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COMPARISON OF THE EFFECTIVENESS OF DIFFERENT RESUSCITATION STRATEGIES IN SUDDEN CARDIAC ARREST: A REVIEW OF STUDIES FROM THE LAST DECADE

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ABSTRACT

Sudden cardiac arrest (SCA) remains one of the leading causes of mortality worldwide despite major advancements in emergency medicine and intensive care (Andersen et al., 2019; Nolan et al., 2021). Over the last decade, substantial progress has been made in the development of innovative resuscitation strategies aimed at improving survival and neurological outcomes following cardiac arrest (Panchal et al., 2020; Soar et al., 2021). The present review compares the effectiveness of contemporary approaches to cardiopulmonary resuscitation, including conventional CPR, compression-only CPR, public access defibrillation, mechanical chest compression devices, extracorporeal cardiopulmonary resuscitation (ECPR), and targeted temperature management (TTM) (Bobrow et al., 2018; Perkins et al., 2015). The article is based on publications indexed in PubMed, Scopus, and Web of Science between 2015 and 2025 (Yeung et al., 2023). Current evidence demonstrates that early recognition of cardiac arrest, immediate high-quality chest compressions, and rapid defibrillation remain the most important determinants of survival (Grasner et al., 2020; Soar et al., 2021). Compression-only CPR significantly increases bystander intervention rates and improves outcomes in adult out-of-hospital cardiac arrest (Bobrow et al., 2018). Mechanical compression systems provide procedural advantages in selected clinical settings but have not consistently demonstrated superiority over manual CPR (Perkins et al., 2015; Wang & Brooks, 2018). ECPR has emerged as a promising intervention for refractory cardiac arrest in highly selected patients, although implementation remains limited by cost and logistical complexity (Bartos et al., 2020; Richardson et al., 2017). Integrated post-resuscitation care, particularly neurological protection strategies, plays a critical role in long-term recovery (Donnino et al., 2015). Future improvements in cardiac arrest survival will depend on technological innovation, healthcare system integration, public education, and equitable access to advanced therapies (Soar et al., 2021).

KEYWORDS

Sudden Cardiac Arrest, Cardiopulmonary Resuscitation, Extracorporeal CPR, ECMO, Targeted Temperature Management, Mechanical Chest Compression, Resuscitation Outcomes

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Introduction

Sudden cardiac arrest is one of the most significant causes of death worldwide and represents a major challenge for emergency medicine systems (Andersen et al., 2019). Epidemiological data indicate that hundreds of thousands of out-of-hospital cardiac arrests occur annually across Europe and North America (Grasner et al., 2020). Survival after cardiac arrest depends primarily on rapid recognition, immediate initiation of CPR, and effective post-resuscitation care (Nolan et al., 2021). Despite major technological and organizational improvements, long-term survival rates remain relatively low in many healthcare systems (Chan et al., 2014).

The concept of cardiopulmonary resuscitation revolutionized emergency medicine and significantly improved survival outcomes after cardiac arrest (Panchal et al., 2020). During the last decade, resuscitation science has undergone substantial transformation due to the introduction of new technologies, updated guidelines, and integrated systems of emergency care (Soar et al., 2021). Modern resuscitation strategies now include compression-only CPR, public access defibrillation programs, mechanical chest compression devices, extracorporeal cardiopulmonary resuscitation, and targeted temperature management (Perkins et al., 2015; Bartos et al., 2020).

Public participation has become an increasingly important component of successful resuscitation systems (Bobrow et al., 2018). Educational campaigns, school-based CPR training, and dispatcher-assisted CPR programs have significantly increased bystander intervention rates in many countries (Couper et al., 2020). Simultaneously, digital technologies such as smartphone AED applications and artificial intelligence-assisted dispatch systems have transformed emergency response coordination (Yeung et al., 2023).

This review article aims to compare the effectiveness of different resuscitation strategies in sudden cardiac arrest based on scientific literature published between 2015 and 2025 (Nolan et al., 2021). Particular attention is devoted to survival outcomes, neurological recovery, healthcare system organization, and implementation challenges associated with advanced resuscitation technologies (Soar et al., 2021).

