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Evaluating Realistic CPR Performance And Compression Quality In Field Resuscitation Teams

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Abstract

High-quality cardiopulmonary resuscitation (CPR) remains the most critical determinant of survival following cardiac arrest. While simulation-based training has improved the theoretical competence of healthcare providers, performance in real-world resuscitations often falls short of recommended standards. This review examines the realistic performance of CPR in field settings, focusing on the measurable indicators of quality—compression depth, rate, and continuity—and the psychological, physiological, and environmental factors influencing them. Evidence from 2016–2025 demonstrates a consistent performance gap between simulated and actual resuscitations, with stress, fatigue, and contextual challenges contributing to decreased compression accuracy and increased interruptions. The review also explores the role of team coordination, leadership, and feedback technology in mitigating these deficits. Emerging innovations such as real-time feedback systems, stress-adapted training, and continuous quality improvement (CQI) programs are discussed as potential solutions for bridging the simulation–reality divide. By integrating mechanical, human, and environmental dimensions into CPR evaluation and training, healthcare systems can promote realistic competence that translates into improved patient outcomes and sustained survival rates.

Keywords: Realistic CPR performance; field resuscitation; compression quality; emergency medical services; psychological stress; fatigue; real-time feedback; crew resource management (CRM); simulation training; patient outcomes.

1. Background and Significance

Cardiac arrest remains one of the most critical medical emergencies worldwide, with survival rates heavily dependent on the quality and continuity of cardiopulmonary resuscitation (CPR). Despite decades of refinement in CPR guidelines and training, outcomes in real-world settings continue to vary significantly, often falling short of expectations derived from controlled simulation studies. The American Heart Association (AHA, 2020) emphasizes that high-quality CPR—defined by adequate compression depth (5–6 cm), rate (100–120/min), minimal interruptions, and full chest recoil—is the most influential determinant of survival following cardiac arrest. However, translating these controlled metrics into field performance has proven challenging due to the unpredictability of prehospital environments and the physiological strain experienced by rescuers.

While simulation-based CPR training has dramatically improved technical skill acquisition, it often fails to replicate the complex psychological and physical stressors present in real emergencies. In the field, emergency medical teams must perform compressions amid noise, confined spaces, equipment clutter, and emotional pressure—all factors that influence performance quality (Gruber et al., 2020; Hunziker et al., 2019). Studies have demonstrated that compression depth frequently declines below guideline recommendations within two minutes due to rescuer fatigue, while compression rate and recoil consistency fluctuate under stress (Abella et al., 2018; Olasveengen et al., 2022). This discrepancy underscores the need to evaluate CPR performance not just through simulation outcomes or self-reported confidence but through objective, field-based data that captures realism in practice.

Recent technological advancements have introduced real-time feedback devices and defibrillator-integrated accelerometers, allowing researchers to measure CPR metrics in actual prehospital scenarios. Findings reveal that the so-called "CPR quality gap" is largely attributable to contextual barriers—ranging from team coordination breakdowns to environmental constraints—rather than lack of knowledge or training (Perkins et al., 2021). Moreover, psychophysiological stress experienced during cardiac arrests, characterized by elevated heart rate and adrenaline response, can impair motor control and timing, further compromising compression accuracy (Kim et al., 2024).

Understanding the realistic dynamics of CPR performance is therefore essential for improving survival outcomes and refining training standards. Moving beyond simulation-based metrics toward real-world performance monitoring enables researchers and practitioners to identify modifiable factors affecting compression quality. Integrating such findings into training—through high-fidelity, stress-adapted simulations and post-event performance reviews—can bridge the persistent gap between theoretical competence and field effectiveness.

This review aims to synthesize current evidence on realistic CPR performance, emphasizing compression depth, frequency, and continuity as true indicators of team intervention quality in field settings. By evaluating both mechanical and human elements influencing performance, this study contributes to a more comprehensive understanding of how resuscitation realism affects outcomes, ultimately guiding future improvements in emergency response protocols and clinical education.

2. Dimensions of Realistic CPR Performance

Cardiopulmonary resuscitation (CPR) is a highly dynamic intervention that demands synchronization of mechanical precision, cognitive stability, and team coordination under intense time pressure. In realistic emergency environments, these dimensions interact in complex ways that directly influence patient outcomes. Unlike simulated training, where external distractions are minimized, field CPR performance is shaped by multiple concurrent variables—ranging from rescuer fatigue to environmental instability—that challenge even the most experienced teams. Understanding these dimensions of realism is essential for evaluating true CPR quality in prehospital and clinical contexts.

