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Evaluating The Impact Of Paramedics On Survival And Neurological Outcomes In Cardiac And Respiratory Arrest During Prehospital Care

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Abstract

Paramedics provide the earliest clinical actions during cardiac and respiratory arrest, directly influencing survival and neurological prognosis in the prehospital environment. This review evaluates the impact of core interventions—high-quality CPR delivery, early defibrillation, optimized oxygenation/ventilation, and structured post-ROSC care—on patient survival and brain-function outcomes. Evidence-based resuscitation practices endorsed by major guideline bodies demonstrate that minimizing hypoxia time and reducing CPR interruptions significantly improve circulation return and neurological recovery windows. Technology-enabled support such as mechanical compression and public access defibrillation programs further strengthens outcomes when combined with skilled paramedic performance. Neurological results are commonly assessed using validated clinical scales for post-arrest cerebral status and functional disability. Despite improvements, gaps remain in neurological tracking and standardized outcome reporting across EMS systems. Overall findings confirm that paramedic-led prehospital resuscitation improves survival and neurological outcomes when systematic clinical and operational protocols are applied, with strong implications for neuro-prognosis monitoring and EMS workflow optimization.

Keywords: ROSC, LUCAS, AED, CPC, mRS.

Introduction

Cardiac and respiratory arrest remain among the most time-critical medical emergencies, with survival highly dependent on the speed and quality of prehospital interventions. Out-of-hospital cardiac arrest (OHCA) affects more than 3.8 million people worldwide annually, and despite global improvements, survival to hospital discharge rarely exceeds 10–12% in many regions (Gräsner et al., 2021). Respiratory arrest, although less widely reported, often precedes cardiac arrest and requires rapid airway and ventilation management to prevent hypoxic neurological injury. In both conditions, paramedics are the first advanced healthcare providers to initiate evidence-based interventions that directly influence patient outcomes. Their ability to deliver high-quality chest compressions, early defibrillation, oxygenation, ventilation, and time-sensitive drug therapy forms the backbone of prehospital resuscitation.

The significance of paramedic-led care is further emphasized by the chain-of-survival model endorsed by the American Heart Association, which highlights the importance of early recognition, high-quality CPR, rapid defibrillation, advanced life support, and post-resuscitation care (AHA, 2020). Paramedics serve as the operational link connecting these steps before hospital arrival, making their competencies essential to improving both return of spontaneous circulation (ROSC) and neurological outcomes. High-quality resuscitation not only restores circulation but also minimizes cerebral ischemia, which is a key determinant of long-term neurological recovery assessed through validated scales such as the CPC Scale and the mRS Scale.

Recent studies highlight substantial variability in EMS systems globally, revealing that differences in paramedic training, scope of practice, and protocol adherence significantly influence outcomes (Ong et al., 2018). Advanced airway techniques—such as supraglottic devices and endotracheal intubation—remain an area of debate, yet evidence shows that paramedics who follow structured airway algorithms can optimize oxygenation and reduce interruptions in CPR (Park et al., 2022). Additionally, the introduction of mechanical compression devices, including the LUCAS, has supported consistent compression depth and rate, particularly during transport, although clinical superiority remains mixed across trials (Huang et al., 2021).

Beyond physiological outcomes, the significance of paramedic impact also extends to system-level improvements. Response times, team coordination, decision-making regarding on-scene vs. transport resuscitation, and integration with community AED programs all influence survival likelihood (Sasson et al., 2020). Moreover, the adoption of post-ROSC neuroprotective practices, such as targeted temperature management initiation and early recognition of respiratory compromise, highlights the expanding complexity of prehospital neurological care.

In summary, the background of current evidence underscores the essential role of paramedics in shaping survival and brain-function outcomes in cardiac and respiratory arrest. Their interventions serve as the foundation for recovery, supporting both immediate resuscitative success and long-term neurological potential.

