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Reducing Epilepsy-Related Mortality: A Review Of Paramedics' Life-Saving Role In Pre-Hospital Settings

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Abstract

Epilepsy remains one of the most prevalent neurological disorders worldwide, affecting over 50 million people and contributing significantly to premature mortality. A substantial proportion of epilepsy-related deaths are preventable, particularly those resulting from status epilepticus, seizure-related accidents, and sudden unexpected death in epilepsy (SUDEP). Paramedics, as the first point of contact in pre-hospital care, play a decisive role in mitigating these risks through timely interventions. Their responsibilities include rapid recognition of seizure activity, airway and breathing management, prevention of hypoxia and aspiration, administration of emergency medications, and safe transport to specialized care facilities. Evidence indicates that paramedic-led interventions significantly improve survival outcomes by reducing seizure duration, preventing complications, and lowering the likelihood of fatal events. Despite these advances, several barriers—such as limited epilepsy-specific training, lack of standardized protocols, and delayed emergency response times—continue to hinder optimal care delivery. This review synthesizes existing literature to explore the life-saving role of paramedics in reducing epilepsy-related mortality, identifies challenges in pre-hospital management, and proposes strategies to enhance their impact. Strengthening paramedic competencies and integrating innovative support systems can contribute to a substantial reduction in epilepsy-related deaths, ultimately improving patient safety and public health outcomes.

Keywords: Epilepsy, SUDEP, Paramedics, Pre-hospital care, Seizure management, Emergency medical services, Mortality reduction.

1. Introduction

Epilepsy is one of the most common chronic neurological disorders, affecting an estimated 50 million people worldwide (World Health Organization [WHO], 2019). It is characterized by recurrent unprovoked seizures that result from abnormal electrical discharges in the brain. While many individuals with epilepsy achieve seizure control through antiepileptic drugs (AEDs), a significant proportion continue to experience breakthrough seizures and associated complications. These complications can lead to substantial morbidity and mortality, with epilepsy contributing to over 125,000 deaths annually across the globe (Devinsky et al., 2018). Importantly, a considerable fraction of these deaths are preventable, particularly those related to seizure-induced respiratory failure, aspiration, trauma, and sudden unexpected death in epilepsy (SUDEP).

The pre-hospital phase of epilepsy emergencies is critical. Most seizure-related deaths occur outside hospital settings, often before patients receive specialized care (Shankar et al., 2017). Timely and effective intervention at this stage can reduce mortality risks considerably. Paramedics, as frontline emergency medical providers, are uniquely positioned to respond promptly to seizures and associated

complications. Their responsibilities extend beyond basic seizure recognition to include airway management, prevention of hypoxia, administration of rescue medications such as benzodiazepines, monitoring of vital signs, and safe transportation to hospitals for further management (Fisher et al., 2021). By stabilizing patients and preventing secondary complications, paramedics can directly reduce mortality associated with epilepsy.

Sudden unexpected death in epilepsy (SUDEP) represents one of the most serious epilepsy-related risks. SUDEP accounts for approximately 17% of all epilepsy deaths and is estimated to affect 1 in 1,000 adults with epilepsy annually (Devinsky et al., 2016). Although the precise mechanisms remain under investigation, cardiorespiratory dysfunction, seizure-induced hypoxia, and delayed resuscitative efforts are thought to play significant roles (Surges et al., 2021). Paramedics, through early recognition of respiratory compromise and the provision of cardiopulmonary resuscitation (CPR), may help mitigate some of these risks. Early interventions in seizure emergencies not only preserve life but may also prevent long-term neurological damage.

Globally, guidelines for the management of epilepsy emergencies underscore the importance of rapid intervention. The International League Against Epilepsy (ILAE) emphasizes the need for urgent treatment of prolonged seizures and status epilepticus, as delays are strongly associated with increased mortality (Trinka et al., 2015). However, disparities in pre-hospital care remain evident. In many regions, paramedics lack specialized training in epilepsy, and standardized protocols for seizure emergencies are underdeveloped or inconsistently applied (Beghi et al., 2019). These limitations contribute to avoidable delays and suboptimal outcomes.

