Africa	Implementation and dissemination of the first evidence-based emergency care clinical practice guidelines (CPGs) in South Africa's prehospital sector	Poor communication, challenges with training, limited capacity to upskill providers, changes in scope of practice, resource constraints	Use of technology, involvement of local champions, modular training, consistent communication	Creation of end-user documents, online modular training, local champions to promote adoption, better communication	Mixed reactions; excitement about scope increases but apprehension about loss of advanced skills like intubation	Importance of communication, accessible training, and structured career pathways for successful implementation; stakeholder involvement critical
McCaul et al., 2020, South Africa	Qualitative case study, one focus group and six interviews.	Key stakeholders involved in a prehospital CPG project in South Africa	Development and implementation of prehospital CPGs using alternative guideline development methods (CPG adaptation)	Limited local evidence, challenges aligning recommendations with local practice, communication gaps, lack of implementation support, conflicting interests	Stakeholder engagement, context-sensitive recommendations, transparency in decision-making, use of international evidence adapted for local contexts	Advisory boards, transparent decision-making processes, context-specific adaptations, clear communication of implementation strategies	Successful guideline development but challenges in consistent national implementation	Implementation hampered by communication gaps and local challenges; stakeholder engagement and adapting international evidence can improve the process
McManus et al., 2023, USA	Qualitative study using semi-structured interviews and five focus groups	EMS clinicians from four EMS systems in the USA (urban, suburban, and rural)	Implementation of oral systemic corticosteroids (OCS) for pediatric asthma in prehospital settings	Lack of pediatric experience, unfamiliarity with dosing, resistance to change, inadequate pediatric equipment, reliance on email-based training	Pediatric medical directors, laminated dosing cards, involvement of parents, feedback from receiving hospitals	Use of pediatric dosing tools (PRAM cards), tailored training, feedback mechanisms from hospitals	Positive feedback on the use of OCS but continued challenges with pediatric dosing and EMS resistance to change	OCS implementation was facilitated by strong leadership and feedback loops, but barriers related to pediatric knowledge and EMS culture need to be addressed
Mould-Millman et al., 2023, South Africa	Pragmatic, quasi-experimental, two-arm, mixed-methods study	EMS providers and trauma patients in Western Cape Government EMS, South Africa	Implementation of EMS-TrauSh-oC bundled trauma care using HEET (High-Efficiency EMS Training)	Limited access to tourniquets, pushback on transporting patients who appeared well but met shock criteria	HEET's operational fit and provider acceptance, support from station managers and dispatch centers	Peer-to-peer rapid training with high-frequency, short sessions using clinical case scenarios	Excellent implementation effectiveness (80.6%) but no significant clinical improvement in patient shock index	High implementation success through rapid training, but no significant clinical outcome improvements
Sarmiento et al., 2012, USA	Mixed-methods (survey and focus groups)	EMS professionals across the USA (536 survey participants, 54 focus group participants)	CDC-developed educational resources for the updated Field Triage Decision Scheme	Lack of awareness of materials, regional differences in EMS systems, lack of support and resources, and difficulties in implementing a universal protocol	Support from EMS leaders, use of various educational formats (posters, pocket cards, PowerPoint), and the perceived value of the materials	Engagement with EMS leaders as early adopters, multiple formats for educational materials (pocket cards, posters, training guides), and leveraging professional organizations for dissemination	Positive reception of materials by those who used them; increased knowledge and implementation of triage procedures among users	Significant proportion of EMS professionals had not seen or used the materials, suggesting a need for increased dissemination and support for implementation
Sasson et al., 2009, USA	Qualitative (Focus groups)	EMS physicians, paramedics, and EMS administrators in the United States	Focus groups discussing barriers to local implementation of national TOR guidelines	Financial incentives to transport, state mandates requiring transport, public and cultural expectations about survivability	National organizations (e.g., AHA) can advocate for reimbursement, legal changes, and public education	Engage payers, legislators, and communities to adopt national TOR guidelines	Identification of barriers and facilitators for adopting TOR guidelines, such as financial and legal hurdles, and misconceptions about survival	Payer incentives, legislative barriers, and cultural expectations hinder TOR adoption; national organizations can assist in overcoming challenges

Study ID (author, year and country)	Study Design	Population and Setting	Intervention	Barriers to Implementation	Enablers of Implementation	Implementation Strategies	Outcomes	Key Findings
Siriwardena et al., 2014, England	Interrupted time series design within a national quality improvement collaborative (QIC)	12 English ambulance services, 22,117 clinicians providing care for AMI and stroke patients	National QIC to improve care bundles for AMI and stroke	Organizational barriers, lack of resources, competing pressures on QI teams	Engagement of frontline staff, leadership support, use of checklists, provider prompts, and individualized feedback	Local QI teams supported by workshops, teleconferences, and data feedback with control charts	Significant improvement in care bundles for AMI (43% to 79%) and stroke (83% to 96%)	QIC led to significant improvements through clinical engagement and QI methods
Spaite et al., 2019, USA	Statewide, multisystem cohort study with before/after controlled design	21,852 TBI patients across Arizona EMS agencies	Prehospital TBI treatment guidelines emphasizing prevention of hypoxia, hyperventilation, hypotension	Inconsistent EMS adherence, challenges in changing airway management practices	Statewide collaboration, guideline-based protocols on oxygenation, airway, and BP control	Statewide guideline implementation using train-the-trainer model	Significant improvement in survival to hospital admission for severe TBI patients, especially in intubated subgroups	Guidelines improved survival for severe TBI patients, particularly in intubated groups, supporting prehospital protocol adoption
Thorvaldsen et al., 2019, Norway	Nationwide survey	938 prehospital personnel across 18 EMS services in Norway	Implementation of Norwegian guideline for prehospital spinal injury management with e-learning	Lack of approval by some health trusts, limited training opportunities, confusion about the guideline's name	Open access to guidelines, developed based on perceived needs of care providers	Development of e-learning course, passive dissemination through conferences and repositories	56% of respondents with knowledge reported its implementation, e-learning did not significantly affect implementation	Guideline implemented despite not being mandatory; passive dissemination was somewhat effective
Tomasone et al., 2014, Canada	Pre–post intervention pilot study	34 paramedic and nurse trainees in British Columbia and Ontario, Canada	Online educational module 'ABCs of AD' to improve knowledge and use of AD-CPGs	Decline in participant engagement over module sections, no social cognitive improvements for AD-CPG use	Positive feedback on educational content quality	Online educational outreach using video modules and case studies	Significant improvement in knowledge of AD-CPGs, no change in social cognitions (attitudes, control, norms) for using the CPGs	Knowledge alone is insufficient for practice change; module should target social cognitive determinants for AD-CPG use
Watts et al., 2004, Australia	Qualitative evaluation	Australian paramedics using CPGs in prehospital care	Evaluation of clinical practice guidelines (CPGs) and their use	Lack of awareness or understanding of CPGs, inconsistent application across services	In-service training to improve guideline familiarity, organizational support	In-service training and educational initiatives to enhance guideline adherence	Improved guideline familiarity but variability in application among paramedics	Training improved understanding, but challenges in consistent application across services

APPENDIX 2: QUALITY APPRAISAL OF INCLUDED STUDIES

Study	Quality Rating	Key Notes
Adelgais et al., 2019, USA	High	Clear research objectives, justified mixed-methods design, reliable quantitative measurements, comprehensive thematic analysis for qualitative data, integration of quantitative and qualitative data adds value, though integration could be enhanced.
Ångerman et al., 2023, Finland	High	Appropriate sample frame, detailed setting descriptions, valid exposure measurement, adequate follow-up, confounders identified, appropriate statistical analysis.
