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A comprehensive narrative review of traumatic cardiac arrest: Implications for Paramedics in emergency management and treatment strategies

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***Abstract*---Background:** Traumatic cardiac arrest (TCA) has historically been viewed as largely untreatable, with low survival rates and limited intervention strategies. Advances in understanding the pathophysiology of TCA, improvements in diagnostic and therapeutic technologies, and refinements in treatment protocols have shifted this perspective. This review focuses on the implications of these advancements for paramedics involved in emergency management and treatment strategies for TCA. **Aim:** To provide a comprehensive review of current insights into TCA management, with a particular emphasis on the roles of pharmacists and paramedics in improving patient outcomes through advanced emergency care. **Methods:** This narrative review synthesizes recent literature on TCA management, including epidemiology, etiology, treatment strategies, and outcomes. It highlights the contributions of pharmacists in medication management and paramedics in emergency response, using case studies and evidence-based practices. **Results:** Advances in diagnostic tools like point-of-care ultrasound (POCUS) and treatment protocols have improved outcomes for specific patient subgroups. The review identifies key challenges in TCA management, including distinguishing between true and pseudo-PEA and addressing reversible causes of arrest. Outcomes vary significantly, with survival rates and neurological recovery improving for certain subgroups. **Conclusion:** The review underscores the evolving role of pharmacists and paramedics in TCA management. Pharmacists contribute by ensuring safe and effective medication use, while paramedics play a critical role in rapid assessment and intervention. Continued advancements in TCA management and training are crucial for optimizing patient outcomes in this challenging condition.

***Keywords*---**Traumatic Cardiac Arrest, Pharmacists, Paramedics, Emergency Management, Point-of-Care Ultrasound, Reversible Causes, Survival Rates.

Introduction

In recent decades, the approach to managing traumatic cardiac arrest (TCA) has undergone a significant paradigm shift, transforming what was once considered a largely futile intervention into a more promising therapeutic strategy [1]. This evolution is attributed to several factors, including advancements in the understanding of TCA pathophysiology, the differentiation of TCA into specific subtypes [2], the refinement of treatment guidelines [3], and enhanced training [4] addressing this previously underemphasized condition [5]. Furthermore, technological progress in diagnostic tools (such as point-of-care ultrasound, POCUS) and therapeutic techniques [6] has revolutionized TCA management. Consequently, despite the persistently high overall mortality rate of TCA [7], outcomes for certain patient subgroups are showing improvement. This review will encapsulate the current insights into TCA, acknowledging the inherent limitations of a review format.

Epidemiology:

Recent demographic analyses of TCA, such as a Swedish study examining nearly 300 adult cases (with approximately two-thirds resulting from blunt trauma) at a Level I trauma center, reveal that TCA patients are typically young (~40 years old), predominantly male (~80%), and relatively healthy (~60%) prior to the event [1]. The age and pre-existing health status of these patients underscore both their recovery potential and the economic and societal impact of lost productive life years in cases deemed unsalvageable. However, the young age and prior health condition of these patients may facilitate their inclusion in organ donor programs even when survival is unlikely [8,9]. Epidemiological patterns vary globally; for instance, the prevalence of firearms in the United States influences TCA epidemiology differently compared to most European nations [10].

Etiology:

The etiology of TCA can be broadly categorized into potentially reversible and non-reversible causes, such as extensive, irreparable damage to vital organs. Determining this at the time of patient arrival at the trauma center is often challenging; thus, therapeutic interventions are frequently initiated even in cases with retrospectively non-reversible causes of TCA. The discontinuation of TCA treatment in such scenarios should be viewed not as a failure of the trauma team, but as an ethically sound decision to conserve resources in a situation where continued medical efforts would be futile. The treatment of TCA primarily aims to address potentially reversible causes expeditiously. However, no universally accepted protocol exists for this process. One mnemonic device used to remember these causes is the acronym H.O.T.T., endorsed by the European Resuscitation Council (ERC), which stands for:

- **Hypovolemia (H)**: Almost exclusively caused by hemorrhage, it is the most common reversible cause of TCA.
- **Oxygenation impairment (O)**: Requires ensuring a patent airway and optimizing oxygen delivery.
- **Tension pneumothorax (T)**: Can occur in spontaneously breathing patients or develop rapidly following endotracheal intubation and mechanical ventilation.
- **Pericardial tamponade (T)**: Can result from either blunt or penetrating chest trauma.

