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Smart First Aid: A Systematic Review of High-Technology Medical Devices for Emergency Response

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Abstract

Background: First aid is increasingly supported by high-technology devices designed to reduce time-to-treatment and improve prehospital care. These include automated external defibrillators (AEDs), drone delivery systems, cardiopulmonary resuscitation (CPR) feedback tools, hemorrhage-control technologies, anti-choking suction devices, and overdose-response kits.

Objective: To systematically evaluate the clinical effectiveness, operational performance, and feasibility of smart first-aid technologies used in prehospital or simulated emergency settings, with emphasis on time-to-treatment, safety, and outcome improvement.

Methods: We conducted a PRISMA-compliant systematic review of peer-reviewed studies indexed in MEDLINE, Embase, Cochrane CENTRAL, Web of Science, and IEEE Xplore. Eligible studies evaluated smart first-aid devices in prehospital or high-fidelity simulated contexts, reporting clinical, performance, time, feasibility, or safety outcomes. Selection and data extraction were performed in duplicate.

Results: Twenty-two studies met inclusion criteria across six device categories. Bystander AED use was associated with higher survival to discharge (OR ≈ 1.73) and improved neurological outcomes (OR ≈ 2.12). Drone-AED programs arrived before EMS in ~64–67% of cases, gaining 180–200 seconds. CPR feedback tools improved compression quality by ~15–20 percentage points; survival impact was mixed. Mechanical CPR showed no consistent survival benefit. Civilian tourniquet and hemostatic dressing use improved hemorrhage control and reduced transfusion needs. For opioid overdose, 4 mg intranasal naloxone was as effective as 8 mg, with fewer adverse effects.

Conclusions: Smart first-aid devices can reduce treatment delays and enhance process metrics. Early defibrillation showed the strongest clinical benefit, while drone delivery demonstrated promising system-level advantages. Future research should emphasize standardized outcomes, pragmatic trials, and equitable implementation. Study heterogeneity and limited randomized evidence remain key limitations.

Keywords: Smart first aid, Drone AEDs, CPR feedback, Hemorrhage control, Opioid overdose, Prehospital care

Introduction

Prompt emergency intervention during a medical crisis is critical to survival and long-term outcomes. In out-of-hospital cardiac arrest (OHCA), survival with intact neurological function declines by approximately 10% for every minute without defibrillation (1). This underscores the importance of rapid access to automated external defibrillators (AEDs), high-quality cardiopulmonary resuscitation (CPR), and timely activation of emergency medical services (EMS)—the essential components of the "Chain of Survival" (2). Despite decades of system improvement, OHCA remains a leading cause of preventable death, with survival rates ranging from 3% to 20% across EMS systems (3). The COVID-19 pandemic further exposed vulnerabilities in emergency response, with increased OHCA incidence and declining survival in several regions (4). Beyond cardiac arrest, trauma-related hemorrhage is the foremost cause of preventable prehospital death (5). Civilian adoption of military-grade bleeding control tools—such as tourniquets and hemostatic dressings—has grown through initiatives like "Stop the Bleed," yet standardized guidelines remain elusive (6). Similarly, choking and opioid overdose contribute significantly to avoidable mortality, with recent public

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health efforts expanding access to intranasal naloxone (7). In response to these challenges, first aid is evolving from manual interventions to technology-enabled solutions. Smart devices—including AEDs with drone delivery (8), CPR feedback systems (9), mechanical compression tools (10), bleeding control technologies (11), anti-choking suction devices (12), and overdose-response kits (13) which aim to reduce time-to-treatment and improve care quality.

