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Electrical cardiac treatments in pediatric emergency departments: implications for nursing practice

María Inés Gómez Camafreita[1*]

[1] *Hospital Teresa Herrera, Pediatric Emergency Department, A Coruña, Spain*

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*Corresponding author:
María Inés Gómez Camafreita
Email:
maria.ines.gomez.camafreita@sergas.es

Abstract

Cardiac rhythms requiring electrical treatment—defibrillation, cardioversion, and external pacing—are uncommon in pediatric emergency departments; however, managing them correctly is crucial to improving survival and clinical outcomes.
The effectiveness of electrical therapies depends on the patient's pathophysiological condition, the technical characteristics of the equipment used, and the competence and training of the healthcare professionals administering them.
Nursing staff directly influence all three of these factors, so their level of training contributes considerably to the success of the treatments provided.

TRATAMIENTOS CARDÍACOS ELÉCTRICOS EN URGENCIAS DE PEDIATRÍA. IMPLICACIONES PARA LA PRÁCTICA DE ENFERMERÍA

Resumen

Los ritmos cardíacos que requieren tratamiento eléctrico —desfibrilación, cardioversión y marcapasos externo— en urgencias pediátricas son poco frecuentes; no obstante, su abordaje correcto es crucial para mejorar la supervivencia y los resultados clínicos.
La eficacia de las terapias eléctricas depende de las condiciones fisiopatológicas del paciente, las características técnicas del equipamiento utilizado y el nivel de competencia y formación del personal sanitario implicado en su administración.
El personal de enfermería interviene directamente sobre los tres factores condicionantes por lo que su grado de capacitación contribuye considerablemente al éxito de los tratamientos aplicados.

INTRODUCTION

Electrical cardiac treatments involve applying an electrical current to the heart to correct rhythm disturbances and achieve effective myocardial contraction. Defibrillation, cardioversion, and external cardiac pacing (transcutaneous pacing) are three types of external electrical cardiac treatment used in pediatric emergency care.[1]

OBJECTIVE

To describe the available scientific evidence on the use of cardiac electrical therapies in pediatric emergency

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care, identifying the main factors determining their effectiveness and the implications for nursing practice.

METHODOLOGY

A literature review was conducted in October 2025 using the PubMed, Scopus, and CINAHL databases.

Search strategy

The search combined the terms *defibrillation*, *cardioversion*, *external pacemaker*, and *electric countershock* with the MeSH descriptors «*Pacemaker, Artificial*» and «*Electric Countershock*», and terms related to the pediatric population (*pediatrics*, *child*, *infant*, *adolescent*). Filters were applied for language (English and Spanish), publications from the last five years, and a population aged 0 to 18 years; only articles with free full-text access were included.

TABLE 1. Search strategy. Prepared by the author.

Database	Search strategy	Filters applied
PubMed	((((defibrillation[Title/Abstract]) OR (cardioversion[Title/Abstract])) OR (external pacemaker[Title/Abstract])) OR (("Pacemaker, Artificial"[Mesh]) OR ("Electric Countershock"[Mesh]))) AND ((((pediatrics[Title/Abstract]) OR (child[Title/Abstract])) OR (infant[Title/Abstract])) OR (adolescent[Title/Abstract]))	Spanish, English, all child, adolescent: 13–18 years, infant: 1–23 months, child, preschool: 2–5 years, infant, newborn: birth–1 month, all infant, child: 6–12 years, last 5 years
SCOPUS	TI (defibrillation OR cardioversion OR external pacemaker OR electric countershock) OR SU (defibrillation OR cardioversion OR external pacemaker OR electric countershock) OR AB (defibrillation OR cardioversion OR external pacemaker OR electric countershock) AND TX (pediatric or child or children or infant or adolescent)	Spanish, English, last 5 years, pediatric population (0–18 years)
CINAHL	TI (defibrillation OR cardioversion OR external pacemaker OR electric countershock) OR SU (defibrillation OR cardioversion OR external pacemaker OR electric countershock) OR AB (defibrillation OR cardioversion OR external pacemaker OR electric countershock) AND TX (pediatric or child or children or infant or adolescent)	Spanish, English, last 5 years, pediatric population (0–18 years)