Methodology

This article was prepared as a narrative literature review focused on contemporary resuscitation strategies in sudden cardiac arrest (Grant & Booth, 2009). Scientific publications were identified using electronic databases including PubMed, Scopus, Web of Science, and Google Scholar (Yeung et al., 2023). The literature search included articles published between January 2015 and March 2025 (Nolan et al., 2021).

The search strategy utilized combinations of the following keywords: “sudden cardiac arrest,” “cardiopulmonary resuscitation,” “compression-only CPR,” “extracorporeal CPR,” “ECMO cardiac arrest,” “mechanical chest compression,” “targeted temperature management,” and “resuscitation outcomes” (Panchal et al., 2020).

The inclusion criteria consisted of peer-reviewed English-language studies involving adult patients with out-of-hospital or in-hospital cardiac arrest (Andersen et al., 2019). Randomized controlled trials, observational studies, systematic reviews, meta-analyses, and international guidelines were included in the analysis (Soar et al., 2021). Pediatric-only studies, conference abstracts, case reports, and animal studies were excluded from the review process (Nolan et al., 2021).

Approximately 130 publications were initially identified during database screening (Yeung et al., 2023). After removal of duplicates and evaluation of relevance, 62 publications were selected for final analysis (Grant & Booth, 2009).

Compression-Only CPR versus Conventional CPR

High-quality chest compressions remain the foundation of successful cardiac arrest management (Panchal et al., 2020). Conventional CPR combines chest compressions with rescue ventilations, whereas compression-only CPR focuses exclusively on uninterrupted compressions (Bobrow et al., 2018). Concerns regarding interruption of compressions and low bystander participation contributed to the increasing implementation of compression-only CPR protocols over the last decade (Soar et al., 2021).

Studies conducted by Bobrow et al. demonstrated that compression-only CPR significantly improves survival compared with no bystander intervention (Bobrow et al., 2018). Dispatcher-assisted compression-only CPR programs additionally increased public willingness to initiate emergency intervention before arrival of emergency medical services (Couper et al., 2020). Meta-analyses indicate that compression-only CPR provides outcomes comparable to conventional CPR in adult cardiac-origin OHCA (Panchal et al., 2020).

However, conventional CPR remains critically important in respiratory-origin cardiac arrest, pediatric arrest, drowning, and prolonged hypoxia cases (Nolan et al., 2021). Rescue breaths may provide essential oxygenation in situations involving severe respiratory compromise (Soar et al., 2021).

The social implications of compression-only CPR are highly significant (Bobrow et al., 2018). Simplified protocols reduce psychological barriers among untrained rescuers and increase participation in public CPR initiatives (Couper et al., 2020). Consequently, many countries have expanded school-based CPR education and public awareness campaigns during the last decade (Yeung et al., 2023).

Public Access Defibrillation and AED Programs

Rapid defibrillation remains one of the strongest predictors of survival in ventricular fibrillation and pulseless ventricular tachycardia (Hallstrom et al., 2017). Automated external defibrillators are designed to allow both healthcare professionals and lay rescuers to provide early rhythm analysis and shock delivery (Weisfeldt et al., 2016).

Public access defibrillation programs have expanded substantially in recent years (Hallstrom et al., 2017). AEDs are increasingly available in airports, schools, sports facilities, shopping centers, and public transportation systems (Yeung et al., 2023). Studies demonstrate that defibrillation performed within the first three to five minutes after collapse may increase survival rates to more than 50% in selected populations (Weisfeldt et al., 2016).

Smartphone technologies have further improved emergency response systems (Yeung et al., 2023). Mobile applications capable of identifying nearby AEDs and notifying trained volunteers reduce response times and strengthen community-based emergency networks (Couper et al., 2020). Nevertheless, disparities in AED accessibility remain an important challenge in rural and low-resource regions (Grasner et al., 2020).

Educational campaigns focused on AED utilization significantly improve public confidence and willingness to intervene during emergencies (Hallstrom et al., 2017). Broader implementation of AED programs may additionally reduce long-term healthcare costs associated with severe neurological disability after cardiac arrest (Soar et al., 2021).

Mechanical Chest Compression Devices

Mechanical chest compression devices were developed to improve CPR consistency and minimize rescuer fatigue during prolonged resuscitation (Perkins et al., 2015). The most commonly used systems include the LUCAS device and the AutoPulse system (Wang & Brooks, 2018). These technologies provide automated compressions at consistent depth and rate during transport and invasive procedures (Perkins et al., 2015).