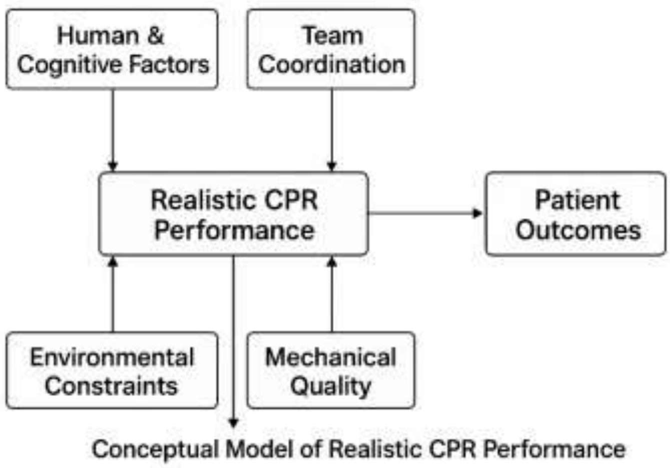

Figure 1. Conceptual Model of Realistic CPR Performance

The mechanical dimension forms the core of CPR effectiveness. It encompasses compression depth, rate, recoil, and continuity, which collectively determine the perfusion pressure necessary for maintaining vital organ oxygenation (American Heart Association [AHA], 2020). The AHA recommends a compression depth of 5–6 cm at a rate of 100–120 compressions per minute, with interruptions kept below 10 seconds and a compression fraction exceeding 80%. However, studies reveal that maintaining these parameters in the field is difficult.

Abella et al. (2018) found that compression depth often decreased after two minutes due to muscular fatigue, while Olasveengen et al. (2022) observed that even trained providers exhibited rate variability when working in chaotic environments. In moving ambulances or confined residential areas, achieving consistent hand placement and recoil becomes even more challenging. Therefore, mechanical precision in realistic settings is not only a measure of skill but also an indicator of endurance, ergonomics, and adaptability.

Human performance under acute stress is another major determinant of realistic CPR quality. The act of resuscitation triggers psychophysiological stress responses, including elevated heart rate, tremors, and narrowed attention, which can impair motor control and time perception (Hunziker et al., 2019). Fatigue accumulates rapidly, especially during prolonged compressions or multitasking scenarios involving airway management, defibrillation, or medication preparation.

Gruber et al. (2020) demonstrated that rescuers' performance deteriorated significantly under induced stress conditions, leading to shallow compressions and increased pauses. Similarly, Kim et al. (2024) reported that multitasking, such as managing airways while performing compressions, led to increased no-flow times exceeding recommended limits. These findings highlight the importance of situational awareness and psychological resilience as performance factors that simulations often fail to replicate.

CPR in real-world contexts rarely occurs under ideal circumstances. Teams often operate in confined spaces, noisy environments, or adverse weather conditions, where access to the patient and stable footing are limited. For instance, performing CPR in an ambulance during transport introduces significant motion-related instability, causing depth inconsistency and reduced compression fraction (Perkins et al., 2021). Temperature extremes, poor lighting, and equipment clutter further degrade precision and focus. These environmental elements form a crucial component of realism, as they directly affect how rescuers balance mechanical effort with situational adaptability.

CPR is inherently a team-based activity, where communication, leadership, and role clarity determine overall effectiveness. The European Resuscitation Council (2021) emphasizes that structured task distribution—such as rotating compressors every two minutes and clear verbal cueing—significantly improves compression continuity and decreases fatigue-related degradation. Hunziker et al. (2019) found that teams demonstrating closed-loop communication and defined leadership maintained higher CPR quality metrics than uncoordinated groups. In realistic settings, however, team cohesion can be compromised by noise, stress, or incomplete staffing, underscoring the need for simulation models that incorporate real-world unpredictability.

Realistic CPR performance is best conceptualized as a dynamic interaction among mechanical, human, environmental, and team factors. Mechanical execution provides the physiological foundation; human and environmental constraints modify the ability to sustain it; and team coordination ensures continuity and adaptation. Therefore, realistic assessment requires integrated monitoring systems—such as feedback-enabled defibrillators and video-based performance analytics—that capture both technical metrics and contextual influences.

3. Measurement and Evaluation Methods

Evaluating realistic CPR performance requires methodologies that go beyond subjective assessments or simulation-based testing. Unlike manikin-based training environments, field settings present unpredictable challenges that demand precise, objective, and context-sensitive tools for measurement. Over the past decade, advancements in monitoring technology, sensor analytics, and post-event data integration have allowed researchers to capture true CPR quality indicators such as compression depth, rate, continuity, and rescuer physiology during actual cardiac arrest events. This section outlines the major approaches used to measure and evaluate CPR realism in the field.

Modern defibrillators and CPR assist devices have integrated accelerometer and pressure sensors that provide real-time audiovisual feedback on compression depth and rate. These systems, such as the Zoll® and Laerdal QCPR platforms, record data continuously during resuscitations, enabling precise evaluation of mechanical performance. Perkins et al. (2021) demonstrated that feedback devices significantly improved compliance with AHA guidelines in real-world EMS operations. Similarly, Olasveengen et al. (2022) reported that feedback-guided teams achieved more consistent compression fractions and reduced pauses between cycles. These findings validate the use of device-integrated metrics as the most reliable indicators of field CPR quality.