The role of paramedics is not limited to direct patient care. They also act as crucial links within the broader healthcare system. Effective communication between paramedics, emergency departments, and neurology specialists ensures continuity of care and reduces the likelihood of recurrent emergencies. Moreover, paramedics often provide education to families and caregivers regarding seizure first aid, thereby enhancing community preparedness and potentially preventing deaths before medical help arrives (Alving et al., 2020).

Despite the recognized importance of paramedics in epilepsy care, there remain significant barriers that hinder their optimal contribution to reducing mortality. These include limited access to rescue medications in ambulances, insufficient awareness of SUDEP risks, geographic challenges in response times, and psychological stressors that may affect decision-making in emergencies (Holmes et al., 2018). Addressing these barriers through targeted training, protocol development, and integration of advanced technologies such as telemedicine could substantially improve outcomes.

This review aims to synthesize the available evidence on the role of paramedics in reducing epilepsy-related mortality. It explores their responsibilities in seizure recognition, emergency interventions, and SUDEP prevention, while highlighting clinical outcomes and barriers to effective practice. Furthermore, it proposes strategies to strengthen paramedics' roles in pre-hospital epilepsy care, with the overarching goal of improving survival rates and enhancing patient safety. Given the high global burden of epilepsy and the preventable nature of many seizure-related deaths, reinforcing the life-saving role of paramedics represents a crucial step toward reducing epilepsy-associated mortality and advancing public health.

2. Paramedics' Role in Epilepsy Emergencies

Epilepsy emergencies are unpredictable, often occurring outside of controlled environments such as hospitals or clinics. In many cases, family members, bystanders, or caregivers are the first to witness a seizure episode and call emergency medical services (EMS). This makes paramedics the initial point of professional intervention, positioning them as critical agents in reducing the risks of morbidity and mortality associated with epilepsy. Their role encompasses rapid recognition, immediate stabilization, and timely transfer of patients to definitive care facilities. Each of these components is vital in reducing preventable deaths, including those caused by status epilepticus, seizure-induced respiratory failure, and sudden unexpected death in epilepsy (SUDEP).

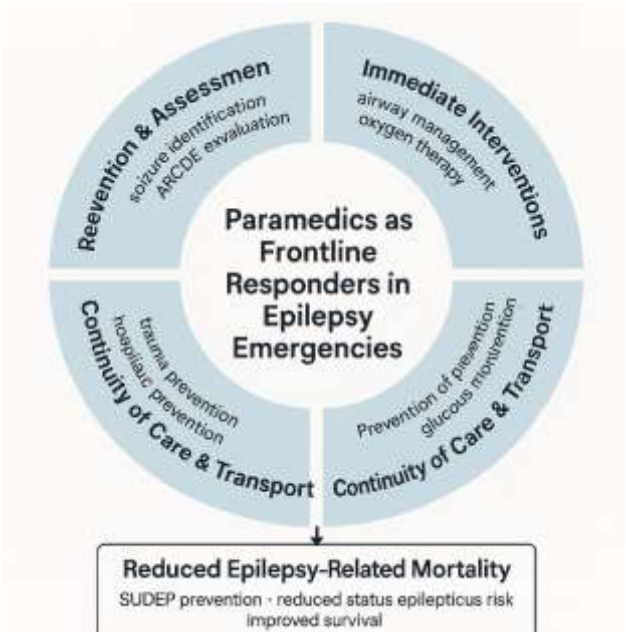

Figure 1. Conceptual Framework of Paramedics' Role in Reducing Epilepsy-Related Mortality

The ability of paramedics to recognize seizure activity quickly and accurately is a fundamental aspect of pre-hospital epilepsy care. Generalized tonic-clonic seizures are usually identifiable through visible convulsions and loss of consciousness, but other seizure types—such as focal seizures with impaired awareness or absence seizures—may be more subtle (Fisher et al., 2021). Paramedics are trained to differentiate seizures from other conditions with similar presentations, including syncope, hypoglycemia, and cardiac arrhythmias. Accurate assessment ensures the initiation of appropriate interventions and prevents unnecessary delays in care.

A structured approach, often guided by the ABCDE (Airway, Breathing, Circulation, Disability, Exposure) framework, is typically employed to assess the patient's immediate risks. Paramedics also gather critical background information, such as the patient's medical history, duration and type of seizure, current medications, and whether the episode represents a first seizure or a known diagnosis of epilepsy (Shankar et al., 2017). This information is crucial for guiding treatment decisions and informing hospital teams upon patient transfer.