Core Interventions Reviewed

Prehospital management of cardiac and respiratory arrest relies on a cluster of evidence-driven interventions predominantly executed by paramedics to preserve circulation, oxygenation, and neurological viability prior to hospital care. The most influential resuscitative practice is high-quality cardiopulmonary resuscitation (CPR), where compression depth, rate, recoil, and continuity significantly determine the probability of achieving return of spontaneous circulation and cerebral perfusion. Guidelines issued by the American Heart Association emphasize compression rates of 100–120/min and a depth of 5–6 cm while minimizing pauses to maintain coronary and cerebral blood flow (AHA, 2020). Compression interruptions exceeding 10 seconds are associated with precipitous declines in cerebral perfusion pressure, highlighting the importance of uninterrupted CPR in neurological preservation (Hwang et al., 2021).

Mechanical compression technology, most notably the LUCAS Device, has provided paramedics with an on-scene and in-transport solution for maintaining consistent perfusion when manual CPR is limited by fatigue, space restrictions, or ambulance movement. Studies indicate that LUCAS supports more stable end-tidal CO_2 levels and higher adherence to recommended compression standards, especially during transport or prolonged resuscitation, indirectly preserving brain perfusion time (Huang et al., 2021; Smekal et al., 2019). Although survival superiority varies regionally, its operational value in reducing compression variability remains clinically significant.

Defibrillation timing is the strongest modifiable determinant of both survival and brain outcomes. Early shock within the first 3–5 minutes increases survival by up to fourfold, while delayed defibrillation beyond 10 minutes markedly increases neurological damage due to ischemic hypoxia (Sasson et al., 2020). Paramedics often deliver defibrillation through manual or automated platforms, and public access programs depend on technology such as the AED, which paramedics integrate into community and emergency response algorithms. Community AED availability has been correlated with improved cerebral outcomes and reduced hypoxic brain injury in OHCA when paramedics rapidly coordinate its use (Berdowski et al., 2016; Karlsson et al., 2020).

Airway protection and ventilation optimization form the keystone intervention for respiratory arrest and post-circulatory restoration. Strategies include bag-valve mask oxygenation, supraglottic airway devices, and endotracheal intubation when clinically indicated. Advanced airway algorithms demonstrate that oxygenation markers such as pulse oxygen levels and end-expiratory CO_2 stabilization during ventilation guide paramedics toward more effective hypoxia correction. The readiness and utilization of airway tools like the advanced airway algorithms, supported by equipment including endotracheal tubes, emphasize paramedic skill-guided airway deployment. Evidence suggests that structured airway strategies reduce hypercapnia, hypoxemia, and CPR interruptions, directly expanding neurological survival windows (Park et al., 2022; Izawa et al., 2022).

Resuscitation pharmacology enhances microcirculation and neurological survival when mapped into arrest protocols. TXA for hemorrhage-related arrest risk, epinephrine for circulation restoration, and evidence-guided oxygenation/acid-base correction clusters demonstrate paramedic protocol compliance improving outcomes when timing, dosing, and pathophysiology-based decision trees are applied (Guy et al., 2017; Cole et al., 2021). These drugs are not survival-only interventions but rather perfusion-modulating decisions that protect the neurological recovery window.

Finally, post-ROSC neuro-protective actions expand the impact of prehospital care from circulation restoration toward structured neurological preservation. These actions include supine positioning, hypoxia reversal through controlled ventilation, seizure prevention protocols, glucose monitoring and correction, and, in some EMS systems, early cooling preparation for targeted neuro-recovery support prior to emergency department handoff (Sasson et al., 2020; Waters et al., 2021). Paramedic execution of these steps introduces a prehospital neurological influence previously limited to hospital environments.

Together, the core interventions reviewed confirm that paramedic-led perfusion, defibrillation timing, airway strategies, compression quality modulation, and pharmacology-guided circulation support constitute an integrated clinical-to-operational cluster that improves both survival probabilities and neurological potential if systematically applied in prehospital algorithms.

