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Systematic Review

Early Defibrillation for Ventricular Fibrillation Cardiac Arrest in the Emergency Department; Systematic Review

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Abstract

Background: Ventricular fibrillation (VF) and pulseless ventricular tachycardia (pVT) are time sensitive cardiac arrest rhythms where survival depends on rapid defibrillation. In the emergency department (ED), both out of hospital cardiac arrest (OHCA) arrivals and in ED and in-hospital cardiac arrest (IHCA) events may be encountered. The ED specific evidence base on early defibrillation is limited in ED cohorts and broader in hospital registries. **Objective:** our study aim to analyze original articles from PubMed Central on the association between early defibrillation and outcomes in VF and pVT cardiac arrest managed in ED settings. **Methods**: We followed PRISMA methods, structured question, reproducible search strategy, eligibility criteria, dual stage screening, standardized extraction, and narrative synthesis. We searched electronic databases for full-text on December 2026 for studies reporting VF and pVT arrests with a measurable defibrillation time variable (time to first shock, defibrillation within 2 minutes, or rhythm analysis before arrest team arrival). We included original human studies and excluded reviews, editorials, simulations, and single patient case reports. **Results**: Ten original studies met inclusion criteria, in ED-managed arrests, time to first defibrillation differ widely (median 2 to 3 minutes in one ED cohort with survivors vs non-survivors showing similar times, and 10 to 12 minutes in shockable cases in another ED based study). In a large adult IHCA

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-registry analysis, defibrillation within 2 minutes was associated with better longer term survival reported as a 49% higher likelihood of 1 year survival. A pediatric IHCA registry analysis found no significant association between defibrillation time and survival to discharge. In Danish hospitals, rhythm analysis before cardiac arrest team arrival was associated with higher ROSC. **Conclusion:** our finding prioritize rapid defibrillation for VF/pVT, with strong adult in hospital registry signals favoring very early shocks (≤2 minutes), while ED-specific cohorts show variable timing and outcomes. Pediatric in-hospital data indicate that timing effects differ by age group or clinical context. Higher-quality ED-specific prospective studies were needed.

Keywords: Emergency department; Ventricular fibrillation; Pulseless ventricular tachycardia; Early defibrillation; Time to shock; Return of spontaneous circulation; In-hospital cardiac arrest.

Introduction

VF/pVT cardiac arrest is treatable because defibrillation terminate the malignant rhythm when delivered early, making defibrillation timing important Chain of Survival target in resuscitation quality frameworks (1). Overall IHCA survival has improved in some settings, survival still limited and varies by hospital characteristics, arrest location, monitoring status, and resuscitation processes (2).

The ED occupies a unique position in cardiac arrest care, it receives OHCA patients often after prolonged and low no-flow intervals and also manages arrests occurring in the ED. Studies describing ED cardiac arrest epidemiology show that initial rhythm predicts outcome and that system factors, training, workflow, and readiness influence time sensitive interventions (3). In addition, ED crowding and operational strain affect resuscitation performance and impact timeliness even in monitored environments (4).

In hospital registries provide large samples of shockable arrests and commonly track key process measures, including defibrillation within 2 minutes for VF/pVT (5). ED only evidence is comparatively sparse, and ED focused studies report time to defibrillation distributions without directly estimating timing-outcome dose response relationships (4).

Our systematic review analyze original articles on early defibrillation for VF/pVT cardiac arrest managed in the ED where the response is integral, we focused on outcomes including ROSC, survival to discharge, neurologic status, and longer term survival.

Methods

Protocol and reporting framework

This review was conducted using PRISMA-aligned principles pre-specified question, eligibility criteria, systematic search, transparent selection and synthesis. A formal protocol was not prospectively registered.