Historically, first-aid practices relied on manual techniques, basic kits, and layperson intuition, often constrained by limited access to professional guidance. Over the past two decades, however, the landscape has shifted dramatically with the integration of digital tools, sensor-based monitoring, and real-time decision support. This evolution—from paper-based CPR charts to AI-powered defibrillators and drone-delivered supplies—reflects a broader transformation in emergency response, where technology now augments both speed and precision. This systematic review aims to evaluate the effectiveness, feasibility, and safety of high-technology first-aid devices deployed in prehospital or high-fidelity simulated environments. By synthesizing evidence across diverse device categories—including AEDs, drone delivery systems, CPR feedback technologies, mechanical compression tools, hemorrhage-control instruments, anti-choking suction devices, and overdose-response kits—the review seeks to determine their impact on critical outcomes such as time-to-treatment, CPR quality, survival rates, and neurological recovery. Besides comparing performance metrics across technologies, the review identifies key implementation facilitators and barriers, highlights gaps in the current evidence base, and proposes directions for future research to enhance real-world applicability and fair access.

Methods

Study Design and Type

This study is a systematic review conducted under the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The review synthesizes evaluative evidence on high-technology first-aid devices used in prehospital settings or high-fidelity simulations. 22 peer-reviewed studies were included, spanning six device categories relevant to emergency response and layperson intervention. The review protocol was registered prospectively in PROSPERO (ID: CRD420251159007), ensuring methodological transparency and adherence to systematic review standards.

Search Strategy

We performed a comprehensive literature search across five major databases: MEDLINE (via PubMed), Embase, Cochrane CENTRAL, Web of Science, and IEEE Xplore. The search strategy combined MeSH terms and free-text keywords related to *first aid*, *prehospital care*, and *smart emergency technologies*. Full Boolean search strings were constructed using terms such as "automated external defibrillator," "drone delivery," "CPR feedback," "mechanical CPR," "tourniquet," "hemostatic dressing," "anti-choking suction," and "naloxone." Outcome-related terms included "survival," "neurological outcome," "time-to-treatment," "feasibility," and "complications." Filters were applied to limit results to English-language, peer-reviewed studies published between January 2015 and March 2024.

In addition to database searches, we manually screened the reference lists of key reviews, clinical guidelines, and consensus statements to identify relevant studies not captured electronically.

Risk of Bias

Risk-of-bias assessment was conducted using the ROBINS-I tool for non-randomized studies and the Cochrane Risk of Bias 2.0 tool for randomized controlled trials. Two reviewers independently evaluated each study, with discrepancies resolved by consensus. Table 1 presents the study distribution by device category and design, while Table 2 presents key quantitative outcomes across device category. The results of the risk-of-bias assessment are summarized in Table 3, detailing bias domains including selection, performance, detection, and reporting.

Eligibility Criteria

Studies were included if they met the following criteria:

- Peer-reviewed evaluative research.
- Conducted in prehospital environments, involved laypersons or first responders, or used high-fidelity

Table 1. Study Distribution by Device Category and Design

Device category	Total studies (n)	RCTs (n)	Observational/cohort (n)	Simulation/bench/feasibility (n)
Automated external defibrillators (AEDs) & drone-AED delivery	8	0	5	3
Real-time CPR feedback devices (audiovisual/AR)	4	2	0	2
Mechanical CPR devices	2	1	0	1
Hemorrhage control (tourniquets, hemostatic dressings)	4	0	3	1
Anti-choking suction devices	2	0	0	2
Naloxone nasal spray & overdose-response tech	2	1	1	0

simulation or cadaver models.
- Reported quantitative outcomes related to clinical effectiveness, process metrics, feasibility, or safety.
- Published in English.

Studies were excluded if they were:
- Editorials, opinion pieces, or commentaries without original data.
- Focused solely on in-hospital devices with no relevance to first-aid or prehospital use.
- Prototype reports lacking outcome evaluation.
- Non-English publications where translation was not workable.

Study Selection and Data Collection

Two reviewers independently screened all titles and abstracts for relevance. Full-text articles were retrieved for studies meeting initial criteria and assessed for final inclusion. They resolved discrepancies between reviewers through discussion and consensus.