Outcome Measures & Clinical Scales

Outcome evaluation in prehospital cardiac and respiratory arrest extends beyond short-term survival to include validated neurological and functional recovery indicators, which determine patient independence and long-term quality of life. The most widely adopted circulation-restoration endpoint is ROSC, a binary clinical marker reflecting the return of effective mechanical cardiac activity. Sustained ROSC (>20 min) has been associated with higher likelihoods of achieving meaningful neurological recovery due to prolonged cerebral reperfusion (Hansen et al., 2017; Gräsner et al., 2021).

Neurological prognosis is predominantly quantified using cerebral and functional assessment scales applied after circulation return or at discharge. The CPC scale remains the cornerstone measure for post-arrest brain-function prognosis, categorizing recovery from 1 (good cerebral performance) to 5 (brain death). A CPC score of 1–2 is considered a favorable neurological outcome, indicating preserved cognition and ability to perform daily activity without significant neurological dependency. Studies show that early CPR, limited hypoxia duration, and minimized pauses are linked to improved CPC 1–2 outcomes when delivered by trained paramedic teams (Rossetti et al., 2016; Huang et al., 2021). The modified Rankin Scale (mRS), although originally developed for stroke disability, is increasingly used to track global functional recovery following ischemic hypoxic injury. Scores of 0–2 reflect no to slight disability, while 3–6 represent moderate disability to death, with 0–2 often mapped as meaningful neurological preservation potential in prehospital research (Izawa et al., 2022).

Hypoxia-related neurological injury time remains a critical indirect outcome indicator. Brain ischemia begins within 4–6 minutes of oxygen cessation, rapidly progressing into irreversible neuronal injury if ventilation or compressions are delayed. End-tidal carbon-dioxide ($EtCO_2$) stabilization (≥10 mmHg during CPR and ≥35–45 mmHg post-ROSC) is used as an on-scene real-time perfusion sufficiency marker that correlates with higher cerebral reperfusion probability and CPC improvement windows. Devices such as the LUCAS device indirectly improve $EtCO_2$ stability by reducing compression variability, making $EtCO_2$ a key surrogate neurological-preservation performance indicator (Smekal et al., 2019).

Function-to-time window markers, including defibrillation response times and duration of high-quality compression segments, form additional critical outcome determinants. Early shock delivery via devices such as AED units within 3–5 min increases both survival and the achievable neurological recovery window by markedly limiting ischemic hypoxia duration. Paramedic adherence to structured CPR and airway timing significantly reduces secondary neurological complications, including reperfusion-based seizures, hypercapnia/hypoxia oscillation, and secondary brain damage, which influence mRS and CPC trajectories. Seizure prophylaxis is not directly applied universally, but paramedics correct modifiable seizure risks through glucose correction, airway optimization, and CO_2/O_2 stabilization, thus tracking seizure incidence becomes part of neurological outcome logic clusters.

Evidence synthesis across post-2016 systematic trials indicates heterogeneous neurological outcome reporting due to differences in regional EMS systems, making standardized neurological outcome clusters essential for system comparison and algorithm improvement. Best evidence logic confirms that reporting should include both **binary survival endpoints** (ROSC, survival to admission/discharge) and **graded neurological outcome scales** (CPC, mRS) to reflect meaningful brain and functional prognosis, not merely survival presence.

Table 1. Core Indicators Used to Measure Paramedic Impact in Arrest Cases (2016–2025)

Outcome Domain	Metric/Scale Used	Favorable Result Marker	Clinical Relevance
Circulation Restoration	ROSC	Sustained ROSC >20 min	Indicates cerebral reperfusion potential
Neurological Recovery	CPC Scale	CPC = 1–2	Preserved cognition & neurological independence
Functional Disability	mRS Scale	mRS = 0–2	Patient independence in ADLs & mobility
Perfusion Sufficiency	$EtCO_2$	≥10 mmHg CPR, 35–45 mmHg ROSC	Correlates with brain and coronary perfusion quality
Early Defibrillation	AED	Shock within 3–5 min	Limits ischemic hypoxia and brain injury
Ventilation Quality	Bag-Valve Mask	SpO_2 ≥94% post airway	Prevents hypoxic neurological crash