One of the most immediate threats during a seizure is compromised airway patency and breathing difficulty. Seizures can lead to tongue biting, aspiration of saliva or vomit, and hypoxia due to prolonged apnea or impaired ventilation (Surges et al., 2021). Paramedics are trained to ensure airway protection through simple maneuvers such as head tilt, jaw thrust, or suctioning. In more severe cases, advanced airway interventions such as placement of oropharyngeal or nasopharyngeal airways may be required. Oxygen supplementation is often administered to prevent hypoxemia, which is a key risk factor for SUDEP (Devinsky et al., 2016).

Another critical responsibility of paramedics in epilepsy emergencies is the administration of rescue medications. Benzodiazepines such as midazolam, lorazepam, or diazepam are the drugs of choice for terminating ongoing seizures, particularly status epilepticus (Trinka et al., 2015). Evidence shows that early administration of benzodiazepines in pre-hospital settings significantly reduces seizure duration and the risk of progression to refractory status epilepticus, a condition strongly associated with increased mortality (Alroughani et al., 2018).

Some EMS systems allow paramedics to administer intranasal or buccal midazolam, which provides a rapid and non-invasive route for medication delivery, especially when intravenous access is difficult to obtain in convulsing patients (McIntyre et al., 2018). This rapid intervention can be life-saving and is considered a standard of care in many countries.

Beyond seizure termination, paramedics play an important role in preventing secondary injuries and complications. During convulsive episodes, patients are at risk of trauma from falls, burns, or accidents. Paramedics often secure the environment, remove harmful objects, and position the patient safely to minimize injury. They also monitor blood glucose levels, as hypoglycemia can mimic or exacerbate seizures, ensuring that metabolic causes are promptly addressed (Holmes et al., 2018).

Following stabilization, rapid and safe transport to a healthcare facility is essential. Paramedics determine the urgency of transport based on factors such as seizure duration, patient consciousness, cardiorespiratory status, and presence of comorbidities. Patients with prolonged seizures, repeated episodes without recovery, or suspected head injuries are prioritized for urgent transfer to hospitals with neurology or intensive care facilities. The role of paramedics in effective triage ensures that high-risk patients receive timely specialist care, which is critical for survival.

Paramedics also serve as key links between the community and hospital-based systems. Through effective communication and detailed documentation, they ensure continuity of care. The handover report provided by paramedics to emergency physicians often includes vital details about seizure onset, interventions delivered, patient response, and contextual information from bystanders. This data is essential for both acute management and long-term care planning.

Although their primary role is acute care, paramedics often provide seizure first-aid education to caregivers and families during emergencies. They reinforce practices such as placing the patient on their side during seizures, avoiding restraint, and not placing objects in the mouth. By educating communities, paramedics indirectly reduce risks of complications and improve patient safety before professional care is available (Alving et al., 2020).

3. Clinical Outcomes of Paramedic Interventions

The effectiveness of paramedics in reducing epilepsy-related mortality has been increasingly recognized in clinical literature. Their interventions in seizure emergencies, particularly status epilepticus and seizure-induced complications, play a decisive role in determining patient outcomes. By providing immediate treatment in the pre-hospital phase, paramedics influence survival, morbidity, and the risk of long-term neurological damage. This section examines the available evidence on clinical outcomes associated with paramedic interventions, focusing on seizure termination, prevention of complications, survival rates, and the reduction of sudden unexpected death in epilepsy (SUDEP).

One of the clearest outcome measures in pre-hospital epilepsy care is seizure termination. Status epilepticus, defined as seizures lasting longer than five minutes or recurrent seizures without recovery, is strongly associated with increased mortality and neurological injury (Trinka et al., 2015). Several studies show that timely benzodiazepine administration by paramedics substantially reduces the risk of refractory status epilepticus and improves survival outcomes. For example, McIntyre et al. (2018) demonstrated that intranasal midazolam delivered by paramedics in pediatric patients was both safe and effective in stopping seizures, reducing the need for hospital-based interventions.

Respiratory compromise is a major contributor to epilepsy-related deaths. Paramedic interventions, including airway protection, oxygen administration, and suctioning, have been shown to prevent hypoxia and aspiration pneumonia. Surges et al. (2021) highlighted that early airway interventions are critical in reducing seizure-related cardiorespiratory arrest, which is strongly linked to SUDEP. This preventive effect, though less visible than seizure termination, is nonetheless vital for patient survival.