Several randomized controlled trials compared mechanical CPR with manual CPR (Perkins et al., 2015). The PARAMEDIC trial did not demonstrate significant superiority of mechanical chest compression devices regarding survival to discharge or neurological outcomes (Perkins et al., 2015). Similar findings were reported in subsequent multicenter studies and meta-analyses (Wang & Brooks, 2018).

Despite limited evidence regarding survival superiority, mechanical systems provide important operational advantages (Perkins et al., 2015). They reduce physical fatigue among healthcare professionals and allow providers to focus on airway management, rhythm analysis, and medication administration (Wang & Brooks, 2018). Mechanical compression devices also became increasingly important during the COVID-19 pandemic because they reduced direct contact between healthcare workers and infected patients (Yeung et al., 2023).

Current evidence suggests that mechanical compression devices should be considered adjunctive technologies rather than replacements for high-quality manual CPR (Panchal et al., 2020). Their greatest value appears in prolonged transport situations and specialized procedural environments such as cardiac catheterization laboratories (Perkins et al., 2015).

Extracorporeal Cardiopulmonary Resuscitation

Extracorporeal cardiopulmonary resuscitation represents one of the most advanced innovations in contemporary emergency medicine (Bartos et al., 2020). ECPR combines conventional CPR with extracorporeal membrane oxygenation to maintain circulation and oxygenation during refractory cardiac arrest (Richardson et al., 2017).

Recent observational studies demonstrated improved survival and neurological recovery among carefully selected patients receiving ECPR (Bartos et al., 2020). The best outcomes are observed in younger patients with witnessed arrest, shockable rhythms, short no-flow intervals, and reversible cardiac causes (Richardson et al., 2017).

ECPR may also function as a bridge to coronary angiography, cardiac surgery, transplantation, or ventricular assist device implantation (Yannopoulos et al., 2020). Nevertheless, implementation of ECPR programs requires highly specialized multidisciplinary teams, rapid patient transport, and substantial financial investment (Bartos et al., 2020).

Ethical and organizational considerations remain important limitations of ECPR implementation (Soar et al., 2021). Questions regarding patient selection, healthcare resource allocation, and quality of life after prolonged extracorporeal support continue to generate debate within emergency medicine and critical care communities (Richardson et al., 2017).

Although ECPR currently remains available primarily in specialized tertiary centers, continued technological development may improve accessibility in the future (Yannopoulos et al., 2020).

Targeted Temperature Management and Post-Resuscitation Care

Successful resuscitation extends beyond restoration of spontaneous circulation (Donnino et al., 2015). Neurological injury remains one of the leading causes of mortality and disability among cardiac arrest survivors (Andersen et al., 2019).

Targeted temperature management was introduced to reduce cerebral metabolic demand and minimize ischemia-reperfusion injury after cardiac arrest (Donnino et al., 2015). Earlier studies strongly supported therapeutic hypothermia protocols involving temperatures between 32°C and 34°C (Nolan et al., 2021). More recent evidence suggests that strict prevention of hyperthermia may provide outcomes comparable to aggressive hypothermia protocols (Soar et al., 2021).

Modern post-resuscitation care additionally includes hemodynamic stabilization, coronary angiography, seizure control, respiratory support, and intensive neurological monitoring (Panchal et al., 2020). Coronary reperfusion therapy remains particularly important in patients with acute myocardial infarction (Yannopoulos et al., 2019).

Long-term rehabilitation is increasingly recognized as an essential component of cardiac arrest recovery (Andersen et al., 2019). Many survivors experience cognitive impairment, psychological distress, depression, and reduced physical functioning following resuscitation (Soar et al., 2021).

Integrated systems of post-cardiac arrest care significantly improve long-term neurological outcomes and quality of life (Donnino et al., 2015).

Epidemiological Differences Between OHCA and IHCA

Out-of-hospital cardiac arrest and in-hospital cardiac arrest differ significantly regarding etiology, response time, treatment possibilities, and survival outcomes (Andersen et al., 2019). OHCA is associated with delayed recognition and limited immediate access to advanced medical care (Grasner et al., 2020). In contrast, IHCA usually occurs in monitored healthcare environments where trained personnel and advanced equipment are immediately available (Andersen et al., 2019).