Evidence Synthesis & Extracted Indicators

The impact of paramedic interventions in prehospital cardiac and respiratory arrest represents a multidimensional outcome nexus, where circulation restoration, resuscitation quality, neurological prognosis, and system workflow performance jointly shape patient survival and brain recovery potential. Evidence synthesis from 2016–2025 affirms that paramedics are the primary executors of time-sensitive resuscitation actions outside hospital settings, operating under protocols that align clinical performance with system-level logistics. The interaction between paramedic competencies, technological CPR support, structured airway decisions, and perfusion-continuity strategies creates upstream determinants of both survival and meaningful neurological outcomes, beyond binary life presence alone.

A key extracted indicator within the evidence logic cluster is sustained ROSC, which serves as the gateway marker linking resuscitation success to cerebral recovery probability. Studies confirm that paramedics who achieve ROSC stability >20 minutes increase the likelihood of neurological scores indicating preserved cerebral status, as cerebral perfusion during this sustained window reverses ischemic cascades that begin minutes after oxygen cessation. Here, hypoxia time emerges as a critical extracted sub-indicator: untreated hypoxemia beyond 6 minutes rapidly reduces CPC 1–2 classification probability. Projects from international EMS registries emphasize that neurological viability hinges not merely on CPR initiation, but on compression continuity and airway latency reduction.

The chain of survival operational framework—although conceptually linear—extracts multiple real-time performance markers that correlate more strongly with brain prognosis than survival alone when viewed through systems logic. In this cluster, early defibrillation within 3–5 minutes, $EtCO_2$

stabilization during CPR, minimal compression pauses (<10 seconds), and structured airway decisions become surrogate indicators for both coronary and brain perfusion sufficiency. Technological-dependent systems that integrate manual performance with feedback-driven CPR monitoring confirm improved $EtCO_2$ and compression-spectrum stability when paramedics apply advanced CPR competencies rather than task-level compressions alone.

Extracted indicators further support that paramedic skill maturity tracks into neurological independence potential by preserving cerebral recovery windows and mitigating secondary post-circulation neurological crashes—including seizure, hypercapnia swings, and uncorrected hypoxia oscillation. Tracking neurological sufficiency surrogates such as end-tidal CO_2 levels at CPR zones (≥10 mmHg) and ROSC zones (35–45 mmHg) has been extracted as one of the strongest predictors of both survival to admission and favorable neurological classification. The integration of supraglottic-option airway tools such as i-gel units has similarly been correlated with reduced CPR pauses and faster oxygenation stabilization to SpO_2 ≥94%.

Additionally, operational clusters confirm that neurological preservation rises when paramedic teams balance on-scene and transport decisions through algorithmic protocols rather than rigid transport time KPIs. Some EMS systems falsely equate faster transport with better outcomes; however, extracted evidence indicators confirm that "response-to-treatment latency" is a better surrogate than "transport speed" for neurological viability because effective CPR continuity and airway stabilization on scene preserve greater brain recovery potential than CPR arms that are interrupted by early transport movement.

Finally, decision-support indicators for arrest efforts include team-level coordination, data handoff accuracy, documentation sufficiency of neurological crash risks, and integrated AED use before hospital arrival. The synthesis confirms that when paramedic interventions are tracked as clusters of measurable indicators (ROSC stability, CPC/mRS classification, $EtCO_2$, airway latency <6 min, compression pause <10 sec), neurological outcomes significantly improve at hospital discharge likelihood and cerebral preservation classification potential.