Although SUDEP remains difficult to predict and prevent, evidence suggests that prompt paramedic response during seizure emergencies may reduce associated risks. By preventing prolonged hypoxemia and facilitating rapid resuscitation, paramedics address two of the hypothesized mechanisms underlying SUDEP (Devinsky et al., 2016). Shankar et al. (2017) also noted that paramedic-led interventions improve monitoring and early CPR initiation, both of which may lower SUDEP incidence in high-risk populations.

Several population-based studies demonstrate improved survival rates where paramedic interventions are robust. Alroughani et al. (2018) found that mortality from status epilepticus was significantly

reduced in regions with well-trained EMS systems equipped with seizure protocols. Beyond immediate survival, paramedics also influence long-term outcomes by reducing seizure duration, preventing trauma-related injuries, and minimizing delays to definitive care. These effects collectively contribute to a reduction in epilepsy-related disability and healthcare burden.

Comparative analyses highlight the stark differences in outcomes between patients receiving pre-hospital paramedic care and those who do not. Beghi et al. (2019) reported that patients with seizures managed solely by family members had higher rates of aspiration, prolonged seizure duration, and increased mortality, compared to those attended by trained EMS providers. This underscores the indispensable role of paramedics in epilepsy care.

Despite positive findings, several limitations exist in the evidence base. Studies often vary in methodology, outcome measures, and regional EMS protocols, making comparisons difficult. Furthermore, controlled trials specifically assessing paramedics' impact on epilepsy-related mortality remain limited. Nonetheless, the consistent trends across observational studies and systematic reviews strongly suggest that paramedic interventions reduce risks and improve patient outcomes.

Table 1. Summary of Clinical Outcomes from Studies on Paramedic Epilepsy Interventions

Author (Year)	Sample/Setting	Intervention	Outcomes
McIntyre et al. (2018)	Pediatric patients, UK EMS	Intranasal midazolam administration	Effective seizure termination, reduced hospital needs
Alroughani et al. (2018)	Adults with status epilepticus, Kuwait EMS	IV benzodiazepines, airway management	Lower mortality, shorter seizure duration
Shankar et al. (2017)	Epilepsy patients, UK EMS	Seizure checklist + CPR initiation	Improved survival, reduced SUDEP risk
Surges et al. (2021)	Observational review, Europe	Airway interventions, oxygen therapy	Reduced hypoxemia, prevention of seizure-related arrest
Beghi et al. (2019)	Global analysis, WHO data	Paramedic response vs. non-paramedic care	EMS care linked to lower aspiration and mortality

Clinical evidence strongly supports the life-saving impact of paramedics in epilepsy emergencies. Through seizure termination, airway protection, and early resuscitation, paramedics improve both short-term and long-term outcomes, including the prevention of SUDEP. Although further controlled studies are warranted, existing data affirm that paramedic interventions are indispensable in reducing epilepsy-related mortality and morbidity.

4. Barriers and Challenges in Pre-Hospital Epilepsy Care

While the role of paramedics in managing epilepsy emergencies is well-recognized, numerous barriers and challenges continue to hinder the delivery of optimal pre-hospital care. These challenges span across clinical, organizational, logistical, and psychosocial dimensions, often leading to delayed interventions and avoidable complications. Understanding these barriers is critical to formulating strategies that can enhance the effectiveness of paramedic services and reduce epilepsy-related mortality.

1. Limited Epilepsy-Specific Training: A significant challenge lies in the limited exposure of paramedics to epilepsy-specific education during their training. Although paramedics are well-versed in general emergency care, specialized knowledge about different seizure types, SUDEP risk, and long-term epilepsy management is often lacking (Holmes et al., 2018). This can result in misdiagnosis, inappropriate interventions, or delayed recognition of life-threatening conditions such as status epilepticus. For example, focal seizures with subtle presentations may be overlooked, while post-ictal confusion can sometimes be mistaken for intoxication or psychiatric disorders. Inadequate training thus contributes to variability in the quality of care delivered.