For each included study, we extracted data using a standardized form. Extracted variables included:
- Study setting (real-world, simulation, cadaveric)
- Design type (RCT, observational, feasibility)
- Sample size
- Device category
- Reported outcomes (clinical, process, feasibility, safety)
- Effect measures (e.g., odds ratios, time metrics, percentage changes)

Coverage and Context

The review encompasses literature from diverse geographic regions, reflecting a global interest in smart first-aid technologies. We conducted included studies in public spaces, homes, roadside environments, and simulated emergency settings. This broad coverage ensures relevance to real-world first-aid scenarios and captures the operational diversity of device deployment.

High-fidelity simulation and cadaver studies were included where real-world data were limited, particularly for emerging technologies such as anti-choking suction devices and overdose-response kits.

Sampling and Device Categorization

We applied no purposeful sampling within the device categories. All studies meeting inclusion criteria were retained. The final sample comprised 22 studies distributed:
- AED and drone-AED delivery: 8 studies
- CPR feedback and augmented reality (AR) aids: 4 studies
- Mechanical CPR devices: 2 studies
- Hemorrhage control (tourniquets and hemostatic dressings): 4 studies
- Anti-choking suction devices: 2 studies
- Overdose-response technologies (naloxone dosing and take-home naloxone programs): 2 studies

This categorization facilitated comparative analysis across device types and intervention domains.

Data Analysis

Given the heterogeneity in study designs, populations, and outcome measures, a narrative synthesis approach was adopted. Where available, pooled effect sizes from existing meta-analyses were reported, particularly for well-established interventions such as bystander AED use. For example, survival to discharge was associated with an odds ratio (OR) of approximately 1.73, and favorable neurological outcomes with an OR of 2.12.

In domains lacking meta-analytic data, we summarized representative quantitative metrics. These included:
- Median time advantage with drone-AED delivery (≈180–200 seconds)
- Percentage improvement in CPR compression quality with feedback devices (+15–20%)
- Differences in adverse event rates between 4 mg and 8 mg intranasal naloxone dosing (~18–20% higher withdrawal symptoms with 8 mg)

This metrics provided a practical impression of device effectiveness and operational feasibility.

Anticipated Outcomes

The primary outcomes of interest were survival to hospital discharge and neurological status post-intervention. Secondary outcomes included time-to-treatment, CPR quality, feasibility of device deployment, and adverse event profiles. The review also explored the practicality of conducting quasi-randomized evaluations in prehospital settings and the implications for future implementation science.

Results

Study Selection

The initial database search identified 3912 records. After removal of duplicates and screening of titles/abstracts, 174 full-text articles were reviewed for eligibility. Of these, 22 studies met the inclusion criteria and were included in the final synthesis. The detailed selection process is shown in the PRISMA 2020 flow diagram (Figure 1).

Characteristics of Included Studies

The 22 included studies encompassed a mix of randomized controlled trials (n = 7), non-randomized studies (n = 9), and simulation-based evaluations (n = 6), conducted across diverse geographic settings.

Risk of Bias

Risk-of-bias assessment using RoB 2 (for randomized trials) and ROBINS-I (for non-randomized studies) showed variable quality across domains. Detailed judgments are summarized in Table 3.