PICO question

- **P (Population):** Pediatric patients treated in emergency departments.
- **I (Intervention):** Administration of electrical therapies (defibrillation, electrical cardioversion, and transcutaneous pacing).
- **C (Comparison):** Other treatments, absence of electrical intervention, or different application techniques/protocols.
- **O (Outcomes):** Return of spontaneous circulation (ROSC), survival, safety, efficacy, response times, procedural success.

Inclusion and exclusion criteria.

- **Inclusion criteria:** Original articles, systematic reviews, meta-analyses, case reports, and international consensus statements; published in the last 5 years (2020–2025); written in English or Spanish; addressing the pediatric population (ages 0–18 years); and with free full-text access.
- **Exclusion criteria:** Studies focused exclusively on the adult population; opinion articles or letters to the editor; studies that did not directly address the research question; and documents with restricted access or duplicated across the different databases.

Source selection.

Study selection was conducted in two phases: an initial review of titles and abstracts to identify potentially relevant articles, followed by a full-text review applying the previously defined inclusion and exclusion criteria. The literature review was conducted by a single reviewer.

Limitations

The review included only studies with free full-text access, a criterion adopted to ensure a comprehensive methodological assessment of the selected publications. However, this restriction may have affected the final selection of evidence by excluding potentially relevant studies with restricted access. In addition, the review was conducted by a single evaluator, which represents a potential source of bias in the selection and interpretation of the included studies.