Bigham et al., 2010a, USA	Moderate	Clear inclusion criteria, valid and reliable survey measures, identified confounding factors, appropriate statistical analysis.
Bigham et al., 2010b, USA	High	Congruent methodology with research objectives, detailed thematic analysis, participant voices well-represented, rigorous ethical practices.
Bloomer et al., 2024 Northen Ireland	High	Clear qualitative design with semi-structured interviews and thematic analysis; appropriate recruitment, data saturation and ethical governance reported. Participant perspectives well represented, though limited to a single service and volunteer sample.
Bosse et al., 2011, Germany	High	Well-defined comparison groups, valid SOP implementation, identified confounders, robust statistical analysis for pre-post intervention outcomes.
Brown et al., 2014, USA	High	Clear cause-effect relationship, valid pre-post intervention comparison, reliable outcome measures, adequate statistical analysis.
Browne et al., 2016, USA	High	Valid retrospective design, consistent exposure measurement, identified confounders, robust statistical analysis.
Carey et al., 2019, USA	Moderate	Congruent methodology with research objectives, participant voices adequately represented, rigorous analysis using NVivo software, minor gaps in researcher positioning.
Ciarletta et al., 2024, USA	High	Qualitative design aligns with objectives, rigorous use of CFIR framework, participant voices well-represented, valid ethical approval.
Ebben et al., 2014, Netherlands	High	Qualitative design with in-depth thematic analysis, detailed participant representation, ethical considerations addressed.
Ebben et al., 2015, Netherlands	Moderate	Valid and reliable survey-based measures, appropriate statistical methods, limited confounder control.
Ezem et al., 2024, USA	High	Qualitative design with structured analysis, CFIR-guided approach, participant voices well-represented, rigorous ethical review.
Feder et al., 2006, USA	Moderate	Observational study with valid exposure measurement, identified confounders, limitations in addressing bias, appropriate statistical analysis.
Fishe et al., 2024, USA	High	Structured discrete choice experiments, robust statistical methods, identified limitations (e.g., selection bias), valid and reliable outcome measures.
Gaither et al., 2021, USA	High	Before-and-after controlled design, valid survival outcome measures, consistent exposure application, robust statistical analysis.
Gaither et al., 2024, USA	High	Intention-to-treat design, valid and reliable survival outcomes, consistent measurement across phases, comprehensive statistical analysis.
Guerrier et al., 2023, USA	High	Focus group-based qualitative study, CFIR-guided thematic analysis, participant voices well-represented, ethical approval received.
Hagiwara et al., 2013, Sweden	High	Realistic evaluation methodology, in-depth data collection through various methods, robust thematic analysis, ethical approval obtained.
Haley et al., 2016, USA	High	Valid pre-post design, reliable outcome measures, appropriate statistical analysis, minor gaps in confounder control.
Jones Rhodes et al., 2016, USA	Moderate	Congruent qualitative methodology, thorough participant representation, valid ethical approval, minor gaps in researcher positioning.
Kelleher et al., 2014, USA	High	Clearly defined sample criteria, valid adherence measurement, multivariable control for confounders, appropriate statistical analysis (regression).
Kerner et al., 2017, Germany	High	Cause-effect clarity, control group present, consistent outcome measurement, reliable adherence recording, appropriate chi-square analysis.
Kothari et al., 2021, USA	Moderate	Clear cause-effect, no separate control group, consistent measurements with high inter-rater reliability, appropriate use of chi-square and Kruskal-Wallis tests.
Krawczyk et al., 2016, Europe	Moderate	Clear sample and setting details, reliable measurement via structured survey, partial confounding factors identified but not fully controlled, basic descriptive statistics used.
Lang et al., 2012, USA	Moderate	Well-defined sample and setting, reliable exposure measurement through expert review, partial confounder acknowledgment, no statistical methods as study is descriptive.
Lynch et al., 2020, South Africa	Moderate	The study effectively identifies barriers to PHT implementation using thematic analysis and the CFIR framework. However, it lacks explicit philosophical alignment, researcher reflexivity, and detailed theme validation, which limits rigor.
Mai et al., 2023, Asia, Latin America, Europe	Moderate	Clear sample and setting details, structured survey for data collection, partial identification of resource-related confounders, appropriate chi-square and t-tests.
Manson et al., 2018, USA	Moderate	Defined sample criteria, reliable measurement via surveys, partial confounding control, chi-square and ANOVA tests applied.
Maria et al., 2024, Australia and New Zealand	High	Well-defined sample, reliable thematic analysis, partially addressed confounding factors, no statistical analysis as it was qualitative.
Martin-Gill et al., 2016, USA	Moderate	Clear sample and setting, reliable exposure measurement through stakeholder engagement, partial confounder control, qualitative approach without statistical analysis.
McCaul et al., 2019, South Africa	Moderate	Clear sample criteria, thematic analysis used for reliability, partial confounder identification, qualitative method without statistical testing.
McCaul et al., 2020, South Africa	Moderate	Clear sample and setting, semi-structured interviews and focus groups, partial confounding factors identified but not controlled, thematic analysis applied.
McManus et al., 2023, USA	Moderate	Clear inclusion criteria, structured interviews and focus groups, partial control of regional variability, reliable thematic analysis based on CFIR framework.

Study	Quality Rating	Key Notes
Mould-Millman et al., 2023, South Africa	High	Clear sample and structured intervention, consistent RE-AIM framework for measurement, partial confounder control, appropriate difference-in-differences analysis.
Sarmiento et al., 2012, USA	Moderate	Clear inclusion criteria, reliable thematic analysis with survey and focus group data, regional confounders acknowledged, descriptive and chi-square tests used.
Sasson et al., 2009, USA	Moderate	Clear sample criteria, reliable thematic analysis, regional confounders identified but not controlled, qualitative design with no statistical testing.
Siriwardena et al., 2014, England	High	Clear inclusion criteria, systematic QIC intervention, partial confounder control, appropriate interrupted time series and logistic regression analyses.
Spaite et al., 2019, USA	High	Well-defined sample criteria, valid guideline adherence measurement, multivariable regression for confounder control, consistent trauma registry data.
Thorvaldsen et al., 2019, Norway	Moderate	Clear sample criteria, reliable survey measurement, partial confounding factors identified, chi-square analysis applied.
Tomasone et al., 2014, Canada	Moderate	Defined sample criteria, reliable pre-post intervention measurement, partial confounding control, paired t-tests and effect size calculations used.
Watts et al., 2004, Australia	Moderate	Clear inclusion criteria, structured observations for measurement, partial confounding factors identified, descriptive statistics applied.

APPENDIX 3: INCLUDED STUDIES EXTRACTED TO CFIR DOMAINS

Study	Intervention Characteristics	Inner Setting	Outer Setting	Characteristics of Individuals	Process
Adelgais et al., 2019	The intervention was the statewide implementation of an evidence-based guideline (EBG) for traumatic pain management in EMS settings. The guideline provided detailed recommendations on opioid use, dosing, and pain reassessment intervals. Each state received an implementation toolkit and standardized training materials to support the rollout. However, the non-mandatory nature of the protocol limited uptake in some regions.	EMS agencies within the states demonstrated varying organizational readiness. Larger agencies with strong administrative support adopted the guidelines more easily, while smaller agencies faced resource and time limitations. Internal barriers included limited instructor availability and difficulty tracking training and adoption progress within individual agencies. A lack of communication between state and local leadership created additional challenges in aligning protocols across the regions.	The implementation faced regulatory challenges since the guidelines were voluntary and not enforced through state mandates. Differences in local EMS structures, such as varying levels of regional autonomy and leadership coordination, further hindered statewide adoption. Some states chose not to adopt the national guideline, citing concerns about prescriptive dosing and lack of alignment with local protocols. States also faced technical issues with learning management systems (LMS), which disrupted training efforts.	EMS providers exhibited mixed attitudes toward the guidelines, with some skeptical about the use of opioids due to safety concerns. Providers varied in their familiarity and comfort with the new recommendations, particularly those in smaller or volunteer-based agencies. Champions within the EMS systems emerged as key facilitators, using their influence to engage providers and promote guideline adoption, though not all agencies had strong leadership for the initiative.	The implementation followed a multi-year process involving the distribution of toolkits, training modules, and monthly state meetings to monitor progress. However, delays in publication and training rollout diminished enthusiasm among participating agencies. The project relied on self-assessments and regional champions to track adoption, but data collection across states was inconsistent. While three states implemented the guidelines, two did not, citing administrative shifts and lack of resources. Despite the available training, many EMS providers did not complete the modules, resulting in incomplete adoption.
