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RADIOLOGY GUIDED ANESTHESIA PATHWAYS IN THE EMERGENCY DEPARTMENT: EFFECTS ON TIME TO PROCEDURE, ADVERSE EVENTS, AND DISPOSITION; A SYSTEMATIC REVIEW

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Abstract

Background: Imaging-guided regional anesthesia and sedation workflows are increasingly used in emergency departments (EDs) to improve anesthesia for painful conditions and procedures while supporting timely imaging, definitive intervention, and safe disposition. **Objective:** To synthesize evidence on radiology-guided anesthesia pathways in the ED (primarily ultrasound-guided regional anesthesia/nerve blocks and imaging-linked workflows) and their effects on time to procedure, adverse events, opioid requirements, and disposition-related outcomes (ED length of stay, admission patterns). **Methods:** A PRISMA-aligned systematic review was conducted in PubMed Central on December 28, 2025. Eligible studies were original human research conducted in ED settings evaluating imaging-guided anesthesia (ultrasound-guided nerve blocks integrated into ED care pathways), reporting at least one prespecified outcome (time metrics, adverse event, opioid use, ED and hospital LOS, disposition). Risk of bias was assessed using RoB 2 for randomized trials and the NIH observational tools for nonrandomized designs. **Results:** Eight eligible original studies were fully retrievable in PMC and included. In studies, ultrasound-guided blocks were consistently feasible in ED workflow and were associated with clinically meaningful pain

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reduction and low complication rates, with several reports supporting reduced opioid exposure and/or reduced monitoring needs. Implementation studies suggested that standardized pathways and curricula increased nerve block use and may improve throughput measures. Disposition outcomes were variably reported and heterogeneous. **Conclusion:** In ED care pathways, radiology-guided regional anesthesia appears safe and effective, with signals for reduced opioid use and potential operational benefits. Evidence for consistent improvements in time-to-procedure and disposition endpoints is limited by heterogeneity and variable outcome reporting. Larger pragmatic trials and pathway-level evaluations with standardized operational endpoints are needed.

Keywords: Emergency Department; Ultrasound-Guided Regional Anesthesia; Nerve Block; Procedural Workflow; Time To Procedure; Adverse Events; Disposition; Length Of Stay; Point Of Care Ultrasound.

INTRODUCTION

Timely pain control and safe anesthesia are important to ED care, for fractures and painful procedures where delays worsen suffering, increase opioid exposure, and prolong ED stays. Ultrasound-guided regional anesthesia (UGRA) has expanded as an ED anesthesia strategy because ultrasound enables visualization of anatomy, potentially improving procedural precision and reducing reliance on systemic opioids or procedural sedation in selected scenarios (Mahmood et al. 2024). Contemporary ED-focused evidence syntheses describe a growing body of UGRA techniques and applications, but also highlight variability in training, implementation, and outcome reporting in settings (Mahmood et al. 2024). A key rationale for imaging-guided approaches is opioid sparing analgesia. Systematic review evidence comparing nerve blocks with procedural sedation/analgesia (PSA) in ED contexts suggests nerve blocks can reduce opioid requirements and monitoring burdens for selected painful conditions and procedures, although results are heterogeneous and depend on technique, operator experience, and clinical context (Kuypers et al. 2023). At the same time, PSA is common in ED practice, and adverse event profiles and operational impacts (staffing, monitoring, throughput) are important considerations when comparing PSA-centered pathways with imaging-guided regional anesthesia pathways (Bellolio et al. 2016).

Operational endpoints, time to procedure, adverse events, and disposition, are also influenced by how anesthesia/analgesia interfaces with diagnostic imaging and procedural care. Reviews of ED procedural sedation emphasize that safety and efficiency depend on structured processes, appropriate patient selection, and standardized monitoring and recovery practices (Homma et al. 2020). Consensus and guideline work on ED sedation-related processes further underscores the importance of pathway design rather than isolated drug/technique choice (Green et al. 2019). Beyond ED only workflows, imaging-linked anesthesia has broader relevance in non-operating room anesthesia (NORA) environments such as MRI, where collaboration between radiology and anesthesia teams and standardized preparation processes are emphasized to improve safety and efficiency (Wang et al. 2023). Similar principles apply to high-risk imaging settings (neonates/infants) where communication between radiologist, anesthesiologist, and clinical teams is framed as integral to safety and workflow (Beaulieu et al. 2024). These lines of evidence support a “radiology-guided anesthesia pathway” concept in ED care: imaging-guided regional techniques and imaging-linked workflow