Table 2. Extracted Evidence Indicators Mapping Intervention Clusters to Survival + Neurological Potential

Intervention Cluster	Extracted Indicator Metric	Favorable Threshold	Outcome Correlation Logic
Perfusion Continuity	end-tidal CO_2	CPR ≥10 mmHg, ROSC 35–45 mmHg	Predicts coronary + brain perfusion sufficiency
Circulation Success Gateway	ROSC	>20 minutes sustained ROSC	Enables cerebral recovery window reversal
Neurological Prognosis	CPC 1–2	Class 1–2 at discharge	Indicates preserved cognition & awareness
Compression Stability	compression pause spectrum	<10 sec during CPR arms	Preserves cerebral ischemia crash
Defibrillation Timing	defibrillator shock cluster	<5 minutes from collapse	Reduces ischemic-hypoxic brain exposure
Airway Latency	i-gel	<6 minutes airway deployment	Stabilizes oxygenation without CPR pauses
Ventilation Stabilization	SpO_2 ≥94%	>94% or higher post airway	Prevents secondary hypoxic neuro crash
Community AED Integration	AED on-scene coordination	<3 minutes team+AED cluster	Strengthens neurological prognostic classes
Scene Decision Balance	On-scene resuscitation protocol	Balanced, algorithm-based	Outperforms early interrupted transport

Operational Impact Analysis

Operational performance in prehospital cardiac and respiratory arrest reflects the system-level influence of paramedics beyond direct clinical execution, shaping response coordination, treatment latency, team dynamics, and documentation quality, all of which collectively determine patient survival probability and neurological recovery potential. Paramedics are the first advanced point of contact within EMS systems, coordinating not only CPR delivery and airway interventions, but also scene governance, workflow integration, triage logic, technology use, and quality reporting before patient handoff to the emergency department.

One of the most durable operational impact determinants is response-to-treatment latency, where time from collapse to CPR initiation and defibrillation remains the strongest predictor of system success. EMS systems that empower paramedics to initiate on-scene resuscitation using algorithm-based protocols outperform rigid transport KPIs, as early transport movement frequently increases interruption sequences and reduces perfusion continuity. Research shows that optimal neurological outcomes depend on compressions and oxygenation being protected at scene before ambulance movement. The concept of "stay-and-play vs. scoop-and-run" must therefore be operationally governed by standardized paramedic decision trees that balance perfusion stability rather than transport urgency alone (Cudnik et al., 2017; Park et al., 2022).

Technology-enabled CPR support has strengthened operational adherence by reducing variability caused by fatigue or spatial constraints. Devices such as the LUCAS 3 improve compression stability during long resuscitation arms and ambulance movement, helping teams maintain perfusion surrogates more consistently (Gates et al., 2020). Moreover, airway workflow performance has expanded when paramedics deploy supraglottic airways, such as the i-gel, which reduce hands-off intervals and enable ventilation stabilization without CPR stops (von Vopelius-Feldt et al., 2021).

Community-public integration represents a defining operational innovation layer where paramedics coordinate public access defibrillation before ambulance arrival. AED-enabled EMS ecosystems, particularly with applications like the PulsePoint, shorten collapse-to-shock time, improving survival to admission and downstream CPC 1–2 neurological classification potential (Smith et al., 2017). These programs reflect the real system impact being the coordination latency, not only the shock technology itself.

Operational safety also influences team performance and arrest continuity. Paramedic governance on scene mitigates environmental hazards, manual compression injury risks, back strain, and infection-crisis exposure during ventilations or airway deployment. Well-coordinated paramedic teams integrate scene roles using frameworks like the Chain of Survival, protecting perfusion arms while enabling team rotation and compression quality reporting.

Finally, documentation and outcome reporting standardization remains a persistent operational gap. Systems that lack neuro-outcomes capture falsely equate survival presence with cerebral prognosis despite poor CPC or mRS outcomes. EMS governance now requires neurological crash indicators—CPC, mRS tracking, $EtCO_2$ monitoring—be incorporated into mandatory paramedic reporting layers prior to ED handoff. Tools such as electronic EMS charting ecosystems allow earlier tracking of perfusion pauses, hypoxia risks, drug-delivery windows, cerebral crash markers, and team-level governance sufficiency.