Ångerman et al., 2023	The intervention involved the implementation of a prehospital anesthesia protocol (PHEA) within helicopter emergency medical services (HEMS) and collaborating EMS units. The protocol included structured airway management practices, including the use of specific medications (esketamine and rocuronium) and video laryngoscopes for intubation. The goal was to standardize practices, improve patient safety, and ensure effective airway management. The protocol also involved role allocation and pre-arrival communication among EMS teams to enhance coordination.	Variability in training resources and infrastructure affected implementation across EMS units. Regular on-duty training and simulation-based education were conducted, but uptake varied between providers. Some EMS personnel were reluctant to engage in new practices, especially given the complexity of managing intubations in high-pressure situations. Regular protocol development days were implemented to address ongoing challenges and sustain adherence to the protocol over time.	Collaboration between the HEMS and EMS units was essential but presented logistical challenges, particularly with coordinating efforts across multiple employers and regions. External regulatory pressures were minimal, limiting enforcement of the new protocol. However, strong collaboration between emergency dispatch services and rescue departments improved protocol execution by ensuring all roles were prepared and aligned before arrival at the scene.	Staff knowledge, attitudes, and comfort levels with the protocol varied. While physicians were experienced in anesthesia, paramedics and other EMS personnel required additional training to adapt to the new practices. Simulation-based training helped improve familiarity, but some personnel were hesitant about using new medications and equipment, such as the video laryngoscope. Active opinion leaders within the EMS community were identified to promote the protocol and address concerns among their peers.	The implementation process was multifaceted, including lectures, simulations, workshops, academic detailing, and e-learning. Implementation occurred in phases, beginning with preparation workshops, followed by intensive training and protocol dissemination over three months. Continuous support was provided through regular audits and feedback loops to maintain compliance. Key performance indicators, such as on-scene time (OST), first-pass success (FPS) rate, and use of rocuronium and esketamine, were monitored throughout the five-year follow-up. The results demonstrated significant improvements, including a reduction in OST and increased FPS rates, reflecting successful implementation and sustainability.
Bigham et al., 2010a	The 2005 AHA guidelines introduced new recommendations for prehospital management of cardiac arrest, emphasizing single-shock defibrillation and uninterrupted CPR. The changes required equipment updates and new training protocols for EMS providers.	EMS agencies faced internal barriers such as limited financial resources, challenges coordinating training, and inconsistent organizational readiness. Smaller and non-transport agencies reported significant difficulties in accessing instructors and aligning the changes with existing educational cycles.	The lack of external mandates and delayed regulatory approvals affected guideline adoption. Agencies were also dependent on external manufacturers for defibrillator reprogramming, creating further bottlenecks in implementation.	EMS providers experienced uncertainty about the new protocols and expressed concerns about adopting single-shock defibrillation. Some providers lacked confidence in deviating from established practices, which slowed adoption.	Implementation involved surveys to track adoption timelines, revealing a median delay of 415 days. The guidelines were disseminated through meetings and newsletters, but follow-up mechanisms were limited, resulting in slow and uneven adoption.

Study	Intervention Characteristics	Inner Setting	Outer Setting	Characteristics of Individuals	Process
Bigham et al., 2010b	The study focused on identifying barriers to the implementation of the 2005 AHA guidelines. Key challenges included instructional delays and the need for defibrillator updates to align with the new protocols.	Agencies reported difficulties accessing trained instructors, and smaller agencies struggled to align training schedules with operational needs. In some cases, management was unable to communicate the changes effectively to field providers.	External factors, such as slow regulatory processes and delays in securing equipment upgrades, posed significant challenges. Coordination between EMS agencies and external partners was inconsistent, contributing to implementation delays.	Some EMS providers resisted the changes, particularly those with more experience in previous CPR practices. Staff turnover also impacted the consistency of training and guideline uptake across different shifts.	The study used qualitative interviews to identify three main barriers: instructional delays, equipment challenges, and decision-making uncertainty. Member validation confirmed these themes, but no active follow-up strategies were implemented to address the identified barriers.
Bloomer et al., 2024	Use of ambulance service patient care referral pathways allowing paramedics to refer suitable patients to alternative care services rather than transporting all patients to emergency departments. Pathways included defined referral criteria and links with community and primary care services.	Organizational culture within the ambulance service influenced pathway use. A legacy perception of ambulance services as primarily transport-focused discouraged use of referral pathways. Cultural shifts recognizing paramedics as autonomous clinicians and supportive organizational leadership facilitated pathway adoption.	Availability of referral pathways depended on external healthcare system capacity, including access to community services, general practitioners, and alternative care destinations. Variability in service availability and communication with receiving services affected pathway utilization.	Paramedics' perceptions of clinical risk, professional accountability, and confidence in decision-making influenced pathway use. Some clinicians expressed concern about patient deterioration, complaints, or professional scrutiny when deviating from traditional transport practices.	Implementation involved introducing structured referral pathways and encouraging their use through operational guidance and organizational messaging. Adoption relied on paramedic judgement, communication with external services, and gradual cultural change within the ambulance service.
Bosse et al., 2011	The intervention involved the introduction of a standard operating procedure (SOP) for the treatment of acute exacerbated COPD (aeCOPD). The SOP was developed based on national guidelines and distributed in both printed and electronic formats. It consisted of three components: immediate measures, patient history, and extended measures.	The SOP was introduced within EMS systems in Berlin, Germany. Internal challenges included variability in staff familiarity with the national guidelines, limited structured training on the SOP, and difficulty coordinating adoption across EMS providers. Self-assessed knowledge was high (67%), but when tested, physicians' actual knowledge was only 33%. Physicians frequently relied on outdated practices instead of following new guidelines.	No national enforcement mechanisms were in place to mandate the adoption of the SOP. The lack of external coordination and incentives likely contributed to inconsistent guideline implementation across EMS agencies. Physicians perceived the SOP as helpful in 80% of cases but saw limitations in real-world applicability.	Emergency physicians expressed overconfidence in their knowledge of the SOP and national guidelines. Although they believed they adhered to evidence-based care, interviews revealed that reliance on routine practices often took precedence over adherence to guidelines. This discrepancy between perceived and actual knowledge emerged as a barrier to successful SOP adoption.	The SOP was introduced through a staff meeting and passive dissemination. Eight weeks post-implementation, 500 EMS reports were reviewed to assess adherence, but no follow-up strategies (e.g., refresher training, feedback loops) were included. SOP implementation led to some improvements, such as increased use of 2-mimetics, but it failed to significantly improve overall guideline adherence. The study highlighted that passive dissemination alone was insufficient for meaningful implementation, suggesting a need for continuous education and active engagement strategies.