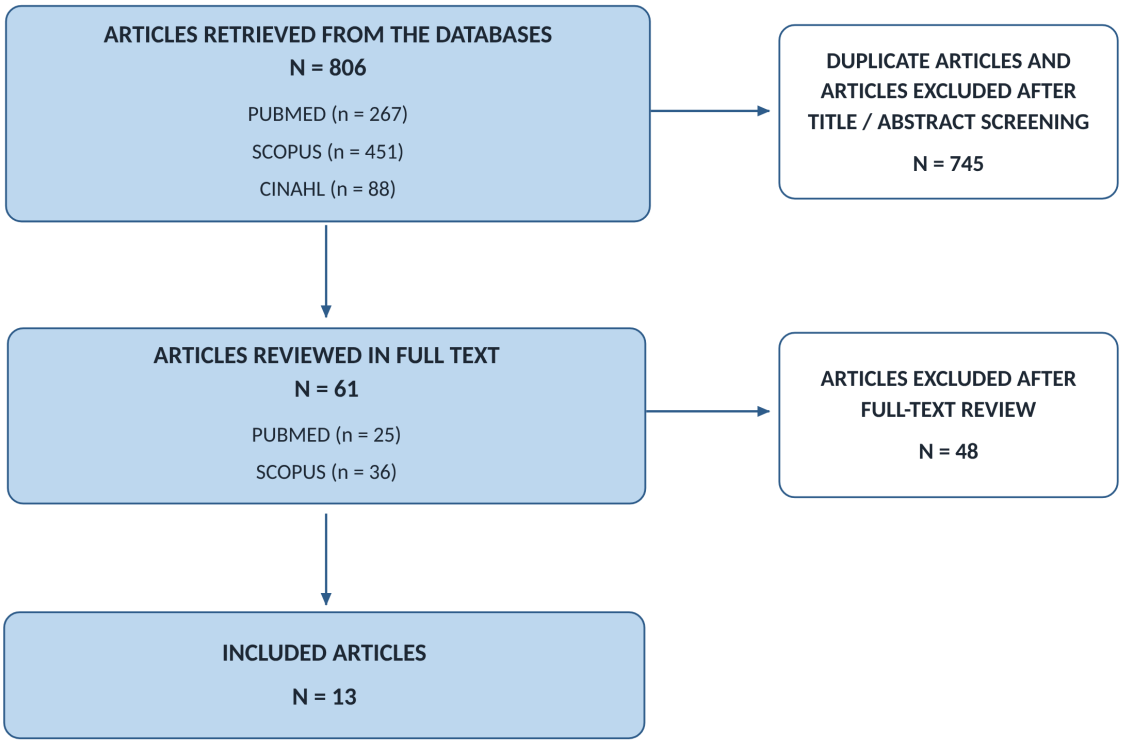


FIGURE 1. Source selection

RESULTS

A total of 806 articles were identified, distributed as follows: PubMed (n = 267), Scopus (n = 451), and CINAHL (n = 88). After duplicates were removed and articles were excluded following review of their titles and abstracts (n = 745), 61 documents were selected for full-text review. Ultimately, 13 articles were included. The final selection of articles was made through a sequential assessment of titles, abstracts, and full texts.

TABLE 2. Included articles.

Author(s)	Year	Title	Journal	Study type	Main topic
Berg KM, Bray JE, Ng KC, et al.	2023	2023 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations	Circulation	International consensus	Update of CPR and emergency cardiovascular care guidelines
Heyer Y, Baumgartner D, Baumgartner C.	2022	A Systematic Review of the Transthoracic Impedance during Cardiac Defibrillation	Sensors (Basel)	Systematic review	Transthoracic impedance during defibrillation
Hsu CH, Considine J, Pawar RD, et al.	2021	Cardiopulmonary resuscitation and defibrillation for cardiac arrest when patients are in the prone position: A systematic review	Resusc Plus	Systematic review	CPR and defibrillation in the prone position
Morgan RW, Kirschen MP, Kilbaugh TJ, et al.	2021	Pediatric In-Hospital Cardiac Arrest and Cardiopulmonary Resuscitation in the United States: A Review	JAMA Pediatr	Narrative review	Pediatric in-hospital cardiac arrest in the U.S.

Author(s)	Year	Title	Journal	Study type	Main topic
Raymond TT, Pandit SV, Griffis H, et al.	2021	Effect of Amplitude Spectral Area on Termination of Fibrillation and Outcomes in Pediatric Cardiac Arrest	J Am Heart Assoc	Observational study	Association between ECG characteristics and outcomes in pediatric cardiac arrest
Tejman-Yarden S, Katz U, Rubinstein M, et al.	2021	Inappropriate Shocks and Power Delivery Using Adult Automatic External Defibrillator Pads in a Pediatric Patient	Pediatr Emerg Care	Case report	Use of adult AED pads in a pediatric patient
Young ML, Exelbert EJ, Roth T, et al.	2020	External Cardioversion-Defibrillation with Pushing Down on the Chest Wall to Increase the Success Rate in Obese Patients	Am J Case Rep	Case report	Maneuver to improve defibrillation in obese patients
Acworth J, del Castillo J, Tiwari LK, et al.	2025	Energy doses for paediatric defibrillation in cardiac arrest: systematic review and meta-analysis	Resusc Plus	Systematic review and meta-analysis	Optimal energy doses for pediatric defibrillation
Anez C, Becerra-Bolaños Á, Vives-Lopez A, et al.	2021	Cardiopulmonary Resuscitation in the Prone Position in the Operating Room or in the Intensive Care Unit: A Systematic Review	Anesth Analg	Systematic review	CPR in the prone position in the operating room or ICU
Gray JM, Raymond TT, Atkins DL, et al.	2023	Inappropriate Shock Delivery Is Common During Pediatric In-Hospital Cardiac Arrest	Pediatr Crit Care Med	Multicenter observational study	Inappropriate shocks during pediatric in-hospital cardiac arrest
Haskell SE, Hoyme D, Zimmerman MB, et al.	2024	Association between survival and number of shocks for pulseless ventricular arrhythmias during pediatric in-hospital cardiac arrest in a national registry	Resuscitation	National registry analysis	Relationship between number of shocks and survival in pediatric cardiac arrest
Kafalı HC, Ergül Y.	2022	Common Supraventricular and Ventricular Arrhythmias in Children	Turk Arch Pediatr	Narrative review	Supraventricular and ventricular arrhythmias in the pediatric population
Ristagno G, Semeraro F, Raffay V, et al.	2025	Pad size, orientation, and placement for defibrillation during basic life support: A systematic review	Resusc Plus	Systematic review	Size and placement of defibrillation pads during basic CPR