Eligibility criteria

We include original human research (randomized trials, cohort studies, registry analyses). Cardiac arrest with shockable rhythm (VF and/or pVT) reported clearly or as a subgroup. A measurable defibrillation timing exposure, time to first shock; defibrillation within 2 minutes; rhythm analysis and defibrillation before arrest team arrival; early vs delayed shock strategy. ED setting, arrests treated in ED or occurring in ED, or in-hospital registry studies whose timing metrics are directly applicable to ED VF/pVT response and include monitored areas typical of ED workflows. We exclude reviews, editorials, simulation only studies, animal studies, single-patient case reports, and studies without a defibrillation timing variable.

Information source and search strategy

We searched electronic databases (PubMed, Scopus, WOS) for original articles available as full text on December 2025 using combinations of terms for ED, VF/pVT, and timing, including: ("emergency department" OR ED) AND ("ventricular fibrillation" OR "pulseless ventricular tachycardia" OR shockable) AND (defibrillation OR "time to defibrillation" OR "defibrillation within 2 minutes") AND ("cardiac arrest"). We also used reference chaining within eligible full text articles to identify additional available original studies.

Study selection

Titles and abstracts were screened for eligibility criteria, followed by full text assessment. Only original studies meeting all inclusion criteria were included in the analysis. Reasons for exclusion at full text commonly included; no shockable rhythm subgroup, no timing exposure, review and simulation format, or non-ED non-applicable setting.

Data extraction

From each included study we extracted: setting, country, design and data source, population, shockable rhythm definition, defibrillation timing metric, comparator definition, and outcome, ROSC, survival to discharge, neurologic status, and longer-term survival.

Risk of bias assessment

Because the included evidence was observational and registry-based, we performed a structured qualitative appraisal selection bias, exposure measurement, confounding control, and outcome ascertainment. Studies with clear adjustment for confounders and standardized registry definitions were considered at lower risk of bias than small single center cohorts with limited adjustment.

Analysis

According to the heterogeneity in populations, timing definitions, and outcomes, meta-analysis

was not performed. Findings are summarized qualitatively with tabular study level results.

Results

Included studies

Ten original studies met criteria: three ED-focused cohorts and seven in hospital database studies with shakable rhythm timing measures relevant to ED defibrillation performance. Key characteristics are summarized in Table 1.

Early defibrillation in adult shockable IHCA is a meaningful quality marker associated with better outcomes in large datasets (5). ED specific cohorts found variability in shock delivery times, in one ED cohort, survivors and non-survivors had similar short median times (2 to 3 minutes), while in another ED environment cohort dominated by OHCA processes, shockable subgroup defibrillation times were much longer (10 to 12 minutes), which indicate that pre-hospital delays and workflow outweigh ED only actions (4).

Discussion

Our review found that the most consistent strong signals supporting early defibrillation for VF/pVT come from large in hospital registries using standardized process measures, while ED only cohorts report timing distributions and outcomes without uniform early vs late effect estimates (5).

Defibrillation is most effective in the earliest phase of VF/pVT, while prolonged arrest shifts the balance toward the need for high quality CPR and coordinated resuscitation bundles. The in hospital prospective analysis by Skogvoll et al. modeled this early window and concluded defibrillation should be prioritized during the first 3 minutes of VF/VT, with CPR becoming beneficial in conjunction with defibrillation later (1). This aligns with resuscitation quality frameworks highlight early rhythm recognition and rapid shock delivery (4).

ED cohorts show weaker timing outcome gradients when most arrests are unwitnessed OHCAs arriving late; prehospital no-flow time dominates outcome; or defibrillation timing is uniformly fast, making it harder to detect an association. The Kim et al. ED study show the latter possibility, survival differences were not explained by a 1 minute median difference in time to first defibrillation (6). In the ED environment cohort studied by Tantarattanapong et al., shockable defibrillation times were longer (median 10 to 12 minutes), which suggest a different case mix with larger prehospital delay components. ROSC differed significantly by resuscitation strategy grouping even when defib timing was similar (5).