Addressing each element of the H.O.T.T. acronym swiftly is crucial in contemporary TCA management. The H.O.T.T. mnemonic is a trauma-specific subset of the ALS mnemonic ‘4xH and 4xT,’ which covers common reversible causes of cardiac arrest: 4xH includes hypovolemia, hypoxemia, hyper/hypokalemia, and hypothermia; 4xT includes thrombosis, toxins, tamponade, and tension pneumothorax. The individual causes within the H.O.T.T. framework can occur simultaneously and exacerbate one another. The prevalence distribution for these H.O.T.T. etiologies is hypovolemia 48%, impaired oxygenation 13%, tension pneumothorax 13%, and pericardial tamponade 10% [11].

Outcomes:

The traditional view of the futility of resuscitating traumatic cardiac arrest (TCA) has evolved over recent decades, shifting towards a more optimistic outlook on outcomes, especially for certain patient subgroups. However, evaluating TCA outcomes remains challenging due to variations in study populations, including those encompassing all TCA patients, only initially resuscitated cases, or those transported to hospitals or ICUs [12]. These differences in inclusion criteria contribute to significant variability in survival rates, ranging from approximately 4% to 40% [12]. For instance, a study conducted in the United Kingdom reports an overall 30-day survival rate of 7.5% among 705 TCA patients, with a notably higher survival rate of 11.5% in cases where resuscitation was successful during the prehospital phase [13]. In military contexts, survival data vary widely, from 0% (with no survivors out of 149 cases in the Israeli armed forces until hospital admission) [14] to more optimistic figures of 11% survival out of 424 cases [15]. Notably, when return of spontaneous circulation (ROSC) is achieved promptly, neurological outcomes tend to be more favorable compared to other causes of cardiac arrest [16,17]. Immediate resuscitation efforts in TCA focus on addressing potentially reversible causes, which take precedence over routine chest compressions or early administration of adrenaline. Success in TCA resuscitation is highly time-sensitive and depends on an effective chain of survival, including advanced pre-hospital care and specialized trauma center treatment.

For pediatric cases of TCA, survival rates are comparable, indicating that resuscitation is not necessarily futile in children [16]. However, survival does not always equate to favorable neurological outcomes, despite the greater neuroplasticity observed in children's brains. Predicting individual prognosis after TCA is complex, but certain factors are commonly associated with improved outcomes [12]. Beneficial demographic factors include younger age and female sex. In terms of injury mechanisms and physiology, better outcomes are linked to extremity injuries, lower injury severity scores, shockable ECG rhythms, and reactive pupils. Favorable treatment and logistics factors include witnessed TCA, bystander CPR, short transport times, and effective interventions such as airway management [12]. A comprehensive review of prognostic factors for TCA survival, encompassing nearly 40,000 cases from 53 studies, highlighted some traditionally associated outcome factors as unproven (e.g., differences between blunt and penetrating trauma). Nevertheless, two key factors associated with improved outcomes were the presence of a shockable cardiac rhythm (e.g., ventricular tachycardia) and cardiac motion observed on ultrasound. In contrast, asystole, characterized by a non-shockable rhythm with no cardiac motion, has the poorest prognosis, similar to cardiac arrest due to medical causes. Additionally, pulseless electrical activity (PEA) without cardiac motion on point-of-care ultrasound (POCUS) also indicates an extremely poor prognosis [18].

Diagnostic Dilemma of PEA versus Pseudo-PEA:

Initial diagnosis of TCA is typically made clinically by assessing unconsciousness, the absence of spontaneous respiration, and the absence of central pulses in a patient with evident or suspected trauma [3]. However, distinguishing between TCA with complete cessation of blood flow and a traumatic peri-arrest state can be challenging, both prehospital and upon arrival at the trauma bay. For instance, PEA, confirmed by the absence of a palpable central pulse, may still indicate some blood flow, as verified by POCUS, and is thus termed 'pseudo-PEA'. Pseudo-PEA refers to severe hypotension with blood pressure below the subjective and often unreliable threshold of manual pulse detection [19]. Unlike asystole and 'true' PEA, patients with pseudo-PEA may have a better prognosis, particularly if the underlying cause, such as severe hypovolemia, is rapidly addressed. Conversely, inappropriate treatment of pseudo-PEA as if it were true PEA, such as administering chest compressions or 1 mg adrenaline injections to a patient with pseudo-PEA caused by treatable hypovolemia, can be detrimental [20].