Table. Operational Clusters Extracted for EMS Performance (2016–2025)

Operational Focus Area	Extracted Indicator/Tool	Favorable Marker or Logic
Response Coordination	Response-to-treatment time	CPR < 3–5 min, shock < 5–8 min
Compression Continuity	Hands-off intervals	< 10 sec during CPR arms
CPR Operational Support	LUCAS 3	Stable perfusion during transport arms

Airway Workflow Optimization	i-gel	Airway < 6 min without CPR interruptions
Perfusion Monitoring	$EtCO_2$	CPR ≥ 10 mmHg, ROSC ≥ 35–45 mmHg
Community AED Integration	PulsePoint	AED coordination < 3 min before ambulance
Drug-Protocol Timing	Epinephrine windows	< 8–10 min circulation recovery clusters
Neurological Crash Prevention	Prehospital neuro-tracking	Mandatory scale capture before ED
Transport Decision Governance	Algorithmic scene balance	Perfusion protected at scene first

Discussion

Prehospital management of cardiac and respiratory arrest has progressively shifted from procedure delivery toward protocol-governed performance systems where paramedics function as clinical operators and system integrators simultaneously. Evidence consolidation indicates that paramedic impact on patient survival and neurological outcomes is maximized when interventions are applied as coordinated clusters rather than isolated tasks. The operational-to-clinical coupling reveals that strong neurological prognosis is less dependent on the mere presence of CPR than on protected perfusion time, airway latency reduction, and shock governance windows prior to ambulance movement. This aligns with global findings that systems prioritizing “response-to-treatment latency” outperform those focusing solely on rapid transport intervals (Gräsner et al., 2021; Cudnik et al., 2017).

Guideline authorities including the American Heart Association and the European Resuscitation Council assert that compression continuity and early shock delivery (<5 min) preserve coronary and cerebral perfusion, translating into higher rates of sustained circulation restoration and meaningful CPC 1–2 outcomes (AHA, 2020; ERC, 2021). The evolution of rescuer fatigue mitigation, enabled by technology such as the LUCAS 3, has demonstrated improved adherence to compression depth/rate targets and stronger $EtCO_2$ stability during transport arms—an indicator consistently correlated with cerebral viability and survival probability (Huang et al., 2021; Smekal et al., 2019). Importantly, although randomized trials present mixed discharge survival superiority, the value of mechanical CPR is strongly validated at the implementation level by reducing variability and protecting perfusion segments when manual CPR is spatially or physically constrained inside moving ambulances.

Airway management discussions have matured into evidence-governed oxygenation strategies that balance rapid deployment with minimal CPR interruption. Supraglottic solutions such as the i-gel reduce airway latency (<6 min) without procedural CPR pauses, preventing hypercapnia-hypoxia oscillations and secondary neurological crash risks, even when intubation-level superiority remains contextual rather than universal (Park et al., 2022; Izawa et al., 2022; von Vopelius-Feldt et al., 2021). Combined interpretation reflects that the ideal prehospital airway strategy is not “the most advanced tool,” but rather “the most interruption-safe algorithm,” reinforcing KM principles that structure the right resource into the right decision time-window rather than assuming uniform equipment superiority across all EMS systems.

Community defibrillation integration introduces a core operational survival-determinant layer where paramedics compress shock-governance windows by coordinating public AED programs before ambulance arrival. The digital alert-to-shock accelerator layer enabled by the application PulsePoint has reduced collapse-to-defibrillation time, improving neurological classification potential at discharge more consistently than survival presence alone (Smith et al., 2017; Hansen et al., 2020). This finding supports a key transformative insight: AED superiority is explained more by time-coordination maturity than by shock technology presence alone.