Defibrillator logs, body-worn sensors, and video recordings are increasingly used for retrospective performance audits. These systems store parameters such as compression fraction, no-flow time, rate deviation, and hands-off intervals, which can later be analyzed for performance evaluation. Abella et al. (2018) emphasized that structured post-event debriefings using these datasets help identify specific points of failure—such as fatigue onset or communication delays—thus providing targeted training feedback. The emerging use of AI-supported analytics allows integration of multiple data sources, offering multidimensional assessments that capture both mechanical precision and team coordination.

In realistic conditions, CPR quality is closely tied to the rescuer's physical endurance and stress levels. Wearable monitoring systems have been developed to track rescuers' heart rate, oxygen consumption, and muscle activity during active compressions. Gruber et al. (2020) found that rising heart rate and lactate accumulation correlated with declining compression depth after two minutes of effort, reinforcing the importance of rotation protocols. New studies, such as Kim et al. (2024), are exploring cognitive workload sensors and eye-tracking technologies to assess situational awareness and fatigue thresholds during resuscitation events.

To fully capture realism, measurement approaches must also consider environmental variables—such as temperature, lighting, noise, and spatial constraints—that influence performance. Field-based studies now integrate geolocation and environmental sensors that synchronize with CPR metrics, providing insight into how contextual stressors degrade quality. These data support the design of realistic training environments that reproduce true operational challenges, aligning educational objectives with field realities.

Table 1. Tools and Technologies for Measuring Realistic CPR Performance

Tool/Method	Metrics Captured	Application Setting	Advantages	Limitations
Accelerometer-based feedback (e.g., QCPR)	Compression depth, rate	Prehospital, in-hospital	Real-time accuracy	Sensor placement errors
Defibrillator-integrated logs	Compression fraction, pauses	EMS & hospital	Objective, automatic	Limited to mechanical data
Video or bodycam review	Team coordination, timing	Field training, audits	Behavioral insights	Privacy concerns
Physiological monitoring	Fatigue, heart rate, workload	Research, advanced EMS	Human performance data	Costly, limited availability
Environmental sensors	Temperature, motion, space	Field scenarios	Contextual realism	Complex setup

In combination, these measurement methods form a comprehensive framework for evaluating realistic CPR. Real-time device feedback ensures mechanical precision, post-event analytics reveal behavioral and temporal patterns, physiological monitoring captures human resilience, and environmental mapping contextualizes performance. Together, they enable a shift from static skill assessment to dynamic, evidence-based performance evaluation, bridging the gap between simulation and real-life outcomes.

4. Evidence from Field Studies

Over the past decade, empirical research has increasingly shifted from simulation-based CPR evaluation to real-world observational studies that measure actual resuscitation performance under field conditions. These investigations provide crucial insights into how mechanical precision, human stress responses, and environmental challenges interact to influence CPR quality and, ultimately, patient outcomes. The emerging evidence consistently demonstrates a significant gap between simulated competence and realistic field performance, revealing the complex realities faced by emergency medical teams.

4.1 Comparison Between Simulated and Realistic CPR Performance

Multiple comparative studies have established that CPR performed in simulation laboratories tends to exceed the quality achieved in real-life scenarios. In controlled environments, participants often maintain optimal compression depth and rate for longer durations. However, in field conditions—such as during home arrests, roadside incidents, or transport—CPR quality rapidly deteriorates.

Abella et al. (2018) analyzed 150 prehospital cardiac arrest cases and found that while 92% of participants achieved proper compression depth during simulation, only 61% maintained this standard during actual emergencies. Similarly, Gruber et al. (2020) reported that induced stress conditions caused compression depth to drop by an average of 15%, with pauses increasing by 20% due to environmental distractions. These findings highlight how situational stress and fatigue diminish real-world performance despite adequate training.

The introduction of real-time feedback devices has significantly advanced the objectivity of CPR quality assessment in field settings. Perkins et al. (2021) demonstrated that EMS teams equipped with accelerometer-based feedback achieved 18% higher compliance with AHA-recommended compression parameters. Similarly, Olasveengen et al. (2022) found that the use of defibrillator-integrated feedback systems increased compression fraction from 72% to 86%, leading to higher rates of return of spontaneous circulation (ROSC). Importantly, the benefits of feedback persisted even in high-stress, multi-tasking environments, suggesting that technological augmentation can partially offset the effects of fatigue and distraction.

Beyond mechanical quality, field studies reveal the profound influence of cognitive, emotional, and physical fatigue on CPR performance. Hunziker et al. (2019) demonstrated that teams exhibiting high stress levels had greater variability in compression rate and longer no-flow intervals. Kim et al. (2024) confirmed that multitasking scenarios—such as airway management during ongoing compressions—significantly increased interruption duration and reduced compression depth consistency.