DISCUSSION

This review shows that most of the available scientific literature focuses on treating shockable rhythms, particularly defibrillation strategies, with no studies identified that specifically evaluate electrical cardioversion or the use of external pacing in pediatric patients.

Although the incidence of ventricular fibrillation and pulseless ventricular tachycardia in the pediatric population is low, both rhythms are associated with high mortality[2]. In this context, it is estimated that approximately 10% of pediatric in-hospital cardiac arrests initially present with shockable rhythms, although these may develop secondarily during cardiopulmonary resuscitation.[3]

The scientific evidence available on pediatric defibrillation remains limited and heterogeneous. The included studies address aspects related to the procedure's efficacy, including the initial energy dose, dose-escalation strategies, factors associated with transthoracic impedance, and the potential predictive value of mean spectral amplitude AMSA (Amplitude Spectral Area) for defibrillation success, as well as relevant safety considerations regarding electrical therapy in this population. Some

studies also describe technical modifications applied in specific clinical settings; however, the limited availability of research and methodological heterogeneity make it difficult to draw consistent conclusions.

Initial dose and dose escalation.

Acworth et al.[4] note that there is no robust evidence to establish an optimal initial energy dose for defibrillation or to consistently link it to improved clinical outcomes. Doses < 1.5 J/kg or > 2.5 J/kg are not associated with significantly better or worse outcomes than doses of approximately 2 J/kg in pediatric cardiac arrest with shockable rhythms. This study did not investigate doses for subsequent shocks. On the other hand, Haskell et al.[5] found no clear benefit of escalating energy doses in terms of ROSC rates. Given the lack of robust scientific evidence, it is considered appropriate to maintain the recommendations currently in effect, as established in official guidelines[6]. Likewise, although studies of electrical cardioversion in pediatrics are scarce, the prevailing clinical consensus continues to recommend an initial dose of 1 J/kg, which may be increased to 2 J/kg if the first shock is ineffective.

Factors associated with transthoracic impedance.

Heyer et al.[7] describe 12 factors that influence transthoracic impedance, concluding that the most influential factors are the pressure applied, and the size and type of patient–defibrillator interface: adhesive electrodes (pads) or manual electrodes (paddles). Ristagno et al.[8], in turn, found no conclusive evidence that electrode size or position improves clinical outcomes. However, they note that changing the defibrillation vector from the anterolateral (AL) to the anteroposterior (AP) position could be beneficial in cases of refractory ventricular fibrillation. In this regard, the European Resuscitation Council (ERC) guidelines consider the anteroposterior position particularly useful in infants and small children (<25 kg) when technically feasible.

Predictive value of mean spectral amplitude (AMSA).

At present, the available evidence does not support the use of mean spectral amplitude (AMSA) as a predictor of the optimal time to deliver an electrical shock in the pediatric population.[9]

Safety of Electrical Therapy

Gray et al.[10] observed that approximately 30% of shocks during pediatric in-hospital cardiac arrests were delivered for non-shockable rhythms. Tejman et al.[11] reported a case of inappropriate shock associated with the use of an AED equipped with adult adhesive electrodes in a neonatal patient, highlighting the importance of optimizing detection algorithms and strengthening healthcare personnel training.

Additional methodological considerations

Young et al.[12] report that increased pressure on manual paddles could improve defibrillation efficacy in obese patients by reducing transthoracic impedance, although this requires methodological validation. Defibrillation in patients in the prone position could be a viable alternative when immediate supination is not feasible[13,14], based primarily on case series.