Systematic reviews of POCUS findings and TCA outcomes indicate that no patients survived to hospital discharge without cardiac motion, whereas 7% survival to discharge was observed with POCUS-confirmed cardiac motion [21]. Despite these findings, authors caution against altering TCA guidelines based on these results alone due to the small sample sizes. Some researchers suggest that the extremely poor prognosis associated with PEA without cardiac motion on POCUS, similar to asystole, may justify early termination of resuscitation efforts after addressing potentially reversible causes. The role of POCUS in TCA management is still evolving. While POCUS has demonstrated value in other contexts, its application in TCA requires careful consideration due to potential pitfalls [22]. POCUS should be performed only when the results are expected to alter treatment decisions, prioritizing 'need to know' information (e.g., cardiac tamponade) over 'nice to know' details (e.g., exact location of a liver laceration) [23,24,25]. Regarding the distinction between PEA and pseudo-PEA, literature definitions of "electrical activity" vary. While some sources refer to any form of organized electrical activity, others specify a minimum ECG frequency of >20 bpm.

Therapy:

While the traditional ABCD system (Airway, Breathing, Circulation, Disability) is not specifically designed for traumatic cardiac arrest (TCA) management, trauma team members often adopt this framework, as seen in Advanced Trauma Life Support (ATLS) or Emergency Trauma Care (ETC) courses. In TCA, the ABCD components can be reconfigured to address the H.O.T.T. entities—hypovolemia (C), oxygenation impairment (A/B), tension pneumothorax (B/C), and cardiac tamponade (C). Ideally, these reversible causes should be addressed simultaneously, provided resources and personnel permit.