Fig 1 PRISMA flow chart

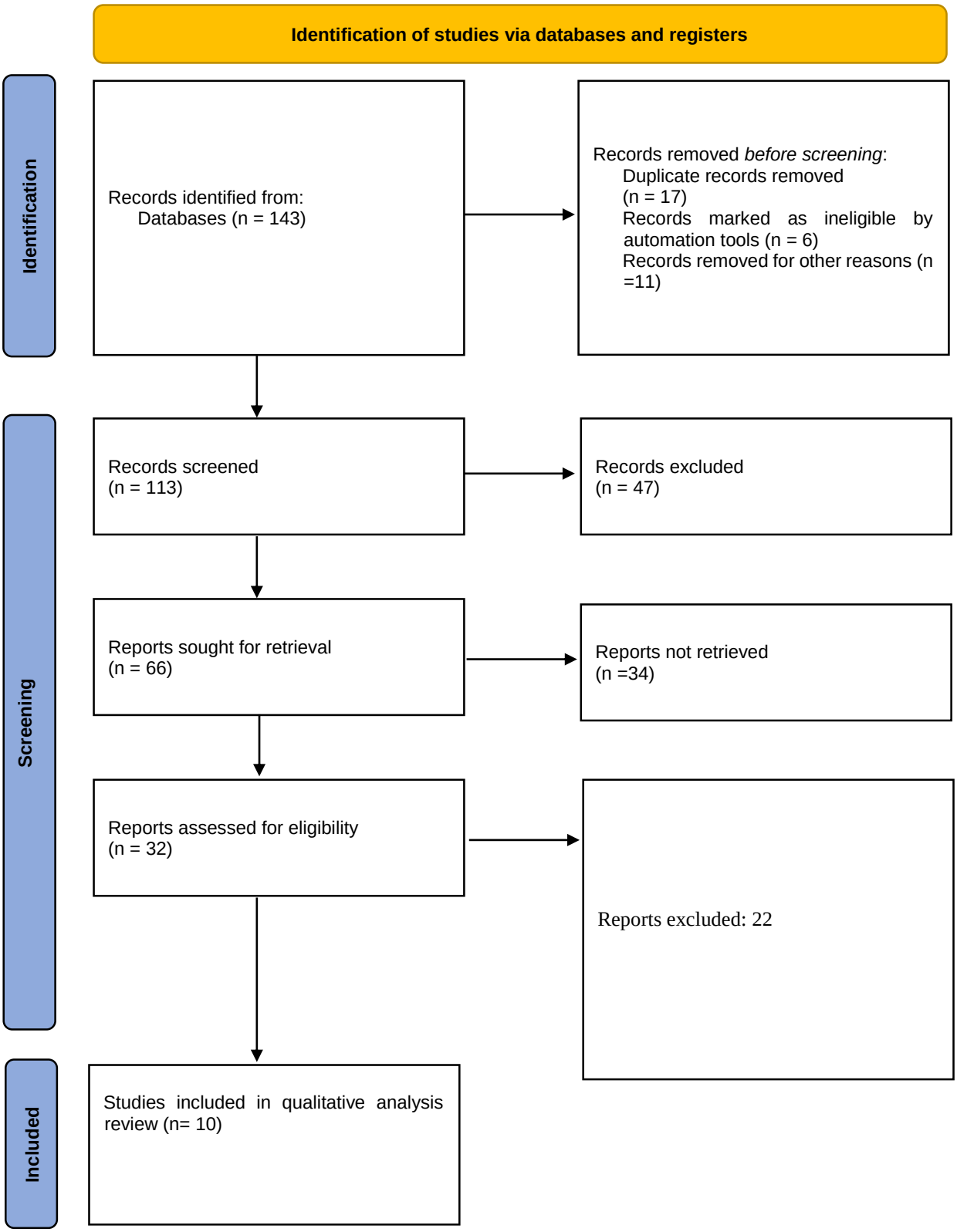

Table 1. Characteristics of included original studies

Study	Design and data source	Location	Population	Early defibrillation and timing metric	Main outcomes reported
Vancini-Campanharo 2015 (3)	Prospective cohort	Brazil	ED treated arrests; VF referenced as prognostically important	Interval from CPR start to first defibrillation attempt collected	ROSC; survival to discharge; longer-term survival
Kim 2020 (4)	Retrospective cohort	Korea	ED cardiac arrest population; rhythm recorded	Time to first defibrillation	Survival to discharge; CPC at discharge
Tantarattanapong 2022 (6)	Retrospective comparison	Thailand	Non-traumatic adult arrests; shockable subgroup described	Time from arrest to defibrillation in shockable rhythm	Sustained ROSC
Skogvoll 2008 (7)	Prospective observational	Norway	VF/VT subgroup modeled	Time from collapse to defibrillation; early minutes (first 3 to 4 min) emphasized	ROSC; survival to discharge
Staerk 2022 (8)	National database and hospital survey	Denmark	All IHCAs; shockable subgroup analyzed	Rhythm analysis before arrest team arrival; device type	ROSC
Patel 2017 (5)	National registry analysis	US	Adult IHCA with first shockable rhythm	defibrillation (≤2 minutes)	1, 3, 5 year survival
Hunt 2018 (9)	National registry cohort	US	Pediatric IHCA with first shockable rhythm	Defibrillation ≤2 vs >2 minutes; per-minute modeling	Survival to discharge; neurologic status
Bradley 2012 (10)	Registry analysis	US	VT/VF arrests emphasized	Time to defibrillation as mediator of outcome improvement	Event survival; survival to discharge
Bradley 2016 (11)	Registry cohort	US	Persistent VT/VF after first shock	Timing between defib attempts; first defib timing differences	Resuscitation outcomes
Starks 2020 (12)	Registry + claims linkage	US	Dialysis vs non-dialysis; shockable subset	Defibrillation within 2 minutes	Survival to discharge; neurologic status

Table 2: Key findings on defibrillation timing and outcomes