2. Absence of Standardized Protocols: Another major barrier is the lack of uniform, evidence-based protocols for pre-hospital epilepsy care. While some emergency medical systems incorporate seizure management guidelines, these protocols are often inconsistent across regions and services (Beghi et al., 2019). In certain areas, paramedics are not authorized to administer benzodiazepines or advanced airway interventions, limiting their ability to provide timely, life-saving treatment. The absence of standardized pathways creates disparities in outcomes, with patients in resource-rich systems benefitting more than those in underdeveloped services.

3. Limited Access to Medications and Equipment: Even when protocols permit intervention, logistical challenges often impede effective care. In some settings, ambulances may lack essential medications such as intranasal midazolam or intravenous diazepam, which are critical for seizure termination (McIntyre et al., 2018). Similarly, shortages of oxygen supply, suction equipment, or airway adjuncts compromise the ability of paramedics to prevent hypoxia and aspiration. Such resource gaps are particularly pronounced in low- and middle-income countries, where healthcare infrastructure is already strained.

4. Delayed Emergency Response Times: The effectiveness of paramedic interventions is closely tied to response time. In rural or geographically dispersed areas, delays in ambulance arrival can render even the best interventions less effective, as prolonged seizures increase the likelihood of mortality and neurological damage (Shankar et al., 2017). Factors contributing to delayed responses include poor road networks, insufficient ambulance fleets, and overburdened emergency dispatch systems. These delays remain a systemic challenge that disproportionately affects vulnerable populations.

5. Psychosocial and Ethical Challenges: Paramedics often face psychosocial and ethical dilemmas when managing epilepsy cases. Family members or bystanders may intervene inappropriately, such as by restraining the patient or inserting objects into the mouth, leading to further complications (Alving et al., 2020). Paramedics may also encounter reluctance from patients who decline hospital transport due to stigma, financial concerns, or fear of medical institutions. Additionally, the emotional burden of recurrent seizure emergencies can contribute to burnout and decision-making fatigue among paramedics, affecting the consistency of care delivered.

6. Data and Communication Gaps: Finally, gaps in communication and data sharing present significant barriers. Paramedics often lack access to patients' full medical histories, which hinders tailored decision-making. Furthermore, inadequate handover processes between EMS and hospital staff may result in critical information—such as seizure duration, interventions performed, or suspected triggers—being lost (Surges et al., 2021). These gaps reduce the continuity of care and undermine the effectiveness of both pre-hospital and in-hospital management.

Barriers to optimal pre-hospital epilepsy care are multifaceted, ranging from insufficient training and protocol inconsistencies to logistical shortages, response delays, and psychosocial challenges. These obstacles collectively reduce the life-saving potential of paramedics in seizure emergencies. Addressing them requires a combination of targeted education, standardized care protocols, resource investment, and better integration of EMS with hospital systems. Without overcoming these barriers, the full capacity of paramedics to reduce epilepsy-related mortality cannot be realized.

5. Strategies for Strengthening Paramedics' Role

The barriers in pre-hospital epilepsy care, while significant, present opportunities for targeted strategies that can enhance the effectiveness of paramedics in reducing epilepsy-related mortality. Strengthening paramedics' capacity requires a multifaceted approach encompassing education, standardized protocols, technological integration, resource provision, and collaboration within the healthcare ecosystem. By adopting these strategies, emergency medical systems can ensure that paramedics are better equipped to manage epilepsy emergencies, prevent complications, and ultimately save lives.