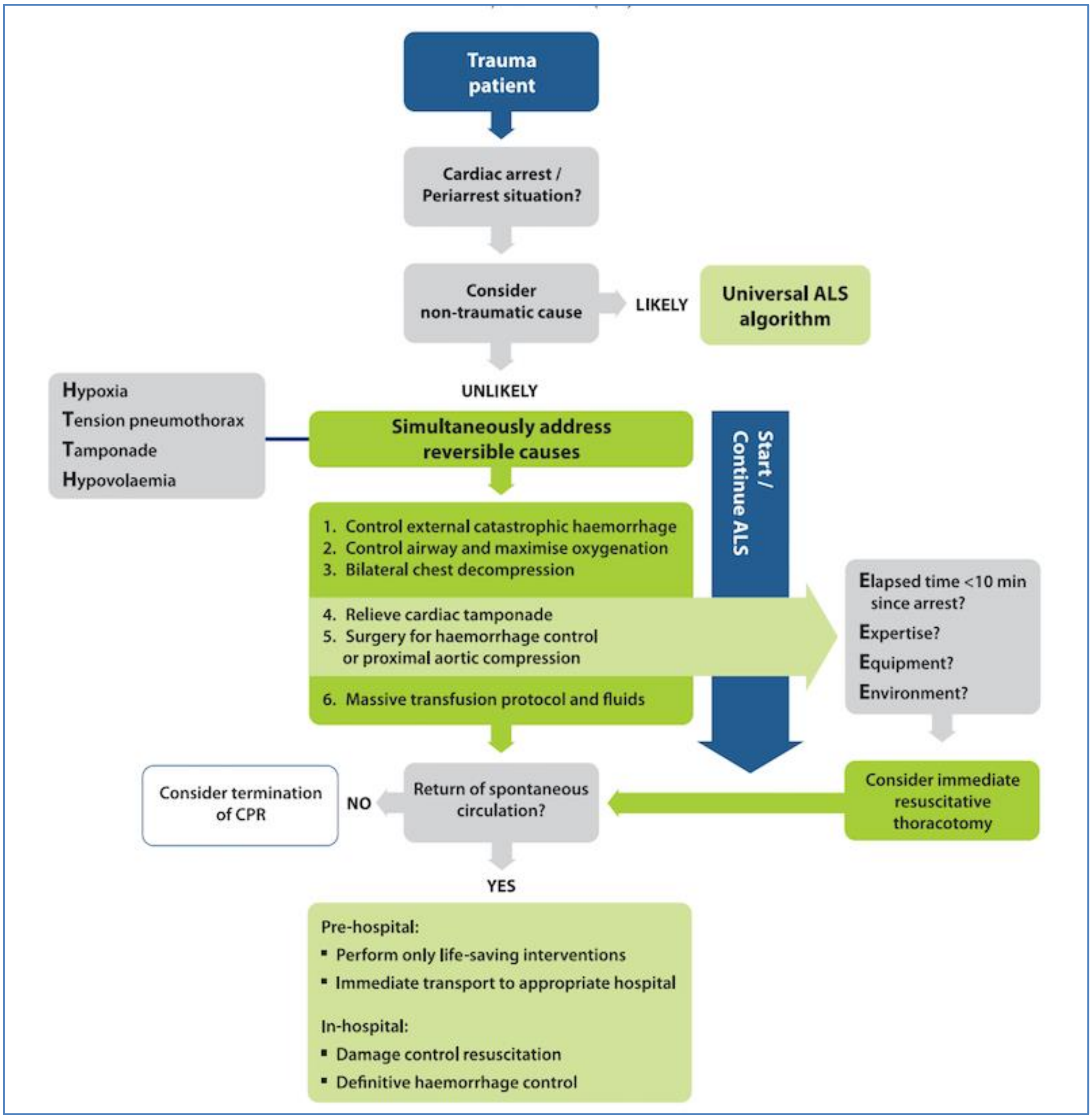

Figure 1: new guidelines of traumatic cardiac arrest

Airway Challenges:

In TCA, airway issues are often functional, such as obstruction by the tongue, soft palate, or epiglottis in unconscious or arrested patients. Other causes of airway obstruction include gastric regurgitation, blood, or foreign materials [26]. Anatomical airway problems, such as severe maxillofacial injuries or trauma to the airway, are less common but can be critical. In some cases, these anatomical issues may be the primary cause of TCA, particularly with significant trauma to the anterior neck. Functional airway problems can typically be managed with standard maneuvers (e.g., jaw thrust) and simple tools (e.g., oropharyngeal airway, suction devices). In contrast, anatomical airway problems may require specialized support and equipment, such as an anesthesiologist or surgical airway sets [27,28]. In the initial TCA treatment phase, ensuring an open airway for reoxygenation is crucial, but establishing a secured airway (e.g., with a cuffed endotracheal tube) should not take precedence over more immediate interventions. Delaying or deferring time-intensive airway-securing maneuvers, such as endotracheal intubation, can save critical resources and reduce cardiovascular effects in hypovolemic patients. This approach aligns with the 'resuscitation before intubation' principle, which has shown that early endotracheal intubation can adversely affect hemodynamics and outcomes in critically injured patients [29]. Intubation in trauma cases is often complicated by anatomical and functional factors, and non-patient-related issues, such as crew resource management (CRM), can also impact success rates [30].

Breathing Challenges:

Reversible causes of TCA include tension pneumothorax [5,31] and, less commonly, massive hemothorax. Other potential causes are traumatic diaphragmatic rupture leading to entero-thorax, multiple rib fractures (flail chest), or blood aspiration. These conditions can impair breathing and oxygenation, making the administration of 100% high-flow oxygen to all TCA patients advisable, given the limitations of initial SpO_2 and blood gas measurements. Positive pressure ventilation may exacerbate hypotension and hypoperfusion by impeding venous return, especially in hypovolemic patients. To optimize cardiac preload, use low tidal volumes, minimal positive end-expiratory pressure (PEEP), and slow respiratory rates. Continuous waveform capnography should monitor ventilation and guide adjustments to achieve target end-tidal CO_2 levels after ROSC.

Tension Pneumothorax:

Tension pneumothorax occurs in approximately 13% of TCA cases. Immediate chest decompression is warranted if suspected. Some protocols suggest routine bilateral chest decompression if no other immediate treatment priorities exist. Scalpel-based thoracostomies or mini-thoracotomies, often finger-assisted ('finger thoracostomy'), are generally considered more effective and faster than needle thoracocentesis [32]. These procedures are performed in the 4th or 5th intercostal space (ICS), just anterior to the mid-axillary line, and can be extended to a resuscitative thoracotomy if necessary. This approach involves making a thoracostomy incision, followed by a clamshell thoracotomy to access the intrathoracic structures for hemorrhage control, pericardial evacuation, and internal cardiac compressions. This procedure also allows for aortic compression or cross-clamping to redistribute cardiac output and limit distal hemorrhage [33].