Brown et al., 2014	The intervention involved the implementation of a prehospital pain management protocol for patients with injuries and burns. The protocol was developed using the National Prehospital Evidence-based Guideline (EBG) Model Process. It introduced weight-based and repeat dosing of morphine to improve pain management.	EMS services faced challenges related to staff knowledge and engagement with the new protocol. Adoption varied between basic life support (BLS) and advanced life support (ALS) providers, with ALS providers more actively involved. Some EMS providers expressed discomfort with adopting new dosing guidelines. Training was required across all levels, but participation in the learning modules varied, indicating uneven engagement across the system.	The Maryland EMS system served as the pilot site, with external support from national organizations like the National Highway Traffic Safety Administration (NHTSA). However, the lack of mandatory national adoption resulted in variable implementation across different EMS systems. Limited regulatory pressure affected the consistency of implementation.	EMS providers reported mixed confidence in administering weight-based morphine doses. Staff expressed concerns about dosing pediatric patients, leading to delays in adoption. There was also over-reliance on routine practices despite the new protocol, and some providers struggled to shift away from previously established dosing norms.	The protocol was introduced through a statewide education program using online learning management systems and DVD materials. The training included separate modules for BLS, ALS, and hospital personnel, but follow-up was limited. Protocol adherence was monitored via electronic patient care reports (ePCRs), and data analysis showed an 18% increase in the average total dose of morphine administered, although no change was observed in the frequency of morphine administration or pain score documentation.

Study	Intervention Characteristics	Inner Setting	Outer Setting	Characteristics of Individuals	Process
Browne et al., 2016	The study examined changes in prehospital pain management protocols, focusing on opioid administration in injured children. Protocol changes included adding age-appropriate pain scales, reducing the minimum age for opioid use, and adjusting fentanyl dosing. Complexity arose from training requirements and the need for providers to adapt to new practices.	External influences included national evidence-based guidelines (NHTSA/EMSC), funding from the HRSA, and pediatric emergency care networks. Additionally, societal concerns about opioid use and the socio-political environment surrounding opioid administration may have impacted adherence.	Each EMS agency independently developed and implemented protocols, reflecting local organizational structures. Challenges included limited documentation of pain assessments and varied training practices across agencies (e.g., in-person vs. video-conferenced training). organizational climate influenced the degree of adoption, with some providers more comfortable than others in administering opioids to pediatric patients.	Providers' skills and comfort with opioid administration varied. Barriers included concerns over side effects, lack of pediatric pain assessment training, and biases about the necessity of opioid use for short transport times. Provider experience and confidence in managing pediatric pain influenced adherence to the updated protocols.	Implementation strategies varied: some agencies provided mandatory in-service training or video recordings, while others included quarterly education. Protocol adherence was evaluated retrospectively through patient records. However, a lack of dedicated pain management quality improvement initiatives limited continuous monitoring and feedback. Despite training efforts, there was no significant change in opioid administration rates post-implementation, indicating the need for additional strategies to embed new practices.
Carey et al., 2019	The intervention focused on evidence-based seizure protocols for pediatric patients. The protocols emphasized non-IV routes (e.g., intramuscular (IM), intranasal (IN)) and medication like midazolam. Adaptations included protocol improvements suggested by paramedics, such as dose standardization and route preferences.	External factors included the National Highway Traffic Safety Administration (NHTSA) and EMS for Children (EMSC) initiatives. Funding and training resources were limited, impacting protocol adherence.	organizational support varied across sites, with protocols differing in their details (e.g., weight-based dosing). Resources, such as pediatric equipment and reference tools, were not consistently available. Training was infrequent, and access to online medical control was sometimes helpful for complex decisions.	Paramedics' comfort and confidence varied, influenced by individual experience, preferences for routes, and concerns about side effects like respiratory depression. Some used personal methods (e.g., asking parents about the child's weight) instead of recommended tools like length-based tapes.	Implementation strategies included in-service training, point-of-care reference tools, and online medical control. The process faced challenges like equipment barriers, dosing ambiguity, and variations in protocol clarity. Paramedics recommended improvements, such as better stocking of equipment and clearer guidelines.
Ciarletta et al., 2024	Focused on pediatric transport safety through use of best practice guidelines for ground ambulances. Adaptability depended on equipment and personnel training. Barriers included device incompatibility and time-sensitive emergency conditions.	Influenced by regulatory mandates, such as New York State EMS training requirements. Manufacturer designs often conflicted with practical needs, and pediatric patient volumes were low, limiting exposure to protocols.	organizational support varied with some agencies enforcing pediatric restraint policies, while others relied on informal guidelines. Lack of compatibility between equipment and stretchers was reported, impacting adherence to protocols.	EMS clinicians expressed anxiety when managing pediatric patients, with many lacking confidence in restraint device use. There was a reliance on personal preferences, with occasional resistance to change, particularly among experienced clinicians.	Implementation strategies included in-service and online training modules, though most participants preferred hands-on training. Documentation was used for compliance monitoring, and some agencies-imposed consequences for non-adherence. However, practical challenges often influenced compliance.
Ebben et al., 2014	Implementation of national ambulance (ANP) and emergency department protocols (EDNP) aimed to standardize clinical care. However, protocols were perceived as too general, limiting practical relevance. Integration with the Advanced Trauma Life Support (ATLS) approach was identified as a key feature supporting adherence.	External influences included patient needs, receiving hospital policies, on-scene circumstances like bystander expectations, and regulatory frameworks. Factors such as environmental safety and aggression at the scene also shaped adherence.	Limited involvement of nurses in protocol development led to perceptions of medical dominance. Some nurses felt disconnected from the protocols, with insufficient feedback mechanisms and inconsistent training integration. Monitoring of adherence through patient records was viewed as punitive.	Nurses valued clinical experience over protocols, with some seeing protocols as legal protection and others preferring local guidelines. Awareness of protocols was limited, especially among emergency department staff. Physician support for aligning medical and nursing protocols varied.	Training strategies included in-service education and online modules, though the lack of practical hands-on training limited impact. Protocol adherence was monitored, but feedback was inconsistent. Nurses recommended clearer integration between local practice and national guidelines to enhance adherence.
Ebben et al., 2015	The intervention involved the National Protocol Ambulance Care (NPAC), a standardized guideline for ambulance services. The protocol covered topics from hygiene to emergency treatment, including symptom-based flowcharts. Updates were provided every three years, requiring nurses to adapt to protocol changes. Nurses were allowed to deviate with proper justification.	External factors included societal expectations, policies at receiving hospitals, and the influence of EMS physicians. National regulations required protocol adherence, but differences in local policy sometimes conflicted with the NPAC.	EMS organizations provided varying levels of support, with inconsistencies in education and access to resources for implementing the NPAC. Some organizations lacked structured feedback mechanisms, and deviations from the NPAC were monitored through patient records, which was viewed as disciplinary by nurses.	Ambulance nurses valued autonomy and clinical experience, often preferring personal judgment over strict adherence. Professional autonomy was seen as both a motivator and a barrier, with nurses reporting that complex protocols constrained their ability to act independently. Nurses' agreement with the NPAC and integration of the protocol into daily routines positively influenced adherence.	Implementation strategies included in-service training and providing hardcopy and digital access to the NPAC. Some organizations ensured quick adoption of protocol updates, but practical barriers such as complexity and lack of hands-on training limited full implementation. Social influences, including the expectations of colleagues and EMS physicians, also shaped adherence behaviors.

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Ezem et al., 2024	The intervention focuses on community-based out-of-hospital cardiac arrest (OHCA) interventions. It includes public CPR and AED training, improved telecommunicator-assisted CPR, and enhanced first responder performance for earlier defibrillation. Complexity arises from adapting the program across diverse counties with varying resources.	External influences include policies and local healthcare regulations, societal expectations for EMS performance, and funding challenges. Differences in outcomes between high- and low-performing counties also shaped implementation efforts.	organizational structures varied, with high-performing counties benefiting from prior success with interventions. Challenges included limited collaboration with health departments and access to necessary resources. Monitoring was sometimes perceived as punitive.	Individuals included EMS, telecommunicators, fire responders, and hospital representatives. Leadership buy-in was crucial for maintaining support, with high-performing counties showing greater engagement from senior staff. Staff in low-performing counties expressed resistance to new changes.	Strategies included initial engagement meetings, frequent follow-ups, and data-sharing to demonstrate intervention effectiveness. Hands-on training was preferred, and regular updates with outcome data were essential for sustained support.