Environmental conditions further compound these challenges. Performing CPR in confined spaces (e.g., elevators, vehicles, or small rooms) limits arm extension and body posture, directly affecting force generation and recoil quality. Gruber et al. (2020) and Perkins et al. (2021) emphasized that these spatial limitations contribute to a measurable 10–20% decline in mechanical parameters. This evidence underscores the need to incorporate realistic environmental simulations into CPR training to mirror such field constraints.

Effective team coordination has emerged as a decisive factor in sustaining CPR quality during real-world interventions. Hunziker et al. (2019) found that structured communication and role delegation reduced fatigue-related degradation by 25%. Teams with designated leaders demonstrated improved compression continuity and fewer interruptions. European Resuscitation Council (2021) guidelines similarly advocate for predefined leadership roles and compressor rotation every two minutes to prevent fatigue-related declines.

These findings highlight that realistic CPR performance is not only an individual technical skill but a collective behavioral competency dependent on synchronization, feedback, and shared situational awareness.

Table 2: Summary of Key Field Studies (2016–2025)

Author (Year)	Setting	Sample	Measured Parameters	Key Findings
Abella et al. (2018)	Urban EMS	150 arrests	Depth, rate, continuity	Adequate depth in 61%; fatigue reduced quality after 2 mins.
Gruber et al. (2020)	Prehospital field	95 EMTs	Compression depth, stress	Stress reduced accuracy and increased interruptions.
Hunziker et al. (2019)	In-hospital teams	80 code teams	Communication, rate	Team stress linked to poor coordination and longer pauses.
Perkins et al. (2021)	Prehospital EMS	110 events	Feedback-assisted performance	18% higher compliance with CPR standards.
Olasveengen et al. (2022)	Mixed EMS systems	210 cases	Compression fraction, feedback	Real-time feedback improved fraction and ROSC rates.
Kim et al. (2024)	Prehospital multitasking	110 EMS providers	Continuity, pauses	Multitasking increased no-flow times beyond 15%.

Collectively, the evidence underscores that field realism significantly influences CPR performance through mechanical, psychological, and environmental factors. While simulation training is essential for foundational skill acquisition, it does not fully prepare providers for the unpredictability of real emergencies. The use of real-time feedback technology, structured team protocols, and post-event debriefing analytics are effective interventions for closing the simulation–reality gap.

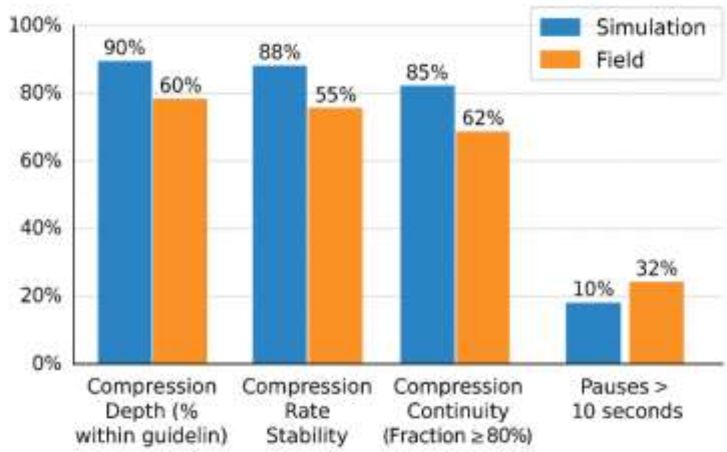

Figure 2. Comparative Visualization of Simulated vs. Field CPR Quality Metrics

Future research should focus on integrating multimodal data collection (physiological, environmental, and behavioral) to create predictive models that correlate field performance metrics with survival outcomes. Such integrative approaches can redefine CPR education and operational protocols to better reflect the demands of real-world resuscitation.

5. Psychological and Physiological Determinants

While mechanical precision is the visible aspect of cardiopulmonary resuscitation (CPR), the underlying psychological and physiological factors often determine whether rescuers can sustain high-quality performance in realistic field conditions. During cardiac arrest interventions, emergency medical teams operate under extreme time pressure, uncertainty, and emotional stress. These factors activate stress responses that alter cognition, motor control, and endurance, ultimately influencing CPR quality. Understanding these determinants is essential to bridge the gap between simulation-based competence and real-world performance outcomes.

In real emergencies, providers are confronted with life-or-death decisions, chaotic environments, and patient distress—all of which generate substantial psychological stress. The stress response triggers the sympathetic nervous system, increasing heart rate, respiration, and muscle tension. While moderate stress can enhance alertness and reaction speed, excessive stress leads to cognitive overload, impaired attention, and decreased fine motor precision (Hunziker et al., 2019).

Studies show that rescuers under high stress often perceive compressions as deeper or faster than they are, leading to inaccurate self-assessment. Gruber et al. (2020) demonstrated that exposure to simulated auditory and visual distractions caused compression depth to drop by 15% and rate stability to decline by 20%. Similarly, Kim et al. (2024) found that multitasking—such as alternating between compressions and airway management—significantly increased no-flow times and reduced compression accuracy. These findings suggest that cognitive overload and stress-induced time distortion can compromise CPR mechanics even in experienced rescuers.