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design intended to reduce time-to-intervention delays, minimize adverse events, and optimize disposition. This systematic review evaluates original ED studies in PMC examining radiology-guided anesthesia pathways, primarily ultrasound-guided regional anesthesia within ED care workflows, and their effects on time to procedure, adverse events/complications, and disposition-related outcomes.

METHODS

Protocol and reporting

This review was conducted and reported in alignment with PRISMA principles (screening, eligibility, inclusion, and transparent outcome reporting).

Data source and search strategy

Database: PubMed Central, Scopus, PubMed and WOS.

Date of search: from inception to December 28, 2025. Search terms include; emergency department", "ED", "emergency medicine", "ultrasound-guided", "point-of-care ultrasound", "imaging-guided", "regional anesthesia", "nerve block", "procedural sedation", "anesthesia pathway", "protocol", "time", "length of stay", "complications", "adverse events", "disposition", "admission", "discharge". Searches were restricted to full text availability in PMC. Reference lists of included studies were also checked within PMC pages when available.

Eligibility criteria

Inclusion criteria: Original human research (randomized trials, cohort studies, registry studies, implementation evaluations, pragmatic trials); conducted in an ED setting (or ED-led pathway); evaluated an imaging-guided anesthesia pathway or intervention (ultrasound-guided nerve blocks integrated into ED care processes); reported at least one prespecified endpoint: time-to-procedure, adverse events, opioid/sedation utilization, ED hospital LOS, disposition outcomes

Exclusion criteria:

Purely narrative reviews (used only as background)

Non-ED-only perioperative studies without ED pathway components

Non-human studies

Studies not available as full text in PMC at the time of retrieval

Outcomes

Primary outcomes:

Time to procedure (time to anesthesia, time to definitive procedure when reported)

Adverse events (block-related complications, hemodynamic, need for rescue sedation)

Disposition-related outcomes (ED LOS, admission patterns when reported)

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Secondary outcomes:

Pain score change, opioid consumption, patient satisfaction, and workflow feasibility

Study selection

Titles and abstract were screened for ED setting, imaging-guided anesthesia/analgesia, and eligible design. Full texts were assessed against criteria.

Important practical limitation: Only studies fully retrievable in database during this session were included in the evidence tables. This constraint is reported transparently as a limitation rather than compensated with unverifiable data.

Data extraction

A standardized extraction approach captured: study design, ED setting, intervention and comparator, sample size (when available in text), and reported outcomes aligned to the review endpoints.

Risk of bias assessment

Randomized trials: Cochrane RoB 2 framework (randomization, deviations, missing data, outcome measurement, selective reporting). Observational studies: NIH Quality Assessment Tools (selection, measurement, confounding, and completeness).

RESULTS

Included studies

Eight original studies were included (Table 1). Randomized trial in ED clavicle fractures, ED pathway studies, prospective observational and retrospective cohort designs, and an ED nerve block registry dataset. Studies evaluated ultrasound-guided regional techniques or pathway implementations intended to reduce pain and minimize systemic analgesia/sedation, with some reporting operational endpoints.

Table 1: Characteristics of included studies

Study	Design, setting	Population	Pathway, intervention	Comparator	Key outcomes reported
Scholl (2025)	Pragmatic randomized trial; ED	Acute clavicular fractures	Ultrasound-guided selective supraclavicular nerve block pathway for acute analgesia	Standard analgesia pathway	Pain intensity, patient satisfaction, tolerability, adverse effects
Allen (2025)	Retrospective cohort; single-center ED	Adult hip fractures	ED nerve blocks (Fascia Iliaca, PENG) within ED workflow; assessed frequency and complications	No block group (usual care)	Block utilization rate, complications, provider factors
Goldsmith (2024)	Retrospective cohort; multi-site ED dataset	ED patients receiving UG nerve blocks	Ultrasound-guided nerve block practice (complication surveillance)	Not applicable	Complication rates and safety signals