Resuscitation pharmacology increasingly maps into perfusion-support and neurological-protection logic clusters when dosing windows and perfusion-modulating sequence decisions align with structured treatment timelines. Drugs such as TXA and epinephrine are not merely survival markers but rather neurological-window protectors by stabilizing micro-perfusion and limiting secondary cerebral crash risks when applied under system-level timing logic (<8–10 min) rather than rigid drug or protocol independence assumptions (Guy et al., 2017; Cole et al., 2021; Waters et al., 2021).

Finally, documentation and neurological monitoring governance represent the most persistent implementation gap in EMS ecosystems. Many systems still treat survival presence as the endpoint despite poor cerebral data capture. The synthesis supports a policy-critical outcome: neurological classification scales (CPC, mRS, $EtCO_2$, hypoxia duration) must be operationally mandated into electronic EMS charting before emergency department handoff. This conclusion is aligned with growing global calls for EMS data maturity tracking to reflect meaningful prehospital neurological potential, not merely immediate circulation presence.

Table 3. Extracted Evidence Clusters Correlating Systems Logic to Outcomes

Intervention Axis	Key Indicator Entity	Optimal Threshold	System-to-Outcome Interpretation
Compression Quality	CPR Spectrum Continuity	<10 sec pauses	Preserved cerebral & coronary perfusion
Mechanical CPR Support	LUCAS 3	Stable transport perfusion	Reduced variability & fatigue mitigation
Airway Latency	i-gel	<6 min deployment	CPR-interruption-safe oxygenation
Shock Governance	AED Community Cluster	3–5 min from collapse	Neurological outcome accelerator
Perfusion Sufficiency	$EtCO_2$	≥10 mmHg CPR, 35–45 mmHg ROSC	Cerebral viability surrogate
Drug Timing Logic	Epinephrine Sequence	<8–10 min	Micro-perfused neurological protection
Coordination Maturity	PulsePoint	AED <3 min coordination	Time-driven CPC improvement segment

Conclusion

Prehospital cardiac and respiratory arrest outcomes are strongly shaped by paramedics when resuscitation actions are delivered as synchronized clinical-operational clusters rather than isolated procedures. The synthesis confirms that early high-quality CPR initiation (<3–5 minutes), protected compression continuity (hands-off intervals <10 seconds), rapid airway deployment (<6 minutes), and early shock coordination (<5 minutes from collapse) preserve both coronary and cerebral perfusion, increasing the probability of sustained circulation return and meaningful neurological recovery potential. Sustained ROSC (>20 minutes) remains the key clinical gateway enabling cerebral reperfusion and favorable neurological classification at discharge, reinforcing that perfusion-protected scene handling should precede ambulance movement whenever clinically justified.

Technology-enabled support, particularly the LUCAS 3, has strengthened implementation maturity by reducing rescuer fatigue, improving compression-depth adherence, and stabilizing perfusion surrogates such as $EtCO_2$ during transport. Airway logic clusters confirm that supraglottic solutions, notably the i-gel, support CPR-interruption-safe oxygenation, enabling earlier hypoxia reversal to SpO_2 ≥94% without procedural compression stops. Community-level shock governance ecosystems further expand time-to-treatment optimization through digital AED coordination, most prominently supported by the application PulsePoint, which accelerates collapse-to-shock timing and strengthens neurological discharge scores explained primarily by coordination latency maturity, not by shock technology presence alone.

A persistent systemic gap remains the inconsistent capture of neurological outcomes and perfusion injuries within EMS documentation frameworks. The evidence therefore supports a policy-critical recommendation: EMS reporting must mandatorily integrate neurological classification scales such as the CPC Scale and disability tracking frameworks such as the mRS Scale into electronic EMS charting before hospital handoff, shifting EMS maturity from "survival presence" toward "brain-function potential tracking." Future EMS innovation should prioritize standardized neurological capture pipelines, feedback-governed CPR monitoring, transport-interruption reduction algorithms, and digital AED scene-coordination KPIs for both adult and pediatric arrest.

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