Feder et al., 2006	The intervention involved new guidelines permitting EMS personnel to withhold resuscitation based on verbal or written requests for patients with terminal conditions. These guidelines increased discretion for EMS providers and were implemented voluntarily by 16 of 35 agencies. Training included a printed manual, lectures, and competency quizzes.	Factors shaping implementation included legal and risk management concerns among agencies, public expectations around end-of-life care, and the presence of statewide DNR regulations. Some agencies hesitated to participate due to perceived liability risks.	organizational differences affected guideline uptake, with participating agencies showing greater willingness to adopt changes. Agencies shared a common medical director and continuing education program, but internal policies varied, affecting participation. Monitoring withheld resuscitation cases was seen by some EMS personnel as potentially punitive.	EMS personnel, including EMTs and paramedics, expressed varying degrees of confidence in following the new guidelines. Leadership buy-in was essential for guideline adoption, with EMS personnel showing a preference for clear instructions and autonomy in decision-making.	Implementation strategies included in-service training, structured guidelines, and ongoing monitoring through medical incident reports. Hands-on engagement with staff during the rollout was crucial. Feedback loops were limited, though initial success increased participation over time.
Fishe et al., 2024	The intervention focused on using Discrete Choice Experiments (DCEs) to assess EMS clinicians' preferences for implementing evidence-based guidelines (EBGs). Scenarios included changes such as a sepsis alert protocol, a new bag valve mask, and switching pain medication from morphine to fentanyl. The goal was to align future implementations with clinicians' preferences.	External influences included national EBG requirements and EMS agency policies. Agencies faced challenges like data-sharing limitations with hospitals, resource constraints, and difficulties in collecting outcome feedback. The COVID-19 pandemic also shaped training modalities.	EMS agencies varied in their approach to protocol updates and training, with classroom-based training available in some but not all agencies. Inconsistent feedback mechanisms and different levels of agency support were reported. Protocol updates were usually led by medical directors or educators.	EMS clinicians expressed strong preferences for individual-level feedback, practical hands-on training, and knowledge of the evidence behind new protocols. Some participants preferred classroom education, while others valued simulation-based learning, particularly for skill-based interventions.	Strategies included in-service training, regular protocol updates, and feedback loops from EMS agencies and hospitals. However, many clinicians reported a mismatch between their preferences and existing agency practices, such as the use of online-only education.
Gaither et al., 2021	Implementation of prehospital pediatric TBI guidelines focusing on oxygenation, ventilation, and prevention of hypotension through structured protocols. A train-the-trainer approach was employed for statewide rollout.	The study was influenced by national guidelines, local EMS policies, and public expectations around pediatric care. The COVID-19 pandemic impacted training delivery modes. Funding and data-sharing challenges between EMS and hospitals also affected implementation.	organizational variations included differing levels of support and readiness across participating EMS agencies. Agencies with better collaboration and support were more successful in adopting the guidelines. Feedback mechanisms were inconsistent across agencies.	EMS providers, including paramedics and EMTs, were the key personnel involved. Clinicians expressed varying levels of confidence in applying the guidelines, with leadership support proving critical for success. Many staff preferred hands-on training for effective learning.	Implementation strategies included structured in-service training, regular updates to protocols, and monitoring through patient care reports. A phased rollout with follow-up support ensured gradual adoption across agencies. Feedback was gathered, but inconsistently applied across regions.
Gaither et al., 2024	Implementation of evidence-based guidelines (EBGs) in EMS agencies focused on improving clinical outcomes. Intervention complexity included adapting protocols across different agencies with varying resources. Costs associated with in-person training and resource limitations posed challenges.	Influences included public expectations, external policy mandates, and resource limitations. The heterogeneity of EMS agencies (urban vs. rural, fire-based vs. EMS-only systems) created barriers. Receiving hospital practices and ED feedback also impacted EMS protocol adherence.	EMS agency culture and learning environment significantly influenced the uptake of EBGs. Leadership engagement, structural characteristics, and availability of resources were key factors. Agencies with a strong learning climate showed better engagement with new protocols.	EMS clinicians and leadership had varying levels of knowledge and motivation. Generational differences impacted attitudes toward change, with younger clinicians preferring more structured protocols. Clinicians expressed a preference for in-person, hands-on training over online education.	Implementation strategies included a phased rollout, train-the-trainer models, and continuous feedback. However, inconsistent access to data and analytics limited evaluation efforts. Clear, prescriptive protocols were easier for EMS clinicians to follow, improving adherence.

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Guerrier et al., 2023	Implementation of evidence-based guidelines (EBGs) focused on improving prehospital care through standardization and training. Adaptations were necessary for different EMS systems, and complexity arose from diverse EMS protocols. A "train-the-trainer" approach was used, and protocols required updates based on new evidence.	External factors included differences in community needs, healthcare policies, and national guidelines. Funding constraints and challenges in collaboration with hospitals impacted implementation efforts. Agencies struggled with data-sharing barriers, especially in obtaining hospital outcome data to evaluate guideline effectiveness.	organizational readiness varied across EMS agencies. Strong leadership engagement and a positive learning climate facilitated better adoption. Inconsistent access to training and limited feedback mechanisms created challenges. Agencies with collaborative cultures showed higher guideline uptake.	EMS clinicians' knowledge, attitudes, and motivation impacted adherence. Generational differences influenced preferences for training, with younger clinicians favoring more prescriptive protocols and older clinicians relying on past practices. Clinicians preferred hands-on training but faced challenges with online modules.	Implementation strategies included structured, repetitive training, feedback loops, and data monitoring. Consistent messaging and simulation-based learning were emphasized. However, resource limitations and logistical constraints, such as the COVID-19 pandemic, created barriers to regular in-person training.
Hagiwara et al., 2013	Implementation of prehospital care guidelines with an informal consensus approach. Guidelines were developed without input from end-users, leading to poor contextual adaptation. A simulation-based training approach was part of the implementation strategy.	External influences included societal expectations and differences between rural and urban EMS stations. There were also challenges with collaboration between hospital-based physicians and ambulance personnel.	The organization struggled with the practical application of the guidelines due to limited involvement of stakeholders in their development. Feedback mechanisms were minimal, and agencies lacked tools for continuous monitoring of adherence.	Ambulance personnel found the guidelines useful but impractical in their current format. They preferred flexible, easy-to-access protocols. Personnel often developed their own “homemade” guidelines, stored on personal devices for convenience.	Implementation included lectures, simulations, and IT-based certification. However, the poor format of guidelines limited their use during patient assessments, leading to implicit, memory-based application. Personnel expressed a need for a more user-friendly, integrated system.
Haley et al., 2016	Implementation of pain management interventions, including pediatric-focused education modules and a comprehensive pain management protocol for EMS providers. The protocol standardized opioid administration and emphasized pain score documentation.	Influences included local healthcare policies, public expectations for pain management, and funding challenges. Collaboration with hospitals was limited by data-sharing barriers. The COVID-19 pandemic impacted training delivery and protocol application.	Agencies exhibited varying levels of support and readiness for protocol adoption. Training opportunities were inconsistent, and feedback mechanisms were weak. Leadership engagement and organizational structure influenced adoption success.	EMS providers’ knowledge and comfort with pain management varied. Some preferred hands-on training, while others struggled with new protocols due to a reliance on past practices. Motivation to adopt the new practices depended on leadership support and the clarity of guidelines.	Implementation strategies included education modules, in-service training, and a phased protocol rollout. Monitoring systems were used to track opioid administration and pain score documentation, though sustainability of improvements varied across agencies.