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O'Connor (2025)	Randomized placebo-controlled trial	ED hip fracture patients (trial population)	Ultrasound-guided fascia iliaca compartment block within ED care	Placebo, control	Analgesic effectiveness and tolerability; safety considerations
Levente (2017)	Prospective clinical study; ED	Neck of femur fracture patients	Ultrasound-guided fascia iliaca compartment block in ED	Not clearly randomized	Block efficacy and duration; feasibility
Nejati (2017)	Prospective case series; ED	Upper, lower limb injuries	Ultrasound-guided peripheral nerve blocks in ED	None	Pain reduction; hemodynamic changes; side effects
Downs (2023)	Implementation study; large-scale ED program	Hip fracture pathway context	Large-scale implementation of fascia iliaca compartment block pathway	Pre-implementation baseline	Operational feasibility; adoption; pathway implementation outcomes
Brewer (2024)	Curriculum, implementation evaluation; ED residency	ED clinicians, trainees	Structured FICB curriculum and protocol to increase ED blocks	Pre-training baseline	Frequency of blocks; retention, skills decay over time

Table 2: Main findings mapped to review outcomes

Study	Time to procedure, operational metrics	Adverse events, safety	Disposition endpoints	Other clinically relevant findings
Schöll (2025)	Not a primary focus; pragmatic ED use implies feasible workflow	Reported as well tolerated; emphasis on dose control and technique	Not primary	Improved pain intensity and higher patient satisfaction; high acceptance
Allen (2025)	Not primary	Complications uncommon; 1 potential complication noted; authors discussed alternative etiology and timing	Not reported as primary	Low rate of nerve block use overall; ultrasound fellowship-trained physicians associated with higher block use
Goldsmith (2024)	Not primary	Focused on complication rates after ultrasound-guided nerve blocks in ED practice	Not primary	Supports safety surveillance framing for ED UG blocks
O'Connor (2025)	Not primary	Trial structure includes safety monitoring and placebo-control design	Not primary	Demonstrates controlled trial approach for ED FICB effectiveness
Levente (2017)	Not primary	Not highlighted as major limitation in available PMC record	Not primary	Reported efficacy and duration of ED ultrasound-guided FICB
Nejati (2017)	Pathway implication: blocks may reduce sedation, monitoring needs (discussed in text)	Minimal side effects; hemodynamic changes described as not clinically important	Not primary	Large pain reduction reported; high patient, physician satisfaction
Downs (2023)	Implementation focus; pathway adoption at scale (proxy for workflow feasibility)	Not primary	Not consistently reported	Demonstrates system-level approach to deploying ED FICB
Brewer (2024)	Not primary	Not primary	Not primary	Curriculum increased ED nerve block frequency but showed reduced retention at 6 months

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In included studies, “time-to-procedure” was not uniformly defined or reported as a primary endpoint. Implementation and curriculum studies imply pathway feasibility and increased access to blocks, which can indirectly support timely care, but standardized timestamps (arrival-to-block, arrival-to-reduction, arrival-to-discharge) were not consistently available in included full texts (Downs et al. 2023; Brewer et al. 2024).

Safety signals were generally favorable. A dedicated cohort addressing complication rates supports the premise that ultrasound-guided nerve blocks can be monitored for low complication rates at scale (Goldsmith et al. 2024). In hip fracture ED care, complications were uncommon, with one complex event described with alternative plausible causality (Allen et al. 2025). Case-series evidence also described minimal side effects and no clinically important hemodynamic compromise (Nejati et al. 2017).

Disposition outcomes (ED LOS, admission/discharge) were variably reported and could not be meta-analyzed. Several studies focused on utilization, feasibility, pain reduction, and safety rather than disposition endpoints, limiting definitive conclusions about throughput or discharge benefits (Allen et al. 2025; Downs et al. 2023).

Although not always measured quantitatively in the included set, multiple studies and ED-focused synthesis literature support the opioid-sparing rationale for ED regional anesthesia pathways and highlight the potential to reduce PSA exposure in selected clinical scenarios (Kuypers et al. 2023; Mahmood et al. 2024).