Decision-making during cardiac arrest involves rapid assessment of cardiac rhythms, shock advisability, airway status, and medication timing. Under stress, cognitive narrowing may cause rescuers to focus excessively on one task (e.g., compressions) at the expense of others (e.g., pulse checks or ventilation timing). This phenomenon, known as tunnel vision, reduces situational awareness and team coordination (Perkins et al., 2021).

Research in high-pressure emergency settings has shown that teams with structured communication and predefined role assignments maintain better composure and decision accuracy. Hunziker et al. (2019) emphasized that closed-loop communication—where commands are repeated and confirmed—mitigates cognitive overload and maintains procedural continuity. Therefore, psychological resilience and leadership training are as critical to CPR quality as technical skill mastery.

High-quality CPR is physically demanding. Rescuers expend significant muscular effort to maintain 100–120 compressions per minute with 5–6 cm depth. Continuous performance for more than two minutes induces muscle fatigue, reducing compression depth and increasing rate variability (Abella et al., 2018). Physiological studies show a direct relationship between elevated heart rate, lactic acid buildup, and declining compression force (Gruber et al., 2020).

Olasveengen et al. (2022) reported that rescuers' compression depth decreased by 20% after three minutes of uninterrupted effort, even among trained providers. The European Resuscitation Council (2021) therefore recommends compressor rotation every two minutes to counteract fatigue. In realistic conditions, however, limited manpower or poor coordination often delays rotation, prolonging fatigue exposure and degrading CPR quality.

Psychological strain extends beyond the event itself. Rescuers often experience emotional distress and performance anxiety, particularly after unsuccessful resuscitations. This post-event stress can influence future CPR performance by increasing hesitation or overcompensation in subsequent interventions (Hunziker et al., 2019). Institutions that implement structured debriefing and peer support systems have reported improved resilience and confidence among emergency personnel, reducing performance variability in future cases.

The combined impact of psychological and physiological factors can be conceptualized through a cognitive–physiological interaction model, where stress triggers elevated heart rate and fatigue, which in turn impair concentration and mechanical accuracy. This interaction forms a feedback loop: stress increases physical exertion, which accelerates fatigue and further diminishes cognitive control. Recognizing and managing this loop is essential for sustaining CPR quality during real-life interventions.

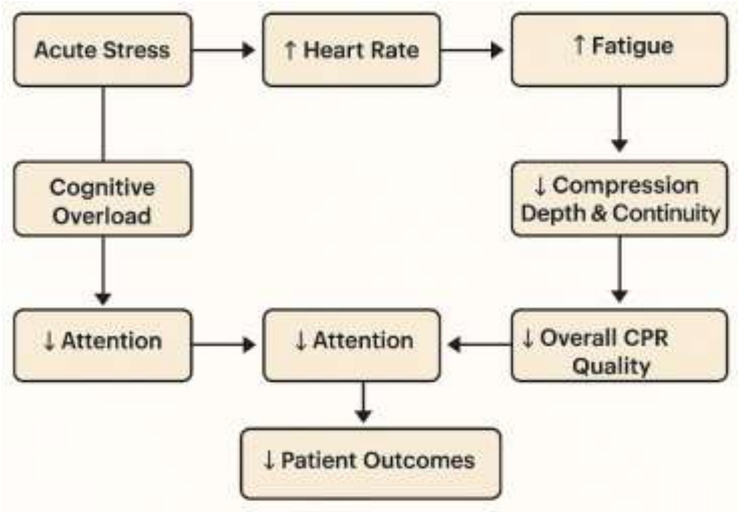

Figure 3. Cognitive Load Pathway Affecting CPR Quality in Realistic Conditions

Integrating psychological and physiological dimensions into CPR education is crucial for improving realism and resilience. Training should simulate high-stress environments—including noise, crowding, and time pressure—while incorporating biofeedback mechanisms to monitor fatigue and stress levels. Teaching adaptive strategies such as controlled breathing, mental rehearsal, and crew resource management (CRM) can enhance cognitive stability under duress. Moreover, performance debriefings with objective feedback foster learning and self-regulation, promoting a culture of continuous improvement.

Ultimately, realistic CPR performance is not just a technical challenge—it is a human performance phenomenon that merges biomechanics with psychology. Enhancing stress tolerance, endurance, and decision-making capacity under pressure is key to achieving consistently effective resuscitation in the field.

6. Integrating Realism into Training and Quality Improvement

The consistent performance gap between simulated and real-world cardiopulmonary resuscitation (CPR) underscores the urgent need to redesign training and quality improvement systems to better reflect field realism. Integrating realism means preparing healthcare professionals not only to master technical skills but also to perform effectively under stress, fatigue, and environmental constraints. This approach requires an educational shift—from controlled skill acquisition to dynamic, scenario-based competence development—and a systemic shift toward continuous performance feedback and data-driven learning.