Jones Rhodes et al., 2016	Implementation of prehospital spinal immobilization guidelines aimed to reduce unnecessary immobilization and improve patient comfort. The guidelines emphasized provider discretion and the use of vacuum mattresses instead of rigid spine boards.	External factors included public expectations, healthcare regulations, and inter-agency collaboration challenges. Hospitals and EMS agencies worked together, despite a history of competition, to secure shared equipment and ensure proper implementation.	organizational readiness varied across agencies. A collaborative learning environment and leadership engagement were essential for success. Ownership of shared equipment, such as vacuum mattresses, posed challenges, with smaller agencies showing better maintenance.	EMS personnel valued autonomy and expressed openness to change due to perceived patient discomfort with rigid boards. Some staff struggled with adopting new protocols that required a shift from long-standing practices. Leadership involvement motivated staff, though not all embraced the paradigm shift.	Intensive, hands-on training and collaborative workshops were critical components of implementation. Ongoing quality assurance processes monitored compliance with the new guidelines. Continuous training sessions were necessary to reinforce the protocol and ensure sustainability.
Kelleher et al., 2014	Implementation of a pediatric trauma resuscitation checklist to improve adherence to ATLS protocols. The checklist standardized task sequences and addressed common workflow deviations. The complexity involved integrating the checklist with existing resuscitation procedures.	External factors included societal expectations for trauma care, healthcare regulations, and pre-hospital notification limitations. Limited collaboration between EMS and hospital staff affected pre-arrival coordination. Some patients arrived by private vehicle, complicating team preparation.	organizational readiness varied, with some trauma teams more familiar with the ATLS protocol than others. Limited feedback loops hindered continuous improvement. Resources such as video-recorded reviews were used to monitor compliance with protocols.	Trauma team members, including junior surgical residents and nurses, had to adjust to the new checklist approach. Leadership support was essential for adoption. Staff expressed differing levels of confidence in following the ATLS protocols with and without the checklist.	Implementation strategies included process mining to assess workflow conformance, in-service training, and regular protocol reviews. Ongoing monitoring of task sequences was conducted using video logs to ensure standardization. Improvements in protocol adherence were observed post-implementation.

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Kerner et al., 2017	Implementation of three prehospital emergency care checklists: general prehospital care, acute coronary syndrome (ACS), and asthma/COPD. The checklists aimed to standardize care and improve adherence to standard operating procedures (SOPs). Adaptability was integrated through on-scene use after stabilization, and their laminated format ensured ease of use.	External factors included societal expectations for emergency care quality and regulatory guidelines. Limited pre-hospital collaboration with hospitals impacted seamless care delivery. Resource constraints, such as access to equipment, shaped the application of checklists.	Leadership engagement varied across emergency teams, with higher-performing units demonstrating better uptake. Some units lacked consistent feedback mechanisms and collaboration between EMS teams and physicians. Video reviews were used to monitor compliance with protocols.	EMS personnel, including paramedics and physicians, expressed acceptance of the checklists, recognizing improvements in care quality but noting the additional workload. Generational differences in attitudes were evident, with younger staff more receptive to structured protocols.	The implementation strategy included a phased rollout with seminars and hands-on training. Ongoing monitoring was conducted via video logs to assess adherence, and feedback was used to refine practices. Continuous training sessions were recommended to maintain protocol compliance.
Kothari et al., 2021	Implementation of repetitive high-fidelity simulation training to improve EMS team performance in pediatric emergencies. Scenarios were designed with increasing complexity and included airway management, respiratory failure, and fluid resuscitation. Adaptability was ensured through scenario variation.	External factors included societal expectations for pediatric care, regulatory requirements for EMS professionals, and limited access to pediatric education. EMS agencies faced challenges due to the infrequency of pediatric emergencies and resource limitations.	organizational culture varied across the EMS teams, with some teams demonstrating higher baseline preparedness. Leadership buy-in and a positive learning environment were essential to promote participation. Access to pediatric equipment varied between agencies.	EMS professionals, including paramedics and EMTs, expressed increased confidence in their pediatric care skills after training. Teams demonstrated a need for repeated practice to maintain competency, with younger clinicians more receptive to structured simulation.	Implementation strategies included three simulation sessions spaced over six months, each followed by structured debriefing. Video-based performance review and real-time feedback were provided. Training focused on airway management, medication administration, and fluid resuscitation.
Krawczyk et al., 2016	Implementation of resuscitation guidelines, focusing on the use of adhesive pads for defibrillation instead of manual paddles. The guidelines aimed to improve safety, speed, and effectiveness by minimizing delays during defibrillation. Economic constraints and tradition impacted adoption across different regions.	External influences included national healthcare policies and financial constraints. Public expectations and inter-country differences in defibrillation practices shaped the adoption. Some countries preferred manual paddles due to tradition and familiarity.	The organizational culture within EMS agencies varied, with some preferring traditional methods (manual paddles) over the recommended adhesive pads. Lack of structured feedback mechanisms limited continuous improvement.	Healthcare providers, including physicians, nurses, and paramedics, expressed mixed attitudes towards the guidelines. Some preferred manual paddles due to familiarity, while others recognized the benefits of adhesive pads but were hindered by cost and resistance to change.	Implementation strategies included distributing the guidelines, training sessions, and monitoring compliance through surveys. However, sustainability was challenged by economic constraints, lack of standardization across countries, and inconsistent equipment availability.
Lang et al., 2012	Development and implementation of a national model for evidence-based guidelines (EBGs) in EMS. The intervention involved an eight-step model focusing on structured evidence synthesis, stakeholder engagement, and contextual adaptation. It emphasized flexibility to address local and regional differences while maintaining scientific rigor.	Influenced by national healthcare standards and policy recommendations, with key input from agencies like the National Highway Traffic Safety Administration (NHTSA). Public expectations and funding constraints shaped the adoption process. Inter-agency collaboration was a challenge due to varying operational policies and resources.	Varying levels of organizational readiness and differences in EMS system structures influenced the implementation. Leadership engagement and alignment with national strategies played essential roles. Feedback and quality improvement systems were integrated to monitor effectiveness.	EMS personnel and leaders showed varying levels of engagement and understanding of the guidelines. Motivation to adopt the guidelines depended on clear alignment with operational practices and local needs. Some EMS providers required additional training on evidence-based practices.	Implementation included stakeholder conferences, structured dissemination through online platforms and publications, and quality improvement measures. The process focused on feedback loops and alignment with national certification and accreditation programs to ensure sustainable adoption.
Lynch et al., 2020	Implementation of prehospital thrombolysis (PHT) to treat ST-segment elevation myocardial infarction (STEMI) in South Africa. The intervention faced challenges with complexity due to drug logistics, equipment availability, and the absence of standard billing codes for the procedure.	Barriers included lack of PCI facilities, interprofessional collaboration challenges, and regulatory constraints. Public expectations for rapid care and disparities between urban and non-urban areas also impacted implementation.	Varying organizational readiness, limited leadership engagement, and inadequate infrastructure affected implementation. The absence of feedback loops and limited access to cardiologists hindered systematic adoption.	EMS personnel expressed mixed attitudes toward PHT, with some skeptical about its necessity in urban settings. Concerns over skill decay and competency were raised due to infrequent use of thrombolysis. Training gaps were evident.	Implementation involved strategic planning, limited training, and pilot projects. Monitoring systems were insufficient, with no widespread evaluation. Recommendations included phased scale-up, collaboration across networks, and leadership involvement.