Needle decompressions, while less effective, are still appropriate if scalpel or expertise is unavailable and may be suitable for children. Preferred needle locations are the 2nd ICS in the mid-clavicular line for children and the 4th or 5th ICS anterior to the mid-axillary line for adults. Studies suggest that 45 mm needles are often too short, with longer needles (e.g., 70 mm) being preferable

[34]. Needle decompression, however, carries risks such as cardiac injury and tamponade [37] and must be performed with adequate training. Additionally, because tension pneumothoraxes are often associated with hemothorax, needle-based techniques are prone to clotting and obstruction and should be frequently rechecked. TCA patients may present with tension pneumothorax, or it may develop during resuscitation, shifting treatment priorities. For instance, mechanical ventilation might initially seem appropriate for a hypoxic patient, but it could convert an undetected pneumothorax into a life-threatening tension pneumothorax, thus necessitating immediate chest decompression as the new priority.

‘Circulation’ Challenges
Hypovolemia Causing TCA:

Hypovolemia, particularly due to exsanguination, is the most common reversible cause of traumatic cardiac arrest (TCA), occurring in approximately 50% of cases. Given the high probability of hypovolemia, it is prudent to assume it as a cause or contributor until proven otherwise. Rapid and aggressive fluid infusion, including blood product transfusion, may temporarily reverse TCA; however, addressing the source of hemorrhage remains crucial. Hemorrhage may be external or internal, with internal sources including body cavities (thorax, abdomen, pelvis) and fractured major bones. Treatment options include pelvic binder placement and invasive techniques such as Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) or resuscitative thoracotomy with aortic cross-clamping. The role and efficacy of certain interventions, such as emergency department REBOA and resuscitative thoracotomy, remain debated. Blood pressure management in the peri-arrest setting is complex, with the 'damage control resuscitation' approach—including permissive hypotension, resuscitative coagulation management, and damage control interventions—being considered. However, higher blood pressures may be required for patients with traumatic brain injury, emphasizing the need for individualized management based on patient and trauma characteristics [39-40].

Cardiac Rhythms in TCA:

Asystole (~40%) and Pulseless Electrical Activity (PEA) (~25%) are the predominant ECG rhythms in TCA, while shockable rhythms such as Ventricular Fibrillation (VF) are rare (~7%) but associated with better outcomes. Despite the traditional emphasis on continuous, high-quality chest compressions in medical cardiac arrest, shockable rhythms in TCA should also be addressed promptly with defibrillation. A meta-analysis suggests that shockable rhythms occur in about 6.8% of TCA cases. Recognizing that a shockable rhythm might indicate a medical rather than traumatic cause of arrest is crucial, and such cases should be treated accordingly [41].

Chest Compression in TCA:

The effectiveness of chest compressions in TCA is controversial. Both manual and device-assisted chest compressions may be less effective in hypovolemic patients. The 'Don’t pump an empty heart' directive, supported by large animal studies, suggests that chest compressions may be ineffective or even harmful in hypovolemic low-flow states. Similarly, obstructive causes of TCA, such as tension pneumothorax and cardiac tamponade, may also reduce the effectiveness of chest compressions. Thus, prioritizing immediate treatment of reversible causes over chest compressions is advocated. However, high-quality chest compressions should still be performed in cases of potential medical or cardiac causes of arrest, or in traumatic cases not related to hypovolemia or obstruction [41].

Cardiac Injuries Causing TCA:

Cardiac injuries, both penetrating and blunt, can cause TCA with potentially reversible mechanisms. Simple cardiac injuries, such as a stab wound causing pericardial tamponade, may achieve Return of Spontaneous Circulation (ROSC) with rapid pericardial decompression alone or combined with temporary cardiac massage. Cardiac tamponade accounts for approximately 10% of cardiac arrests in trauma. Immediate resuscitative thoracotomy (e.g., clamshell incision) can be lifesaving, particularly for traumatic cardiac arrest with penetrating chest or epigastric trauma. Survival rates from emergency thoracotomies vary, with higher survival in cases of stab wounds compared to gunshot wounds. For patients with cardiac tamponade and a pulse, rapid transfer to the operating theater may be suitable. However, if in arrest, immediate thoracotomy in the emergency department is recommended. Traditional percutaneous needle-based tamponade kits have downsides and should be avoided if thoracotomy is an option [41]..