Study	Timing exposure	Key quantitative findings reported in PMC full text	Interpretation for ED VF/pVT care
Kim 2020	Time to first defibrillation survivors vs non-survivors	Median time to first defibrillation 2.0 vs 3.0 min(P=0.59). Survival to discharge 24.6%; good CPC at discharge 20.3%.	In this ED cohort, survival differences were not explained by small median defib-time differences, which suggest other determinants
Tantarattanapong 2022	Shockable subgroup: arrest to defibrillation time	Shockable rhythm subgroup: median time to defibrillation 10 (0 to 22.5) vs 12 (4.5 to 28) min (P=0.564). Sustained ROSC higher with manual strategy 30.1% vs 9.4% (P=0.029).	ED environment resuscitation bundles affect outcomes even when defib timing is similar; timing still long in OHCA-dominant cohorts.
Skogvoll 2008	Collapse to defibrillation; emphasis on first 3 to 4 minutes in VF/VT	Authors conclude defibrillation should have priority during the first 3 minutes of VF/VT; survival modeling showed strong dependence on early defib time.	Supports ED practice of immediate shock when VF/pVT is present early after collapse.
Staerk 2022	Rhythm analysis before arrest team arrival	ROSC higher when rhythm analysis occurred before team arrival: adjusted RR 1.28 (1.12–1.46).	Earlier rhythm recognition, defib capability in the minutes before specialized team arrival improve ROSC, highly relevant to ED staffing and defib availability.
Patel 2017	Prompt defibrillation ≤2 minutes	Prompt defibrillation (≤2 minutes) associated with 49% greater likelihood of 1 year survival, with benefit persisting at 3 and 5 years.	Strong adult registry signal supporting shock within 2 minutes as a quality benchmark applicable to ED shockable arrests.
Hunt 2018	Defib ≤2 vs >2 minutes	No significant association between time to first defibrillation and survival to discharge in pediatric IHCA with shockable rhythm.	Pediatric ED shockable arrests behave differently; timing benchmarks require age specific interpretation.