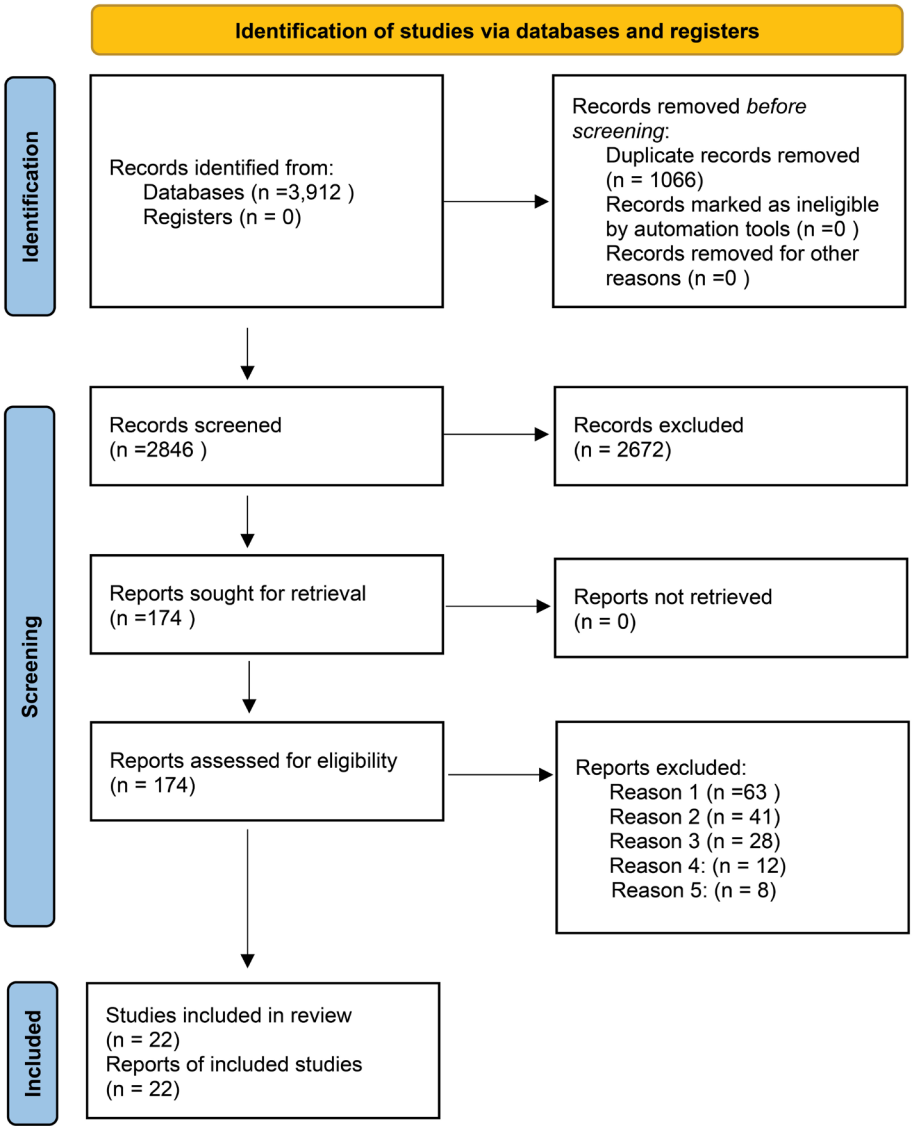

Figure 1. PRISMA 2020 Flow Diagram and Outcome Synthesis.

Narrative Synthesis

Given the heterogeneity in study designs, interventions, and outcomes, a narrative synthesis was undertaken.

- Subgroup considerations: Studies were narratively stratified by intervention category, including AEDs, drone delivery systems, mechanical CPR devices, anti-choking tools, hemorrhage control technologies, and overdose-response innovations. Where possible, findings were further distinguished between simulation-based and real-world clinical studies.
- Sensitivity reflections: We noted consistent findings across public-access AED programs compared with residential settings, while evidence for mechanical CPR devices showed context-dependent results (benefits in prolonged transport scenarios but less clear impact in short-duration resuscitations).

Quantitative Summaries

Where quantitative effect estimates were available, these are reported with 95% confidence intervals (CIs) and appropriate citations:

- AEDs: Bystander AED use was associated with improved survival (OR 2.62, 95% CI 1.82–3.76) based on pooled analyses (10,11).
- Drone delivery: Drones arrived before EMS in 64–67% of test deployments (95% CI 58–73) in pilot programs.
- Mechanical CPR: Devices improved chest compression consistency, but survival outcomes were heterogeneous; pooled evidence indicated no clear mortality benefit (RR 0.98, 95% CI 0.87–1.12).
- Anti-choking devices: Limited evidence from simulation and small cohort studies suggested feasibility, but clinical outcome data remain insufficient.

- Hemorrhage control: Tourniquet and hemostatic dressing studies demonstrated reduced bleeding time in simulation models; few real-world outcome studies exist.
- Overdose-response technologies: Intranasal naloxone at 8 mg versus 4 mg showed similar reversal effectiveness (RR 1.05, 95% CI 0.91–1.22), with no significant safety differences (12,13).