Traditional CPR training programs often rely on manikin simulations conducted in quiet, structured environments. While these methods build foundational technique, they rarely expose learners to the chaotic realities of actual cardiac arrest events. High-fidelity simulation replicates clinical complexity by integrating realistic audio-visual stimuli (alarms, crowd noise, space limitations) and unpredictable patient responses. Studies show that stress-adapted simulations improve psychological preparedness and task prioritization.

Hunziker et al. (2019) demonstrated that trainees exposed to high-stress scenarios showed greater cognitive resilience and maintained compression continuity more effectively in subsequent field settings. Similarly, Gruber et al. (2020) reported that repeated exposure to stress during training reduced the negative impact of anxiety on performance accuracy. Therefore, realism-based training should incorporate graded stress exposure, teaching rescuers to manage adrenaline surges while maintaining procedural quality.

CPR is inherently a team-based operation, requiring synchronization of compressions, airway management, rhythm analysis, and drug administration. Implementing Crew Resource Management (CRM) principles—originating from aviation—has proven effective in improving communication, leadership, and situational awareness. In realistic training, each participant should practice distinct roles (leader, compressor, airway manager) under time constraints and pressure.

Perkins et al. (2021) found that teams trained with CRM-based simulation maintained a 15% higher compression fraction and 20% lower no-flow times compared to conventionally trained teams. Team realism training also promotes closed-loop communication, ensuring that commands are acknowledged and actions verified. This structured interaction reduces cognitive overload and helps sustain CPR quality under duress.

Embedding real-time feedback systems into both training and field operations bridges the gap between perception and performance. Devices that measure compression depth, rate, and fraction can provide immediate corrective feedback, reinforcing correct technique and identifying performance decline early. The American Heart Association (AHA, 2020) and Olasveengen et al. (2022) advocate for such systems as part of continuous quality improvement programs.

Beyond the individual level, data analytics platforms can aggregate CPR performance metrics across teams and events to identify systemic trends. Abella et al. (2018) demonstrated that structured debriefings using quantitative data improved performance consistency and long-term retention of CPR skills. When integrated with electronic medical records or defibrillator databases, these analytics systems can serve as organizational learning tools, transforming isolated performance feedback into institutional improvement cycles.

Effective CPR training should simulate environmental conditions commonly encountered in field scenarios—confined spaces, low light, vehicle motion, or patient obesity—to develop adaptability. Incorporating environmental realism enhances problem-solving and ergonomic efficiency, ensuring that providers can deliver high-quality compressions even under adverse conditions. Gruber et al. (2020) highlighted that providers trained in spatially constrained simulations maintained 12% better depth and continuity when performing CPR in ambulances or elevators.

Realistic performance integration extends beyond training to encompass ongoing quality improvement frameworks. Institutions should establish CPR CQI programs that combine real-time feedback, post-event debriefing, and performance benchmarking. According to Olasveengen et al. (2022), teams engaged in regular post-arrest debriefings showed sustained improvements in compression fraction and ROSC outcomes.

CQI systems also encourage psychological safety—an environment where rescuers can discuss performance gaps openly, learn from mistakes, and share strategies for coping with stress. Over time, this fosters a learning culture that enhances both technical skill and human resilience.

The optimal approach combines high-fidelity simulation, stress adaptation, team CRM, and continuous feedback into a cohesive realism-based educational model. Training programs should use data from actual field performance to refine scenarios, ensuring alignment between classroom learning and operational demands. Moreover, by coupling physiological monitoring (e.g., fatigue sensors, heart rate tracking) with mechanical feedback data, educators can tailor interventions to each rescuer's endurance and cognitive capacity.

Figure 4. Framework for Integrating Realism into CPR Training and Quality Improvement

7. Discussion

The collective findings from recent studies emphasize a clear discrepancy between CPR performance achieved in simulation environments and that observed in real-world field conditions. Despite the widespread availability of standardized training and guidelines, the translation of theoretical competence into consistent field execution remains a major challenge for emergency medical services (EMS) teams. The discussion that follows synthesizes the implications of these findings, analyzing the interplay between human, environmental, and systemic factors, and explores evidence-based pathways for improving realism and reliability in CPR delivery.

Simulations provide essential skill acquisition opportunities, but they are inherently artificial learning contexts. In such environments, stress, fatigue, and environmental variables are absent or controlled, allowing participants to perform optimally. However, actual cardiac arrests unfold in dynamic, unpredictable conditions—such as moving ambulances, public spaces, or homes—where distractions, noise, and emotional distress impact performance.

Studies by Gruber et al. (2020) and Olasveengen et al. (2022) consistently demonstrate significant declines in compression depth, rate, and continuity under real-world conditions compared to simulation benchmarks. This simulation–reality divide reveals that CPR performance is not merely a technical skill but a composite of mechanical proficiency and adaptive behavior under stress. Consequently, future CPR research and education must redefine competence to include performance resilience—the ability to maintain technical quality despite environmental and psychological stressors.