Study	Timing exposure	Key quantitative findings reported in PMC full text	Interpretation for ED VF/pVT care
Starks 2020	Defibrillation within 2 minutes	Defibrillation within 2 minutes occurred 54% vs 58%; survival to discharge similar after adjustment (OR 1.05, 95% CI 0.97–1.13).	high-risk comorbidity groups have different process performance rates; ED teams need targeted readiness in such populations.
Bradley 2016	Defib strategy timing	Among persistent VT/VF, deferred second attempt common (41%); median time to first defib longer in deferred group (1 vs 2 min, P<0.001).	In refractory VF/pVT, defib strategy and minimizing delays matter beyond the first shock.
Bradley 2012	Time to defib as mediator of longitudinal improvement	Authors report that in VT/VF arrests, time to defibrillation attenuated outcome associations over participation time.	Reinforces time to defib as a modifiable system performance target.
Vancini-Campanharo 2015	ED cohort with VF prognostic advantage; timing variable collected	VF identified as a strong predictor compared with PEA; delays in defibrillation are discussed as a survival determinant.	ED cohorts emphasize rhythm and system delay factors, supporting ED QI focus on rapid shock delivery.

Patel et al. provide policy-relevant evidence in a large adult IHCA registry, defibrillation within 2 minutes for shockable arrests was associated with better long-term survival (reported as 49% higher 1 year survival likelihood, sustained at 3 and 5 years) (10). This supports the common institutional benchmark of shock within 2 minutes for VF/pVT and support ED operational priorities: immediate rhythm recognition, defibrillator availability, and minimal task delays.

Hospital participation in resuscitation QI programs and composite resuscitation performance relate to outcomes, with time to defibrillation functioning as a modifiable mediator for VT/VF. Khera et al. highlight that recognized high performing hospitals track and achieve better adherence to process measures including defibrillation within 2 minutes for shockable rhythms, reinforcing the role of organizational readiness and performance measurement (13).

Staerk et al. addressed a practical of early defibrillation whether rhythm analysis occurs before the cardiac arrest team arrives. In Danish hospitals, ROSC was higher when rhythm analysis occurred before team arrival, and there was no evidence that AED use itself modified the association compared with manual defibrillators (8). Hunt et al. found no significant association between defibrillation timing (≤2 vs >2 minutes) and survival to discharge in shockable IHCA (9). Explanations include smaller sample sizes for pediatric shockable events, different arrest etiologies, and differences in pre-arrest physiology.

Limitations of our study is that only a minority of included studies were ED only cohorts; most quantitative "early defibrillation" effect estimates came from in hospital registries; mixed populations, different timing metrics, and varying outcomes precluded meta-analysis; observational studies have confounding by arrest severity, prehospital delay, or care limitations; some ED cohorts reported timing distributions but did not provide adjusted timing-outcome effect sizes for VF/pVT specifically.

Conclusion

Early defibrillation is a central target for VF/pVT cardiac arrest care relevant to ED practice. Large adult in hospital registry data support delivering the first shock within 2 minutes when feasible, with associations extending to long term survival. ED cohorts show that measured time to defibrillation vary by context and case mix, and that outcomes shaped by broader resuscitation and post arrest systems when timing differences are small or when prehospital delays dominate.

Abbreviations

ACLS, Advanced Cardiac Life Support
AED, Automated External Defibrillator
BLS, Basic Life Support
CPC, Cerebral Performance Category
CPR, Cardiopulmonary Resuscitation
ED, Emergency Department

EMS, Emergency Medical Services

GWTG-R, Get With The Guidelines–Resuscitation

IHCA, In-Hospital Cardiac Arrest

IQR, Interquartile Range

OHCA, Out-of-Hospital Cardiac Arrest

pVT, Pulseless Ventricular Tachycardia

ROSC, Return of Spontaneous Circulation

RR, Relative Risk

VF, Ventricular Fibrillation

VT, Ventricular Tachycardia

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