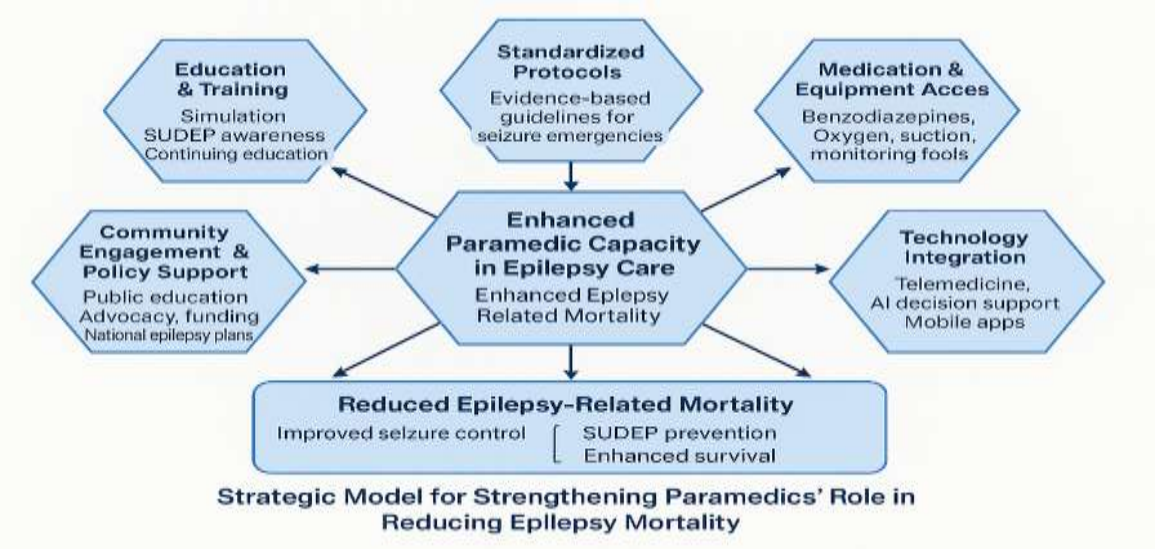

Figure 2. Strategic Model for Strengthening Paramedics' Role in Reducing Epilepsy Mortality

1. Enhanced Education and Training: The foundation of effective pre-hospital epilepsy care lies in improving the knowledge and skills of paramedics. Specialized epilepsy training modules should be integrated into paramedic curricula, with a focus on seizure recognition, airway management, SUDEP awareness, and medication administration (Holmes et al., 2018). Simulation-based learning can be particularly effective, enabling paramedics to practice responding to status epilepticus, seizure-related trauma, and respiratory compromise in controlled environments. Continuing professional development programs are also essential to keep paramedics updated on evolving guidelines and innovations in seizure management.

2. Development of Standardized Protocols: Establishing clear, evidence-based pre-hospital epilepsy care protocols is critical to ensuring consistency across emergency systems. Protocols should outline decision-making pathways for different seizure types, indications for rescue medications, and criteria for hospital transfer. International models, such as the ILAE's guidelines for managing status epilepticus, can serve as a foundation for developing region-specific adaptations (Trinka et al., 2015). Standardization ensures that all patients receive high-quality care regardless of geographic location or EMS provider.

3. Improving Access to Medications and Equipment: Equipping ambulances with the necessary medications and tools is central to empowering paramedics. Intranasal or buccal midazolam should be made widely available, given its effectiveness and ease of administration when intravenous access is challenging (McIntyre et al., 2018). Additionally, all ambulances should be stocked with oxygen, suction devices, airway adjuncts, and monitoring equipment to address respiratory complications. Investment in portable diagnostic tools, such as capnography, can further support real-time decision-making during seizure emergencies.

4. Integration of Technology and Telemedicine: The use of digital health technologies offers a powerful avenue to support paramedics in the field. Telemedicine platforms can connect paramedics with neurologists during emergencies, enabling expert consultation on complex cases. Artificial intelligence (AI)-enabled decision support tools may also assist in seizure recognition and provide real-time prompts for intervention (Surges et al., 2021). Mobile applications designed for caregivers and patients can complement these systems by providing paramedics with access to patient-specific seizure action plans.

5. Strengthening Communication and Care Continuity: To maximize outcomes, paramedic interventions must be integrated into a broader continuum of care. Effective communication systems should ensure seamless handover from paramedics to emergency department teams. Electronic pre-hospital care records can be used to document seizure duration, interventions performed, and patient response, thereby supporting both acute management and long-term epilepsy care planning (Shankar et

al., 2017). Strengthening this care continuum reduces the likelihood of recurrent emergencies and ensures that paramedic interventions have sustained impact.

6. Community and Public Engagement: Paramedics' role can be amplified through engagement with patients, caregivers, and communities. Public education campaigns on seizure first aid can empower communities to provide immediate assistance before paramedics arrive, reducing complications. Paramedics can also collaborate with epilepsy foundations and advocacy groups to promote awareness of SUDEP and encourage adherence to treatment regimens (Alving et al., 2020). By bridging the gap between healthcare systems and communities, paramedics contribute to a more holistic approach to epilepsy mortality reduction.