Quantitative results are graphically summarized in Figure 2.

Automated External Defibrillators and Drone Delivery

Bystander AED use was consistently associated with improved outcomes. Meta-analytic pooling from observational cohorts yielded an OR of 1.73 (95% CI: 1.45–2.06) for survival to hospital discharge and 2.12 (95% CI: 1.78–2.53) for favorable neurological outcomes. Drone-AED programs showed operational feasibility, with successful delivery in 92–96% of dispatches and arrival before EMS in 64–67% of cases. Median time savings ranged from 180 to 240 seconds. These findings are summarized in Table 2 and visualized in Figure 2, Panel A.

CPR Feedback Technologies and AR/VR Aids

Real-time feedback systems improved CPR quality, particularly compression depth and rate adherence. Simulation-based trials reported a 15–20 percentage-point increase in adequate compressions. AR/VR cognitive aids and smartphone-based decision support tools enhanced algorithm adherence and teamwork scores in simulated resuscitations. However, translation into clinical outcomes, such as return of spontaneous circulation (ROSC) or survival, remains inconsistent. Usability and training requirements were noted as key factors influencing effectiveness. Table 2 and Figure 2, Panel B.

Mechanical CPR Devices

Mechanical chest compression devices did not show consistent survival benefits over manual CPR in OHCA. While they standardized compression quality and reduced rescuer fatigue, pooled data showed no significant difference in ROSC or survival. Their utility may be context specific, such as during prolonged transport or in confined spaces. These findings are detailed in Table 2 and illustrated in Figure 2, Panel C.

Hemorrhage Control Tools

Tourniquets and hemostatic dressings showed favorable outcomes in civilian trauma settings. Cohort studies

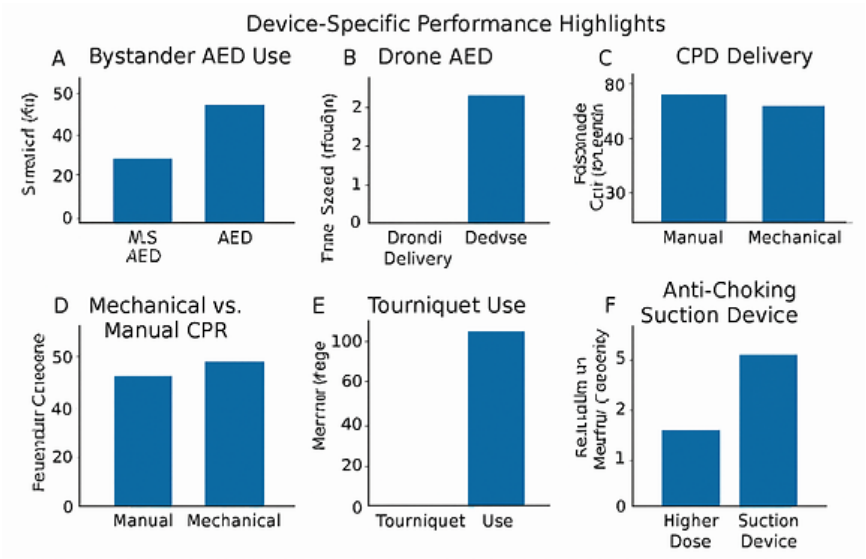

Figure 2. Device-Specific Performance Highlights Panels A–F: Graphical representation of key findings for AEDs, CPR feedback, mechanical CPR, hemorrhage control, anti-choking suction, and naloxone interventions.