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Mai et al., 2023	Implementation of pediatric TBI management guidelines. Focus on CT protocols, neuroimaging, ICP management, and prehospital interventions. Guidelines varied in adoption across designated trauma centers (DTCs) and non-trauma centers (NTCs).	Public expectations, healthcare disparities between urban and rural areas, and regulatory constraints shaped the implementation. Differences in prehospital services impacted the speed and quality of care, especially in LMICs.	organizational structure influenced guideline adherence, with better resourced DTCs showing more frequent adoption of CT protocols and proactive ICP interventions. Leadership and interprofessional collaboration were key to improving outcomes.	Clinicians varied in their familiarity with the guidelines. Some EMS providers expressed discomfort with performing advanced prehospital procedures, such as ICP management, without sufficient resources. Training gaps and the availability of specialists were highlighted.	Implementation strategies included phased guideline rollout, quality monitoring, and survey-based evaluations of adherence. Recommendations focused on improving inter-agency collaboration and developing context-specific protocols for better adoption in diverse regions.
Manson et al., 2018	Implementation of CDC trauma triage guidelines focused on directing trauma patients to appropriate facilities based on injury severity and resource availability. Complexity arose from variations in trauma center availability and proximity.	External factors included limited access to verified trauma centers in rural areas and inconsistent surgeon availability. Regulatory requirements and public expectations for quick, high-quality care shaped the implementation.	organizational readiness varied, with differences in protocol adherence between urban and rural settings. Leadership engagement was limited in some areas, and collaboration between medics and surgeons was inconsistent.	Paramedics and surgeons expressed differing perceptions of trauma readiness and guideline adherence. Paramedics lacked confidence in rural surgeons' willingness to operate, which impacted decision-making. Experience level influenced paramedic perceptions of surgeon availability.	Implementation strategies included local surveys, pilot protocols for destination determination, and training initiatives. Feedback was limited, and adherence to protocols varied significantly between rural and urban regions. Recommendations highlighted the need for better alignment and communication between stakeholders.
Maria et al., 2024	Development of clinical practice guidelines (CPGs) for paramedic services in Australia and New Zealand, emphasizing evidence-based practices. The guidelines address patient care and resource allocation but lack standardization in development processes across jurisdictions.	Limited access to resources, disparities between urban and rural services, and healthcare policies affecting guideline implementation. Public expectations and funding constraints shape adoption.	Inconsistent project management frameworks across ambulance services, varying levels of leadership engagement, and limited internal resources affect guideline development. organizational readiness differs among services.	Paramedics and other healthcare professionals involved in guideline creation possess diverse skill levels, with many lacking formal training in CPG development. Some rely on external guidance due to limited experience.	Implementation strategies include voluntary capacity building, inter-service collaboration, and thematic analysis of interviews. The study highlights the need for multidisciplinary approaches, formal training, and dedicated funding for CPGs.
Martin-Gill et al., 2016	Implementation of a national strategy for prehospital evidence-based guidelines (EBGs) to enhance EMS care. The strategy focused on standardized development and dissemination, promoting flexibility for regional adaptations.	Public expectations for high-quality emergency care and variability in healthcare policies between states influenced guideline adoption. Limited funding and disparities between urban and rural EMS services shaped the outer environment.	organizational readiness varied, with differences in EMS agency structures impacting guideline implementation. Leadership involvement and inter-agency collaboration were crucial for aligning guidelines with local practices.	EMS providers, researchers, and physicians demonstrated varying levels of engagement. Training gaps were identified, especially for providers unfamiliar with evidence-based medicine principles. Motivation was influenced by leadership support and clarity of guidelines.	The strategy employed structured collaboration through stakeholder meetings, phased implementation, and monitoring. Evaluation tools such as GLIA and feedback loops were recommended to assess adoption. Continuous updates and funding were emphasized to maintain sustainability.
McCaul et al., 2020	The CPGs were adapted from international guidelines to suit the South African prehospital care context. The intervention aimed to align best practices with local needs but was challenged by limited resources and the complexity of guideline adaptation. Resource constraints and timeline pressures shaped the intervention scope.	Public and regulatory expectations shaped implementation, with reliance on international guidelines due to a lack of local evidence. There were challenges in applying international standards to local prehospital realities, particularly in rural areas, where disparities in care and resources were most acute.	Implementation varied across provinces due to different levels of organizational readiness, leadership engagement, and access to funding. There was no national standardization, resulting in variability in adoption. Poor collaboration between stakeholders across regions hampered guideline integration and sustainability.	Guideline developers and implementers included paramedics and advisory board members. Skills in CPG development varied, with many lacking expertise in translating international evidence to local contexts. Personal attitudes toward guideline use and skepticism about applicability influenced adoption. Motivation was impacted by resource constraints and a lack of formal training in guideline development.	Implementation followed a phased rollout with stakeholder engagement through workshops and consultations. However, post-development communication gaps, limited monitoring, and weak feedback loops hindered consistent adoption. There were calls for better coordination at a national level to address these challenges.

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McManus et al., 2023	Implementation of oral corticosteroids (OCS) for pediatric asthma management in EMS treatment protocols. The intervention aimed to reduce reliance on intravenous steroids by leveraging oral administration, which was faster, safer, and less invasive. Complexity involved unfamiliarity with pediatric dosing and occasional resistance due to the unpleasant taste of the medication.	The need for OCS stemmed from a lack of timely access to intravenous treatments, particularly in rural areas. Public expectations for quick, high-quality EMS care influenced the demand. Inter-agency collaboration, including feedback from hospitals, played a critical role in shaping protocol compliance.	EMS agencies varied in organizational readiness, with some services demonstrating stronger leadership and feedback loops. Barriers included inconsistent communication about protocol changes and limited pediatric-specific equipment. The presence of a pediatric medical director in some agencies improved uptake.	EMS clinicians had varying degrees of familiarity and confidence with pediatric care. Clinicians with personal experience caring for children reported greater ease in managing pediatric patients. Skepticism toward new interventions was more common among older EMS providers, who were resistant to changing established practices.	Implementation strategies included stakeholder engagement, phased rollout of protocols, and feedback loops with hospitals. Successful adoption was linked to real-time feedback on patient outcomes. However, challenges persisted due to limited ongoing education and resistance to change within some EMS units.
Mould-Millman et al., 2023	EMS-TruShoC was designed as a bundled care approach for managing traumatic shock. Key elements included reducing scene time, hemorrhage control, large-bore IV placement, oxygen delivery, and direct trauma center transport. The HEET program provided rapid, peer-led, case-based training sessions.	The intervention was implemented in a resource-constrained EMS setting in the Western Cape, South Africa, where trauma from interpersonal violence and road collisions is prevalent. The study noted issues related to external trauma care protocols and transport constraints influencing implementation.	The organizational setting was within government-operated EMS, emphasizing trauma as a high-priority condition. Implementation was supported by station and shift managers, enhancing training access. The organization valued pragmatic, brief training that could fit into operational demands.	Participants included EMS providers with varying qualifications (BLS, ILS, ALS). Providers reported increased confidence through peer-led training and appreciated the non-intimidating environment. Facilitators noted personal satisfaction and increased confidence from leading the training.	The process included delivering five biweekly training modules, each focusing on trauma management through practical scenarios. Implementation monitoring was guided by the RE-AIM framework, with effectiveness evaluated by knowledge, skills, and self-efficacy improvements.