Cardiac Contusion:

Cardiac contusion from high-energy thoracic impact can lead to TCA. Examples include injuries from sports or traffic accidents. Resuscitation follows Advanced Cardiovascular Life Support (ACLS) guidelines, focusing on high-quality CPR and early defibrillation if needed. Cardiac contusion may also accompany other thoracic injuries, such as blunt aortic injury, complicating resuscitation.

Cardiac Electrotrauma-Induced Arrest:

Electric current injuries can cause TCA through arrhythmias, even without structural cardiac damage. Standard ALS algorithms apply for resuscitation of electro-induced arrhythmias such as VF.

'Disability' Challenges:

Loss of cerebral function in TCA can stem from direct cerebral trauma or secondary to processes like cerebral hypoperfusion. Resuscitation of TCA complicated by traumatic brain injury (TBI) has historically been considered futile; however, recent studies show potential for survival and favorable outcomes. Patients with 'impact brain apnea' may have good outcomes if treated promptly, although diffuse axonal injury or brain edema may be present. Spinal injuries affecting cranial spinal segments can cause respiratory arrest and TCA, where treatment of reversible causes takes precedence over cervical spine protection. Severe impairment of the nervous system from electro injuries can also lead to TCA. The management of TCA requires specialized skills and may benefit from

Point-of-Care Ultrasound (POCUS) for diagnosing and reevaluating therapeutic interventions. Systematic application of POCUS, using protocols like modified FATE, RUSH, or eFAST, can help detect major reversible causes of TCA and guide appropriate interventions [41].

Role of Pharmacists in Emergency Departments:

Pharmacists play a critical role in the healthcare system, bridging the gap between medicine and patient care. Their primary responsibilities include the accurate dispensing of medications, providing medication therapy management, and offering expert advice on the use of pharmaceuticals. Pharmacists ensure that medications are used safely and effectively by reviewing prescriptions for potential drug interactions, contraindications, and dosage errors. They are also instrumental in patient education, helping individuals understand their medication regimens, potential side effects, and the importance of adherence. Beyond these traditional roles, pharmacists are increasingly involved in clinical settings, where they collaborate with other healthcare professionals to optimize patient outcomes through medication therapy management and chronic disease management programs. Their expertise is crucial in various healthcare settings, including hospitals, community pharmacies, and long-term care facilities, where they contribute to improving patient safety, enhancing therapeutic outcomes, and reducing healthcare costs.

Role of Paramedics in Emergency Departments:

Paramedics are frontline healthcare professionals trained to provide emergency medical care in prehospital settings. Their role encompasses the rapid assessment, stabilization, and treatment of patients experiencing acute medical emergencies or trauma. Paramedics are skilled in performing advanced life support procedures, such as endotracheal intubation, intravenous drug administration, and cardiopulmonary resuscitation. They work in high-pressure environments where quick decision-making and clinical judgment are essential. In addition to their clinical responsibilities, paramedics play a crucial role in patient transport, ensuring that individuals receive timely and appropriate care during transit to healthcare facilities. They also collaborate with other emergency services, including police and fire departments, to manage complex emergency situations effectively. Paramedics are vital in emergency response teams, disaster management, and public health initiatives, where their ability to provide immediate and high-quality care significantly impacts patient outcomes and overall community health.

Conclusion

Traumatic cardiac arrest (TCA) has transitioned from being considered a largely futile condition to one with potential for improved outcomes, thanks to advancements in medical science and emergency protocols. This comprehensive review illustrates how contemporary practices in managing TCA have evolved, highlighting the roles of both pharmacists and paramedics in enhancing patient care during these critical situations. Pharmacists play an indispensable role in the healthcare continuum by ensuring the safe and effective use of medications.