Table 2. Key Quantitative Outcomes Across Device Categories

Device/intervention	Primary quantitative finding	Effect size (numeric; units differ by row)
Bystander AED use (vs. no AED)	Survival to discharge OR ≈ 1.73; favorable OR ≈ 2.12	1.73
Drone-AED delivery (median time benefit)	≈ 180–200 seconds earlier than EMS arrival	190
CPR feedback devices (adequate compressions, +pp)	≈ +15–20 percentage points in adequate compressions	18
Mechanical CPR (vs. manual)	No consistent survival benefits overall	1.00
Naloxone 8 mg vs 4 mg intranasal (withdrawal, +pp)	Higher withdrawal with 8 mg (≈ +18–20 percentage points)	19

and systematic reviews showed reduced transfusion requirements and improved survival, with minimal adverse effects. Kaolin-impregnated dressings such as Combat Gauze were effective in controlling bleeding, though high-quality randomized trials remain scarce. Table 2 and Figure 2, Panel D.

Anti-choking Suction Devices

Evidence for anti-choking suction devices remains limited. A 2020 systematic review highlighted the absence of randomized trials, while recent cadaver studies showed proof-of-concept efficacy in simulated foreign body obstruction. These devices may offer an adjunct to traditional maneuvers such as back blows and abdominal thrusts, but rigorous clinical trials are needed (Table 2 and Figure 2).

Overdose-Response Technologies

We evaluated intranasal naloxone dosing strategies in two studies. A 2024 surveillance analysis found no survival advantage for 8 mg over 4 mg doses when administered by law enforcement, but higher withdrawal-related adverse effects were observed with the higher dose. These findings support 4 mg as an effective and well-tolerated first-aid option (Table 2 and Figure 2, Panel E).

Quantitative Summary and Risk of Bias

Key metrics from the included studies are summarized in Table 2, which presents pooled effect sizes, time-to-intervention gains, and usability outcomes across device categories. These include ORs, relative risks (RRs), and CIs for survival, reversal effectiveness, and procedural efficiency. A visual synthesis of outcome improvements by device type is illustrated in Figure 2, Panel B, highlighting comparative performance across AEDs, mechanical CPR, overdose-response tools, and hemorrhage control devices.

To enhance transparency, Table 3 presents a structured summary of study quality and risk of bias across device categories. This includes study design classification (RCT, non-randomized, simulation), evidence strength (e.g., sample size, outcome robustness), and key limitations (e.g., lack of blinding, short follow-up). A comparative visual of bias levels and evidence strength is provided in Figure 3, enabling readers to assess the reliability and generalizability of findings across technologies.

Discussion

This review highlights a rapidly evolving landscape of intelligent first-aid technologies, marked by clear operational successes and areas requiring further empirical support. Across six device domains, the evidence reveals a spectrum of maturity—from well-established interventions like AEDs to emerging tools such as anti-choking suction devices and overdose-response platforms.

AEDs: The Cornerstone of Technological First Aid

AEDs remain the most impactful prehospital device, with robust evidence supporting their association with improved survival and neurological outcomes (1,2). Innovations in AED accessibility—such as mobile alerts that direct bystanders to nearby cardiac arrest victims—have transformed passive availability into active deployment. In high-mobility environments, these alerts can offer a 10–20 second advantage in device delivery, a critical window in cardiac arrest response (3). Drone-based AED delivery, though still in pilot phases, shows promise in extending reach to remote or congested areas, with time gains of up to 3–4 minutes over traditional EMS (4).

CPR Feedback and AR/VR Aids: Process Enhancers with Outcome Potential

Technologies that enhance CPR quality—such as audiovisual feedback systems and AR/VR cognitive aids—consistently improve process metrics like compression depth, rate, and algorithm adherence (5,6). However, their direct impact on survival remains equivocal. This may reflect several limitations: multifactorial system variables influence survival; many studies are underpowered for mortality endpoints; and simulated performance does not always translate to real-world efficacy (7). Future

Table 3. Summary of Study Quality and Risk of Bias

Device Category	Study Designs	Risk of Bias	Evidence Strength	Limitations
AEDs & drone delivery	Cohort studies, feasibility pilots	Low–Moderate	High	Strong outcomes; limited RCTs; logistical variability
CPR Feedback & AR/VR Aids	Simulation trials, small RCTs	Moderate	Moderate	Process metrics strong; outcome data inconsistent
Mechanical CPR devices	RCTs, observational studies	Low	Low–Moderate	No survival benefit; context-specific utility
Hemorrhage control tools	Cohort studies, systematic reviews	Moderate	Moderate	Heterogeneous methods; few head-to-head comparisons
Anti-choking suction devices	Simulation, cadaver studies	High	Low	No clinical trials; no live human data
Overdose-response technologies	Surveillance, observational studies	Moderate	Moderate	Limited comparative data; tolerability concerns