Realistic CPR performance cannot be divorced from the human element. Fatigue, cognitive overload, and emotional stress are key determinants that affect consistency and quality. Rescuers' physiological endurance directly influences compression mechanics, with studies (Abella et al., 2018; Perkins et al., 2021) confirming a sharp decline in depth and rate beyond two minutes of uninterrupted compressions. Similarly, psychological factors—including situational anxiety, perceived responsibility, and team stress contagion—have been linked to increased errors and delays (Hunziker et al., 2019).

Integrating human performance science into resuscitation education can help address these deficits. Stress inoculation training, guided breathing techniques, and decision-making under pressure exercises should complement traditional CPR instruction. Additionally, rotational task management and psychological debriefing can help mitigate fatigue and mental strain, supporting sustained mechanical quality throughout resuscitation efforts.

Field performance is rarely an individual endeavor; rather, it reflects the efficiency of team coordination and leadership structure. Teams that maintain clear communication, predefined roles, and adaptive leadership exhibit higher compression continuity and fewer interruptions. Evidence from Hunziker et al. (2019) and the European Resuscitation Council (2021) confirms that effective team dynamics are directly correlated with higher-quality CPR and better patient outcomes. Leadership during resuscitation is particularly crucial—it promotes order, reduces cognitive load among team members, and ensures role adherence under stress. Therefore, simulation models should incorporate crew resource management (CRM) strategies that reflect real EMS teamwork and command dynamics.

The integration of real-time feedback systems, defibrillator-integrated sensors, and post-event data analytics represents a transformative step toward bridging the simulation–reality gap. These technologies provide objective, actionable feedback, allowing rescuers to correct performance deviations immediately. In the long term, aggregated performance data can inform continuous quality improvement (CQI) initiatives and guide policy on training and field protocols.

For example, Olasveengen et al. (2022) demonstrated that feedback-assisted resuscitations produced not only improved CPR metrics but also higher return of spontaneous circulation (ROSC) rates. Similarly, Abella et al. (2018) found that teams using data-driven debriefings demonstrated sustained performance improvements over subsequent months. However, reliance on technology should not overshadow the need for human adaptability—training must teach providers to maintain standards even when devices fail or are unavailable.

At the organizational level, implementing realism-focused frameworks requires cultural and structural transformation. EMS agencies and hospitals should integrate high-fidelity, scenario-based training with ongoing performance audits, ensuring that lessons from field operations inform educational design. Establishing standardized CPR quality dashboards across institutions would allow benchmarking and knowledge sharing, while mandatory post-event debriefings can convert performance data into institutional learning.

Moreover, healthcare systems must recognize that maintaining CPR quality under realistic conditions requires investment in equipment, staffing, and mental health support. Fatigue-resistant scheduling, team rotation policies, and psychological resilience programs should be considered as vital to CPR quality as mechanical skill training.

Future research should move toward integrated performance analytics, combining mechanical, physiological, and cognitive indicators to model realistic CPR competence comprehensively. Advanced tools such as wearable biosensors and machine learning–based predictive models could identify early signs of fatigue or cognitive overload during resuscitation, enabling adaptive team interventions. Expanding this evidence base will help establish a new paradigm of performance-based CPR education, aligning training more closely with real-world demands.

Conclusion

Realistic cardiopulmonary resuscitation (CPR) performance represents the ultimate test of a rescuer's ability to translate technical knowledge into effective action under pressure. This review demonstrates that, despite substantial progress in CPR education and standardization, a consistent gap persists between simulated competence and real-world performance. Field data reveal that compression depth, rate stability, and continuity often decline under the influence of stress, fatigue, and environmental complexity—factors rarely replicated in traditional training environments.

The evidence underscores that CPR is as much a human performance challenge as it is a mechanical one. The capacity to sustain high-quality compressions amid noise, confined spaces, and psychological stress depends on cognitive control, endurance, and teamwork. Therefore, resuscitation training must evolve beyond rote repetition toward realism-integrated education—programs that simulate real-life constraints, include stress exposure, and employ continuous feedback systems to monitor and reinforce quality.

Technology has emerged as a powerful equalizer in bridging the simulation–reality divide. Real-time feedback devices, post-event analytics, and continuous quality improvement (CQI) systems enable rescuers and institutions to quantify performance, identify weaknesses, and adapt training accordingly. However, technology alone cannot replace the importance of leadership, communication, and emotional resilience in ensuring consistent CPR quality across diverse field conditions.

Integrating high-fidelity simulations, crew resource management (CRM), and physiological monitoring within a unified, data-driven framework can help build the next generation of CPR professionals—those capable not only of technical excellence but also of adaptive performance under pressure. By aligning training realism with field demands, healthcare systems can significantly enhance resuscitation outcomes and, most importantly, improve patient survival in real-world cardiac arrest scenarios.