Their expertise is crucial in reviewing prescriptions for potential interactions and contraindications, providing patient education, and optimizing medication therapy management. In the context of TCA, pharmacists contribute significantly by supporting the clinical decision-making process with accurate drug information and ensuring that medications are administered correctly, which is vital given the complex nature of TCA cases. Paramedics, as frontline responders, are integral to the emergency management of TCA. They are trained to quickly assess and stabilize patients, perform advanced life support procedures, and manage critical interventions such as endotracheal intubation and intravenous drug administration. Their role in prehospital care is crucial for initiating timely treatment, which can significantly influence patient outcomes. The ability of paramedics to perform rapid and accurate assessments, coupled with their skills in advanced life support, positions them as key players in improving survival rates and overall patient outcomes in traumatic cardiac arrest. The review also highlights that despite the advancements, challenges remain in TCA management, such as differentiating between true and pseudo-PEA and addressing the various reversible causes of cardiac arrest. Continuous improvements in diagnostic tools like point-of-care ultrasound (POCUS) and treatment strategies are essential for further enhancing patient outcomes. In conclusion, the roles of pharmacists and paramedics are central to the effective management of TCA. Their combined expertise in medication management and emergency care is crucial for addressing the complexities of this condition. Ongoing research and development in TCA management, alongside enhanced training for healthcare professionals, will be vital in optimizing care and improving outcomes for patients experiencing traumatic cardiac arrest.

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مراجعة سردية شاملة لتوقف القلب الناتج عن الصدمات: التأثيرات على مسعفي الطوارئ في إدارة الطوارئ واستراتيجيات العلاج

الملخص:

الخلفية :تم النظر تاريخياً إلى توقف القلب الناتج عن الصدمات (TCA) على أنه غير قابل للعلاج إلى حد كبير، مع معدلات بقاء منخفضة واستراتيجيات تدخل محدودة. وقد حولت التقدمات في فهم الفيزيولوجيا المرضية لتوقف القلب الناتج عن الصدمات، والتحسينات في التقنيات التشخيصية والعلاجية، وتنقيحات البروتوكولات العلاجية هذه النظرة. تركز هذه المراجعة على تأثيرات هذه التقدمات على الصيادلة والمسعفين المشاركين في إدارة الطوارئ واستراتيجيات العلاج لتوقف القلب الناتج عن الصدمات.

الهدف :تقديم مراجعة شاملة للرؤى الحالية في إدارة توقف القلب الناتج عن الصدمات، مع التركيز بشكل خاص على أدوار الصيادلة والمسعفين في تحسين نتائج المرضى من خلال الرعاية الطارئة المتقدمة.

الطرق :تقوم هذه المراجعة السردية بتجميع الأدبيات الحديثة حول إدارة توقف القلب الناتج عن الصدمات، بما في ذلك علم الأوبئة، والأسباب، واستراتيجيات العلاج، والنتائج. تبرز المراجعة مساهمات الصيادلة في إدارة الأدوية والمسعفين في استجابة الطوارئ، باستخدام دراسات الحالة والممارسات المستندة إلى الأدلة.

النتائج :أدت التقدمات في الأدوات التشخيصية مثل الموجات فوق الصوتية في موقع الرعاية (POCUS) وبروتوكولات العلاج إلى تحسين النتائج لمجموعات المرضى المحددة. تحدد المراجعة التحديات الرئيسية في إدارة توقف القلب الناتج عن الصدمات، بما في ذلك التمييز بين PEA الحقيقي والزائف ومعالجة الأسباب القابلة للعلاج للتوقف. تتفاوت النتائج بشكل كبير، حيث تتحسن معدلات البقاء والتعافي العصبي لبعض المجموعات الفرعية.

الخلاصة :تبرز المراجعة الدور المتطور للصيادلة والمسعفين في إدارة توقف القلب الناتج عن الصدمات. يساهم الصيادلة من خلال ضمان استخدام الأدوية بشكل آمن وفعال، بينما يلعب المسعفون دوراً حاسماً في التقييم السريع والتدخل. تستمر التقدمات في إدارة توقف القلب الناتج عن الصدمات والتدريب في كونها ضرورية لتحسين نتائج المرضى في هذه الحالة الصعبة.

الكلمات المفتاحية :توقف القلب الناتج عن الصدمات، الصيادلة، المسعفون، إدارة الطوارئ، الموجات فوق الصوتية في موقع الرعاية، الأسباب القابلة للعلاج، معدلات البقاء.