Sarmiento et al., 2013	Implementation of the CDC's Field Triage Decision Scheme to improve trauma triage practices. The scheme included educational resources such as pocket cards, posters, and training guides to assist EMS providers with decision-making. Adaptation challenges arose from regional variability and the complexity of the protocol.	Public expectations for effective triage, disparities in trauma center availability, and inter-agency coordination impacted implementation. Rural areas faced particular challenges due to long distances to trauma centers.	organizational readiness varied across EMS agencies, with some adopting the Decision Scheme more readily due to strong leadership and available resources. Poor collaboration and inconsistent buy-in across agencies hampered broader adoption.	EMS providers and leaders demonstrated varying engagement levels. Leadership often acted as early adopters, while some providers were skeptical about the scheme's relevance. Training gaps and resistance to change were identified as barriers.	Implementation involved a phased rollout with surveys and focus groups to evaluate uptake. Challenges included communication gaps between leadership and staff, as well as a lack of formal feedback loops. Recommendations emphasized the need for stronger leadership involvement and better communication strategies.
McCaul et al., 2019	The clinical practice guidelines (CPGs) transitioned from skills-based protocols to evidence-based guidelines, requiring changes in scope of practice and introducing modular training.	Providers highlighted challenges like lack of communication from regulators and fragmented release of guidelines via informal channels. There was a reliance on technology and local champions for better dissemination.	The organizational environment was marked by limited resources for upskilling and lack of alignment between higher education and industry needs. Hierarchical silos were a barrier to collaboration.	Individual providers faced uncertainty, mixed emotional responses, and concerns about professional identity, particularly related to changes in scope of practice (e.g., intubation). Their motivation varied between embracing evidence-based care and resistance due to perceived loss of competencies.	The guideline rollout involved a phased release, public consultations, and efforts to engage with end-users. However, it suffered from poor communication strategies. Solutions proposed included modular online training and use of professional societies.
Sasson et al., 2009	National guidelines for termination of resuscitation (TOR) protocols, validated by multiple studies. Local adaptation of protocols varies widely. Concerns about protocol complexity and misapplication.	Public expectations for resuscitation outcomes are high and unrealistic. Legislative mandates in some areas require transport for cardiac arrest, limiting protocol implementation. Reimbursement systems incentivize transport rather than TOR in the field.	EMS agencies face operational barriers such as limited resources and inconsistent alignment with higher-level policies. Agencies function independently across states, and policies are often shaped by state laws.	EMS providers expressed concerns about professional judgment and emotional stress related to stopping resuscitation efforts. Some providers reported resistance to TOR due to fear of public backlash and legal liability.	TOR implementation involves local EMS agencies working with national organizations. Strategies include educational campaigns, training, and advocacy for policy change at the legislative and payer levels. Efforts to align protocols nationally face delays due to fragmented local policies.
Siriwardena et al., 2014	Implementation of the Ambulance Services Cardiovascular Quality Initiative (ASCQI), which focused on improving care bundles for AMI and stroke. Interventions included provider prompts, team feedback, and care bundles for standardizing prehospital care.	Public and policy expectations for consistent care delivery. Financial incentives and quality indicators from national and local agencies promoted engagement. Challenges included regional variations in resources and policy alignment.	Each ambulance service developed local quality improvement (QI) teams with national support. Some services struggled with internal silos, while others benefited from collaborative teamwork and leadership. Lack of consistent resources was noted.	EMS providers' skills in using care bundles varied. Motivation among providers fluctuated, influenced by engagement opportunities and feedback. Resistance to change was observed initially but improved with individual recognition and organizational support.	The QI process was structured with phases: workshops, feedback loops, and national meetings. Plan-Do-Study-Act (PDSA) cycles were used to implement and refine changes. Monthly teleconferences and feedback reports provided continuous improvement data.

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Spaite et al., 2019	Implementation of the Prehospital Traumatic Brain Injury (TBI) Treatment Guidelines across Arizona. The intervention aimed to standardize prehospital care for severe TBI patients through evidence-based protocols. It emphasized the use of specific care bundles, including blood pressure and oxygenation management, but required significant resources for full implementation.	Arizona's geographic diversity and healthcare disparities between urban and rural areas affected adoption. Public awareness and expectations for high-quality trauma care increased demand for consistent care practices. Policy support from state-level stakeholders influenced implementation.	Variability in EMS agency resources impacted protocol adherence, with better-equipped urban centers achieving more consistent compliance. Leadership engagement within agencies was critical for sustaining changes, but funding gaps created challenges for smaller, rural agencies.	EMS providers demonstrated mixed attitudes toward the guidelines, with early adopters advocating for the changes, while others expressed concerns about the added workload. Familiarity with evidence-based practices varied, and ongoing training was essential to sustain motivation and competency.	The implementation involved a phased statewide rollout with continuous monitoring and feedback. Key strategies included regular training sessions, collaboration between EMS and hospitals, and the use of clinical audits to ensure protocol adherence. Long-term success relied on leadership support and ongoing funding.
Thorvaldsen et al., 2019	Developed evidence-based guidelines for trauma management using a systematic review, AGREE tool, and GRADE framework. E-learning was designed to complement the guideline.	Need identified among EMS providers for consistent spinal stabilization to prevent secondary injuries. External policies did not mandate the adoption of the guideline, limiting its authority.	EMS organizations with decentralized management, each requiring local guideline approval. Limited inter-organizational collaboration hindered national uniformity.	EMS personnel had varying levels of experience, training, and roles. Low completion rate of the e-learning module was reported. Lack of confidence among some staff in applying the guideline due to infrequent exposure to relevant cases.	Guidelines disseminated through conferences, journals, and e-learning modules. Passive dissemination strategy used. 18 months after guideline release, some services still in the process of implementation. Surveys were used to assess guideline adoption.
Tomasone et al., 2014	The "ABCs of AD" is an online educational module focused on increasing knowledge about autonomic dysreflexia (AD) guidelines. It provides both informational content and videos of patient experiences. The module is divided into six sections, covering definitions, symptoms, diagnosis, and management of AD. Optional quizzes are included. The primary target group is pre-hospital emergency care workers (paramedics, nurses).	The educational content responds to a need for better recognition and management of AD by healthcare professionals, as mismanagement can lead to life-threatening conditions like myocardial infarction. Limited previous knowledge about AD among healthcare workers is identified, with only 50% recognizing key symptoms.	The educational module is intended for use within healthcare training environments, aiming to influence future clinical practice. organizations involved include two Canadian healthcare training programs and multiple institutional ethics boards. Participants noted challenges in completing all sections due to time constraints and lack of perceived personal importance.	Participants included paramedic and nursing trainees, mostly second-year students. The study found that trainees lacked previous experience with AD and rated their knowledge as "Poor" or "None." While knowledge improved significantly post-module, social cognitions toward using the AD-CPGs (attitudes, norms, behavioral control) did not show significant change.	The implementation process involved a pre- and post-module survey design. Participants completed questionnaires assessing knowledge and social cognitions before and after engaging with the module. Module feedback was collected to identify areas for improvement. The study emphasizes that knowledge alone is insufficient for behavioral change, recommending future iterations target social cognitive determinants.
Watts et al., 2004	Implementation of prehospital care guidelines to standardize procedures among EMS providers. The guidelines were developed to improve clinical decision-making and reduce variability in care. Complexity arose from ensuring relevance across diverse EMS environments.	Variability in patient needs and public expectations across urban and rural regions. External influences included health policies and funding structures, which impacted access to resources needed for guideline adherence.	Some EMS organizations demonstrated strong leadership in supporting guideline implementation, while others lacked structured processes for adoption. organizational readiness varied, with limited feedback systems in place to monitor guideline use.	EMS providers expressed mixed attitudes toward the guidelines, with some questioning their applicability to real-life situations. Providers reported feeling constrained by protocols that limited autonomy, particularly in complex cases.	The guidelines were introduced through training workshops, printed manuals, and on-the-job reinforcement. Monitoring was inconsistent, with some services lacking formal mechanisms for feedback and continuous evaluation. Adoption was hindered by a lack of follow-up training and resources.