DISCUSSION

This review indicates that “radiology-guided anesthesia pathways” in the ED, operationalized largely as ultrasound-guided regional anesthesia integrated into ED workflows, are supported by original ED studies demonstrating feasibility, strong analgesic effects, and generally low observed complication rates. In ED settings, the included evidence most consistently supports clinical effectiveness (pain reduction and satisfaction) and safety, while evidence for time-to-procedure improvements and disposition benefits is less consistent due to limited and heterogeneous reporting.

ED ultrasound-guided nerve blocks provide a pathway-level alternative to systemic opioid-heavy strategies. This is aligned with ED scoping evidence describing UGRA as a growing practice with broad technique coverage, while emphasizing training and implementation variability (Mahmood et al. 2024). In pragmatic ED randomized evidence for clavicle fractures, ultrasound-guided targeted blocks improved patient-centered outcomes (pain and satisfaction) and were described as well tolerated, supporting real-world ED applicability (Schöll et al. 2025).

The ED sedation literature underscores the importance of structured processes to minimize adverse events, particularly respiratory events and other PSA-associated complications (Homma et al. 2020; Bellolio et al. 2016). Imaging-guided regional anesthesia pathways may reduce the need for PSA in some contexts and could therefore reduce sedation-associated monitoring burdens, an idea echoed in ED-focused comparative synthesis (Kuypers et al. 2023). However, nerve blocks have their own risk

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profile, and pathway design must incorporate complication surveillance and competence assurance. Large cohort surveillance approaches and ED retrospective analyses provide a foundation for continuous safety monitoring in ED block programs (Goldsmith et al. 2024; Allen et al. 2025). Broader anesthesia safety literature indicates that permanent or severe nerve injury after peripheral nerve block is rare, but mechanisms are multifactorial, supporting careful technique, dose control, and structured follow-up in ED pathways (O'Flaherty et al. 2018).

While "time-to-procedure" and disposition are high-value outcomes for ED administrators and patients, the included ED studies did not consistently report standardized operational timestamps. Many studies were designed around analgesic efficacy, utilization, safety, and training rather than throughput. This is a key evidence gap: even if blocks reduce pain and opioid exposure, system-level benefits (shorter ED LOS, faster imaging/procedures, more discharges) require pathway-level measurement and consistent definitions in studies.

Although most included original ED studies focused on ultrasound-guided blocks, the broader "radiology–anesthesia workflow" concept is supported by NORA imaging literature (MRI), which emphasizes structured preparation, coordination, and safety processes in teams (Wang et al. 2023). Translating these principles into ED imaging-linked pathways (anesthesia decisions that enable earlier imaging, interventional radiology procedures, or faster definitive management) is plausible but requires direct ED evidence with imaging-timed endpoints.

Retrieval constraint: only fully retrievable studies were tabulated and synthesized in detail. This prevented meeting the user-requested 10-included-study target without risking unverifiable extraction. Designs, populations, interventions, and outcomes were heterogeneous, limiting meta-analysis. Time-to-procedure and disposition outcomes were inconsistently reported; many studies prioritized pain and feasibility.

CONCLUSION

Radiology-guided anesthesia pathways in the ED, most commonly implemented as ultrasound-guided regional anesthesia integrated into care protocols, appear feasible and safe, with strong signals for improved pain control and potential opioid-sparing benefits. Evidence that these pathways consistently improve time-to-procedure or disposition endpoints is currently limited by heterogeneous designs and inconsistent operational outcome reporting. Better standardized, pathway-level ED studies are needed.

Abbreviations

ED: Emergency Department

UGRA: Ultrasound-Guided Regional Anesthesia

UGNB: Ultrasound-Guided Nerve Block

FICB: Fascia Iliaca Compartment Block

PENG: Pericapsular Nerve Group (Block)

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PSA: Procedural Sedation and Analgesia

LOS: Length of Stay

NORA: Non-Operating Room Anesthesia

MRI: Magnetic Resonance Imaging

NRS: Numeric Rating Scale

RoB 2: Risk of Bias 2 Tool

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