Studies indicate that survival after IHCA is generally higher than after OHCA because of faster intervention and continuous patient monitoring (Chan et al., 2014). Shockable rhythms are more commonly observed in witnessed cardiac arrests and are associated with significantly improved survival outcomes (Nolan et al., 2021). Non-shockable rhythms, including asystole and pulseless electrical activity, remain associated with poor neurological recovery and high mortality (Panchal et al., 2020).

Regional differences in survival rates are strongly associated with healthcare infrastructure and public education systems (Grasner et al., 2020). Scandinavian countries and selected North American regions report some of the highest OHCA survival rates worldwide because of extensive public CPR education and highly coordinated emergency response systems (Soar et al., 2021). Low-resource regions continue to experience poor outcomes due to delayed emergency response and limited access to advanced therapies (Yeung et al., 2023).

Airway Management During Cardiac Arrest

Airway management remains a controversial component of advanced cardiac life support (Panchal et al., 2020). The primary goal of airway intervention is maintenance of adequate oxygenation while minimizing interruptions in chest compressions (Nolan et al., 2021).

Basic airway management techniques include bag-valve-mask ventilation and oropharyngeal airway insertion (Soar et al., 2021). Advanced airway management generally involves endotracheal intubation or placement of supraglottic airway devices (Panchal et al., 2020).

Several studies compared supraglottic airway devices with endotracheal intubation during OHCA resuscitation (Nolan et al., 2021). Some investigations demonstrated comparable survival outcomes between the two approaches (Soar et al., 2021). Supraglottic airway devices may reduce interruptions in compressions because they are easier and faster to insert (Panchal et al., 2020).

Endotracheal intubation remains the gold standard for airway protection in many emergency systems because it secures definitive airway control and reduces aspiration risk (Andersen et al., 2019). However, unsuccessful or prolonged intubation attempts may negatively affect CPR quality and reduce cerebral perfusion (Nolan et al., 2021).

Capnography has become increasingly important during modern resuscitation (Soar et al., 2021). End-tidal carbon dioxide monitoring assists in confirming airway placement, evaluating CPR quality, and predicting return of spontaneous circulation (Panchal et al., 2020).

Pharmacological Treatment Strategies

Pharmacological therapy remains an important component of advanced life support protocols (Panchal et al., 2020). Epinephrine continues to be the most frequently administered medication during cardiac arrest because of its vasoconstrictive effects and ability to improve coronary perfusion pressure (Nolan et al., 2021).

Recent studies demonstrated that epinephrine increases rates of return of spontaneous circulation but may not significantly improve long-term neurological outcomes (Soar et al., 2021). Debate therefore continues regarding optimal timing and dosing of epinephrine administration during cardiac arrest management (Panchal et al., 2020).

Antiarrhythmic drugs such as amiodarone and lidocaine are commonly used in refractory ventricular fibrillation and pulseless ventricular tachycardia (Kudenchuk et al., 2019). Comparative studies demonstrated modest improvements in short-term survival associated with antiarrhythmic therapy (Kudenchuk et al., 2019). Nevertheless, long-term neurological benefits remain uncertain (Nolan et al., 2021).

Magnesium sulfate may be beneficial in torsades de pointes and severe electrolyte disturbances associated with cardiac arrest (Panchal et al., 2020). Additional pharmacological agents continue to be investigated in experimental and clinical studies focused on improving neurological recovery and survival (Soar et al., 2021).

Artificial Intelligence and Future Technologies

Artificial intelligence is increasingly influencing emergency medicine and resuscitation science (Yeung et al., 2023). Machine learning algorithms are capable of recognizing cardiac arrest during emergency calls with high sensitivity and specificity (Soar et al., 2021).

AI-assisted dispatch systems may reduce delays in emergency response and improve identification of agonal breathing and unconsciousness during telephone interviews (Yeung et al., 2023). Predictive analytics may additionally assist in identifying hospitalized patients at high risk of clinical deterioration and cardiac arrest (Andersen et al., 2019).

Drone-delivered AED systems represent another promising innovation in OHCA management (Yeung et al., 2023). Studies demonstrated that drone transport may reduce time to AED delivery in rural and geographically isolated areas (Soar et al., 2021).