CONCLUSIONS

The available evidence shows that most studies focus on factors affecting the effectiveness of defibrillation in pediatric populations. However, there is a lack of research assessing whether these factors behave similarly in electrical cardioversion and external pacing in this patient group.

Discrepancies in certain technical aspects of electrical therapy in the pediatric population reinforce the need for strict adherence to evidence-based clinical practice guidelines developed through expert consensus. The high percentage of inappropriate shocks highlights the need for ongoing training and periodic updates for the professionals involved.

IMPLICATIONS FOR NURSING PRACTICE

The implications for nursing clinical practice derived from this review are structured around three fundamental areas: optimizing the patient's clinical condition, the technical and operational management of electrotherapy devices (defibrillators and external pacemakers), and procedural safety.

With regard to the **patient**, nursing care includes the systematic application of the ABCDE approach to identify and correct reversible causes, thereby optimizing hemodynamic stability and clinical prognosis. Proper preparation of the skin surface is also essential to ensure effective contact between the interface and the chest, as are monitoring and follow-up care aimed at preventing complications and ensuring the patient's stability.

Regarding the **technical management of electrotherapy devices** (defibrillators and external pacemakers), nursing professionals must be proficient in their operation, configuration, and maintenance. Adhesive electrodes are recommended over traditional handheld electrodes because of their greater safety profile and lower rate of electrical interference. Positioning this contact interface to accommodate the pediatric patient's body size and anatomical features is considered critical to ensuring therapeutic efficacy. In infants and pediatric patients weighing less than 25 kg, an anteroposterior placement of the interface is considered particularly useful whenever technically feasible, in accordance with the recommendations of the European Resuscitation Council (2025).

Nursing practice requires coordinated action with the care team, minimizing errors resulting from simultaneous handling of the device and ensuring strict adherence to

safety measures. During defibrillation, cardioversion, and external pacing, nursing staff participate in preparing and operating the device, verifying synchronization when indicated, assisting with the administration of sedoanalgesia according to protocol, monitoring the patient's clinical and electrical response during and after the procedure, and controlling the environment during energy delivery. In particular, when using transcutaneous pacing, they must clinically confirm mechanical capture (by palpating the pulse or assessing perfusion or blood pressure), without assuming that the therapy is effective based solely on the appearance of spikes on the monitoring display.

The level of nursing staff involvement may vary depending on institutional protocols, professional competencies, and the organizational framework of each center.

TABLE 3. Comparison of electrical cardiac therapies. Prepared by the author.

Electrical Therapy	Main indications	ECG synchronization	Energy dose / Output	Sedation and analgesia
Defibrillation	Ventricular fibrillation (VF) and pulseless ventricular tachycardia (pVT).	Asynchronous (immediate energy delivery).	Initial: 4 J/kg. For refractory VF/pVT (> 5 shocks): progressive escalation up to a maximum of 8 J/kg (without exceeding the adult dose).	Not applicable (patient in cardiopulmonary arrest).
Electrical Cardioversion	Supraventricular tachycardia (SVT) or VT with a pulse associated with hemodynamic instability.	Synchronous (shock coordinated with the R wave of the QRS complex).	Initial: 1 J/kg. If ineffective, increase to 2 J/kg.	Strongly recommended if the patient's hemodynamic stability permits.
Transcutaneous Pacing	Symptomatic bradycardia refractory to ventilation, oxygenation, and chronotropic drugs.	Demand or Fixed (depending on the presence of the patient's intrinsic rhythm).	Gradual adjustment of (mA) until effective electrical and mechanical capture is achieved (clinically confirmed by pulse, perfusion, and blood pressure).	Essential in conscious patients because of the pain caused by muscle stimulation.

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Conflict of interest

I declare that there is no commercial or financial conflict of interest related to this research.

Author Contributions

María Inés Gómez Camafreita: Drafting, reviewing, and editing

Use of AI

Adaptation of the text to scientific language and correction of the bibliography format.

Data availability

The data supporting the findings of this study are available from the corresponding author upon request.

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