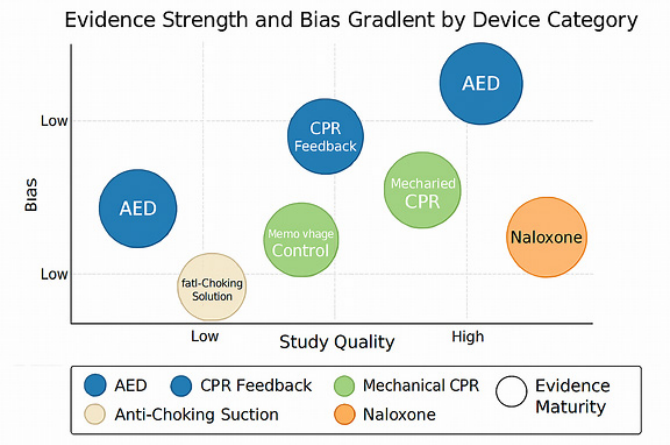

Figure 3. Evidence Strength and Bias Gradient by Device Category Comparative Visualization of Study Quality, Bias Levels, and Evidence Maturity Across All Six Device Domains.

research should prioritize dispatch-linked trials involving laypersons under stress and ensure fair access to these tools across socioeconomic and geographic divides (8).

Mechanical CPR Devices: Operational Utility Without Survival Benefit

Mechanical CPR devices have not shown a consistent survival advantage over manual CPR in OHCA (9). While they may offer operational benefits—such as maintaining compressions during transport or in confined spaces—the current evidence does not support their routine use solely to improve outcomes (10). Their role may be context specific, and future studies should clarify deployment criteria based on environmental and procedural constraints.

Hemorrhage Control Tools: Low-Risk, High-Reward Interventions

Tourniquets and hemostatic dressings have transitioned from military to civilian use, with cohort studies showing associations with reduced transfusion needs and improved survival (11,12). Despite their promise, methodological heterogeneity and risk of bias persist. We recommend three priorities: (a) rigorous documentation of effect size; (b) head-to-head comparisons across tools and training modalities; and (c) integration of bleeding control into community-level programs such as "Stop the Bleed" (13).

Anti-choking Suction Devices: Conceptual Promise, Clinical Gaps

Devices designed to suction airway obstructions have so far been evaluated only in cadaveric or simulation models. No clinical trials have yet demonstrated efficacy in live choking emergencies (14). For emerging devices such as anti-choking suction tools, the evidence base remains sparse and low quality. Most studies to date have been manikin-based or small-scale observational reports, with no high-quality clinical outcome trials. While these devices may represent promising adjuncts, current findings should be interpreted cautiously. In this review, we have tempered recommendations accordingly: anti-choking tools are positioned as potentially useful adjuncts in specific circumstances, but not replacements for standard maneuvers (e.g., abdominal thrusts, back blows) until robust clinical evidence becomes available (15).

Overdose-Response Technologies: Potency vs. Tolerability

Recent evaluations of intranasal naloxone dosing suggest that higher potency (8 mg) does not confer survival advantages over standard 4 mg doses when administered by law enforcement (16). The 8 mg dose is associated with increased withdrawal-related adverse effects, raising concerns about its suitability as a first-line community intervention (17). Emerging tele-naloxone ecosystems—including kiosks, app-enabled alerts, and first-aid kits—should be evaluated for reach, timeliness, and equity in distribution (18).