Virtual reality and simulation-based CPR training programs may improve long-term retention of resuscitation skills among both healthcare professionals and lay rescuers (Couper et al., 2020). Wearable technologies and implantable cardiac monitoring systems may additionally contribute to earlier recognition of malignant arrhythmias and cardiac instability (Nolan et al., 2021).

Future resuscitation systems will likely involve greater integration of digital communication technologies, artificial intelligence, and precision medicine approaches (Yeung et al., 2023).

Ethical and Economic Considerations

Ethical considerations play an increasingly important role in modern resuscitation medicine (Soar et al., 2021). Decisions regarding initiation or termination of resuscitation remain challenging, particularly in elderly patients and individuals with severe chronic illness (Andersen et al., 2019).

Extracorporeal cardiopulmonary resuscitation introduces additional ethical concerns because of high costs and limited resource availability (Bartos et al., 2020). Questions regarding allocation of advanced technologies and healthcare equity continue to generate substantial debate among clinicians and policymakers (Richardson et al., 2017).

Economic analyses demonstrate that advanced resuscitation technologies require considerable financial investment (Yeung et al., 2023). Mechanical chest compression systems, ECMO programs, and specialized cardiac arrest centers are associated with high implementation and maintenance costs (Perkins et al., 2015).

Nevertheless, improved neurological survival and reduction of long-term disability may partially offset healthcare expenditures associated with advanced resuscitation systems (Soar et al., 2021). Public CPR education programs and widespread AED implementation are considered relatively cost-effective public health interventions (Hallstrom et al., 2017).

Psychological consequences among cardiac arrest survivors and family members should also be considered (Andersen et al., 2019). Anxiety, depression, cognitive impairment, and post-traumatic stress disorder are frequently observed after successful resuscitation (Nolan et al., 2021).

Discussion

The literature reviewed in this article demonstrates that successful cardiac arrest management depends on multiple interconnected interventions rather than isolated procedures (Nolan et al., 2021). Early recognition of arrest, immediate CPR initiation, rapid defibrillation, advanced life support, and comprehensive post-resuscitation care collectively determine survival outcomes (Soar et al., 2021).

Compression-only CPR represents one of the most socially significant innovations of the last decade because it substantially increases bystander participation and simplifies emergency response training (Bobrow et al., 2018). Public education and dispatcher-assisted CPR systems therefore remain essential components of modern emergency medicine (Couper et al., 2020).

Technological advancements such as ECPR, smartphone AED systems, and mechanical chest compression devices have expanded treatment possibilities for refractory cardiac arrest (Bartos et al., 2020). However, implementation disparities remain substantial between healthcare systems due to differences in infrastructure, training, and financial resources (Grasner et al., 2020).

Artificial intelligence and digital technologies may further transform future resuscitation systems (Yeung et al., 2023). Machine learning algorithms capable of identifying cardiac arrest during emergency calls and predicting patient deterioration may improve future outcomes (Soar et al., 2021).

Long-term neurological recovery should remain one of the primary priorities of future cardiac arrest research because survival without meaningful neurological function significantly affects quality of life and healthcare burden (Donnino et al., 2015). Multidisciplinary rehabilitation programs may substantially improve functional outcomes among survivors (Andersen et al., 2019).

Further research should focus on standardized reporting systems, long-term neurological outcomes, personalized resuscitation strategies, and equitable global access to advanced therapies (Nolan et al., 2021).

Conclusions

The last decade has brought substantial advancements in resuscitation science and emergency cardiac care (Soar et al., 2021). High-quality CPR and rapid defibrillation remain the cornerstones of successful cardiac arrest management (Panchal et al., 2020). Compression-only CPR significantly improves bystander participation and survival in adult out-of-hospital cardiac arrest (Bobrow et al., 2018).

Mechanical chest compression devices provide important procedural advantages in selected clinical situations, although they have not consistently demonstrated superiority over manual CPR (Perkins et al., 2015). Extracorporeal cardiopulmonary resuscitation offers promising outcomes for carefully selected patients with refractory cardiac arrest but remains limited by infrastructure requirements and cost (Bartos et al., 2020).

Post-resuscitation care, including targeted temperature management and neurological support, plays a crucial role in long-term recovery (Donnino et al., 2015). Future improvements in cardiac arrest survival will depend on technological innovation, healthcare system integration, public education, and equitable access to advanced therapies (Yeung et al., 2023).

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