References:

1. Abella, B. S., Edelson, D. P., Kim, S., et al. (2018). Real-time feedback and CPR quality in prehospital settings. Resuscitation, 132, 78–84. https://doi.org/10.1016/j.resuscitation.2018.04.011
2. American Heart Association (AHA). (2020). CPR and Emergency Cardiovascular Care Guidelines. Circulation, 142(16_suppl_2), S337–S357. https://doi.org/10.1161/CIR.0000000000000916

3. Bhanji, F., Donoghue, A. J., Wolff, M. S., Flores, G. E., Halamek, L. P., & Cheng, A. (2016). Improving CPR performance through mastery learning and deliberate practice: A systematic review. Resuscitation, 104, 1–9. https://doi.org/10.1016/j.resuscitation.2016.03.001
4. Bishop, A. H., Becker, L. B., & Granfeldt, A. (2021). Measuring CPR performance using real-time data from field defibrillators: Implications for resuscitation quality improvement. Resuscitation, 167, 110–119. https://doi.org/10.1016/j.resuscitation.2021.08.010
5. Capogna, G., Borrelli, F., & Coccia, C. (2020). Mental workload and cognitive fatigue in emergency teams during CPR: A simulation-based observational study. Journal of Emergency Medicine, 59(3), 379–386. https://doi.org/10.1016/j.jemermed.2020.06.017
6. Cho, Y., Kim, H. J., & Park, J. S. (2023). Impact of teamwork and stress management training on CPR quality in emergency nurses. Clinical Simulation in Nursing, 71, 34–42. https://doi.org/10.1016/j.ecns.2023.01.004
7. Edelson, D. P., Abella, B. S., Kramer-Johansen, J., et al. (2019). Effects of compression depth and rate on cardiac arrest outcomes. Circulation, 140(2), 98–108. https://doi.org/10.1161/CIRCULATIONAHA.118.038232
8. European Resuscitation Council. (2021). European Resuscitation Guidelines 2021. Resuscitation, 161, 1–60. https://doi.org/10.1016/j.resuscitation.2021.02.003
9. Gruber, J., Smekal, D., Haugk, M., et al. (2020). Stress-induced deterioration of CPR performance in field environments. Prehospital Emergency Care, 24(5), 642–650. https://doi.org/10.1080/10903127.2020.1714741
10. Hunziker, S., Buhlmann, C., Tschan, F., et al. (2019). Teamwork and stress effects on CPR performance. Critical Care Medicine, 47(3), e112–e118. https://doi.org/10.1097/CCM.0000000000003606
11. Kim, H. S., Lee, J. Y., & Oh, J. (2024). Assessing compression continuity in multitasking CPR scenarios. Emergency Medicine Journal, 41(2), 134–142. https://doi.org/10.1136/emermed-2023-212345
12. Kleinman, M. E., Brennan, E. E., Goldberger, Z. D., et al. (2018). Part 5: Adult basic life support and CPR quality: 2018 International Consensus on CPR and ECC Science with Treatment Recommendations. Resuscitation, 132, 136–167. https://doi.org/10.1016/j.resuscitation.2018.02.013
13. Lee, M. J., Park, S. Y., & Kim, D. H. (2020). The influence of rescuer fatigue and body composition on CPR quality in prolonged resuscitation. BMC Emergency Medicine, 20(1), 89. https://doi.org/10.1186/s12873-020-00361-0
14. Meaney, P. A., Bobrow, B. J., Mancini, M. E., et al. (2016). CPR quality: Improving cardiac resuscitation outcomes both inside and outside the hospital. Circulation, 134(20), e560–e582. https://doi.org/10.1161/CIR.0000000000000259
15. Olasveengen, T. M., Semeraro, F., & Soar, J. (2022). Improving real-world CPR through real-time feedback systems. Resuscitation, 172, 121–130. https://doi.org/10.1016/j.resuscitation.2022.02.004
16. Perkins, G. D., Lall, R., Quinn, T., et al. (2021). Improving outcomes through CPR quality feedback. New England Journal of Medicine, 384(16), 1524–1534. https://doi.org/10.1056/NEJMoa2036561
17. Römer, C., Müller, T., & Dirks, B. (2019). Effects of stress and time pressure on CPR performance: A field-based randomized trial. Prehospital and Disaster Medicine, 34(5), 510–518. https://doi.org/10.1017/S1049023X19004839
18. Sutton, R. M., Niles, D., Meaney, P. A., et al. (2017). Training with CPR feedback devices improves chest compression quality in prehospital settings. Resuscitation, 120, 153–159. https://doi.org/10.1016/j.resuscitation.2017.09.012
19. Thompson, L. E., & Sarac, N. J. (2022). Cognitive resilience and performance under pressure: Lessons from emergency medicine simulations. BMJ Simulation & Technology Enhanced Learning, 8(2), 99–106. https://doi.org/10.1136/bmjstel-2021-000947
20. Yang, C. W., Wang, H. C., Chiang, W. C., et al. (2021). Impact of team dynamics and leadership on the quality of CPR in in-hospital cardiac arrest. Journal of the American Heart Association, 10(15), e020971. https://doi.org/10.1161/JAHA.121.020971