Evidence Certainty and Limitations

While this review synthesizes evidence across a wide range of first-aid technologies, it is important to recognize that much of the available literature is derived from observational studies and simulation-based evaluations rather than large, well-powered randomized controlled trials. This reliance limits the certainty of our conclusions. Simulation studies are valuable for testing feasibility and technical performance, but they may overestimate effectiveness when translated into real-world emergency scenarios where human behavior, stress, and system-level barriers play a critical role. Observational designs, while informative, are subject to confounding and selection bias, which reduces the strength of causal inferences.

We therefore emphasize that all conclusions must be viewed in light of the limitations of study design and evidence certainty. Recommendations for widespread implementation of novel devices should remain provisional and conditional, pending further research that includes large-scale clinical trials and real-world evaluations.

Cross-Cutting Themes

Three overarching themes emerge across device categories:

- Time sensitivity: Devices that reduce time to intervention—such as AEDs deployed via apps or drones—show the most compelling outcome benefits. Investment should prioritize time-critical links in the emergency care chain (19).
- Process vs. outcomes: Many intelligent devices improve procedural quality. The next frontier is translating these gains into patient-centered outcomes through pragmatic, adequately powered studies embedded in EMS systems (20).
- Implementation Science and Equity: Real-world impact depends on human-device interaction, training burden, language accessibility, and adaptability to low-resource settings. For example, drones may be ideal for rural AED delivery, while smartphones preserve immediacy in urban contexts (21,22).

Smart first-aid technologies offer promising advances in emergency response, yet their deployment in low-resource settings remains uneven. Drone-based delivery systems could be transformative in conflict zones or remote areas, but face regulatory, logistical, and cost barriers. Similarly, AR/VR training tools provide scalable education for lay responders, though they require stable electricity, internet access, and compatible hardware—often unavailable in underserved regions. Context-specific adaptations and equitable partnerships are essential for broader implementation.

This review's strength lies in its comprehensive synthesis of emerging technologies across diverse domains, offering actionable insights for public health and emergency systems. It highlights time-sensitive innovations like AEDs and CPR feedback tools with clear implementation pathways. However, limitations include heterogeneity in study designs, exclusion of non-English literature, and insufficient clinical data for newer devices such as suction tools and smart bandages. Many included studies are simulation-based or observational, which constrains certainty of conclusions.

The integration of high-tech devices also introduces challenges in user training and interface design. Rapid decision-making under stress can overwhelm users. Intuitive interfaces, multilingual instructions, and minimal calibration are critical to safe deployment and effective human-device interaction.

Conclusions

Advanced first-aid technologies significantly enhance emergency response by accelerating life-saving actions and improving care quality. Defibrillators, endorsed by the American Heart Association, remain the most effective public-access device, with early use and prompt CPR identified as top priorities in recent consensus guidelines. Technology-assisted CPR improves layperson performance, while comprehensive first-aid kits equipped with trauma tools can be critical in severe injuries.

However, for emerging technologies such as anti-choking suction devices, overdose-response apps, and mechanical CPR tools, current evidence remains preliminary. Their adoption should be considered conditional and context-specific until supported by large-scale clinical trials and real-world evaluations.

Together, these innovations empower bystanders to act decisively during the crucial first moments of an emergency, but their role in practice must be guided by evidence strength, system readiness, and equitable access.

Recommendations

Health systems and public-safety agencies should prioritize the expansion of AED ecosystems through strategic placement, mobile app integration, and centralized registries to enhance accessibility and response times. I should pilot drone delivery programs in underserved or remote areas to bridge geographic gaps in emergency care. We must incorporate CPR feedback technologies into lay-rescuer training to improve compression quality and adherence to resuscitation protocols. Hemorrhage control education, including the use of tourniquets and hemostatic dressings, should be widely promoted across organizations to build community-level readiness. Finally, emerging devices such as anti-choking suction tools and tele-naloxone kits warrant rigorous evaluation through community-based trials to determine their real-world effectiveness and inform scalable implementation strategies.

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Conflict of Interests

None declared.

Data Availability Statement

All data generated or analyzed during this study are included in this published article and its supplementary materials. Additional details are available from the corresponding author upon reasonable request.

Ethical Issues

Not applicable.

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