7. Policy and System-Level Support: Finally, strengthening paramedics' role requires supportive health policies and adequate funding. Policymakers should prioritize investment in EMS infrastructure, training programs, and technological innovation. National epilepsy action plans should explicitly recognize the role of paramedics, ensuring that EMS systems are aligned with broader goals to reduce epilepsy-related mortality. Research funding is also needed to generate stronger evidence on the impact of paramedic-led interventions in seizure emergencies.

6. Discussion

The evidence reviewed underscores the pivotal role of paramedics in reducing epilepsy-related mortality, particularly during the pre-hospital phase where timely interventions can mean the difference between life and death. By rapidly recognizing seizures, managing airways, administering rescue medications, and preventing complications, paramedics directly address the most immediate threats to survival. This discussion section integrates the findings from earlier sections, critically evaluates their implications, and highlights opportunities for future development in pre-hospital epilepsy care.

Paramedics are uniquely positioned at the interface between community settings and hospital-based care. Most seizure-related deaths, including those from status epilepticus and sudden unexpected death in epilepsy (SUDEP), occur outside hospitals, making the pre-hospital environment the most vulnerable phase for patients (Shankar et al., 2017). Early interventions—such as airway protection and benzodiazepine administration—are consistently associated with improved outcomes (McIntyre et al., 2018). Thus, paramedics act not only as emergency responders but also as critical gatekeepers for survival.

The role of paramedics does not end with acute seizure termination. Effective communication with emergency departments and neurology teams ensures continuity of care, reducing the risk of recurrent emergencies and long-term morbidity. For instance, when paramedics provide comprehensive handover information—seizure duration, interventions given, and suspected triggers—clinicians can make informed decisions about acute and future management. This highlights the need for standardized documentation systems that bridge pre-hospital and hospital-based care (Surges et al., 2021).

Despite their crucial role, several barriers reduce the effectiveness of paramedics in epilepsy care. Variability in training, the absence of standardized seizure management protocols, and limited access to essential medications undermine their capacity to deliver optimal care (Holmes et al., 2018). Resource shortages in low- and middle-income countries are particularly concerning, where paramedics often operate without benzodiazepines, oxygen, or airway equipment. In such contexts, the life-saving potential of paramedics remains underutilized.

Another challenge is delayed response times, especially in rural or underserved areas. Even well-trained paramedics cannot offset the negative consequences of prolonged seizure activity if systemic delays prevent timely arrival. This highlights the need to strengthen emergency medical service (EMS) infrastructure and improve equitable access to care across regions (Beghi et al., 2019).

The strategies outlined in Section 5 present a roadmap for overcoming these challenges. Enhanced education and simulation-based training can equip paramedics with specialized epilepsy knowledge, reducing misdiagnosis and inappropriate interventions. Standardized pre-hospital epilepsy protocols would ensure consistency across EMS systems, minimizing outcome disparities. Additionally,

expanding access to rescue medications such as intranasal midazolam could reduce status epilepticus progression and related deaths (Trinka et al., 2015).

Emerging technologies further amplify opportunities. Telemedicine can connect paramedics to neurologists in real time, enabling expert guidance in complex cases. Artificial intelligence (AI)-enabled tools may also support seizure recognition and clinical decision-making. Such innovations not only improve immediate patient outcomes but also contribute to data collection for research and long-term planning.

At the policy level, integrating paramedics' role into national epilepsy action plans is vital. Policymakers must recognize that reducing epilepsy mortality requires investment in EMS systems, training programs, and technology adoption. Furthermore, public education campaigns that complement paramedic efforts can enhance community preparedness, reducing risks before EMS arrival (Alving et al., 2020). A comprehensive approach—linking paramedics, hospital care, communities, and policymakers—offers the greatest potential for sustainable improvement in epilepsy outcomes.

Despite encouraging evidence, gaps remain. Few controlled trials directly evaluate the impact of paramedic-led interventions on epilepsy mortality, making it difficult to quantify their precise contributions. More robust studies are needed to evaluate outcomes such as seizure duration, survival rates, and SUDEP prevention in different EMS systems. Comparative research across regions could also illuminate best practices and inform the development of universal protocols.

The discussion highlights that paramedics serve as life-saving first responders in epilepsy emergencies, but their effectiveness is limited by barriers such as inadequate training, resource shortages, and systemic delays. Strategic interventions—including enhanced training, standardized protocols, technology integration, and policy support—offer promising solutions. Ultimately, strengthening paramedics' role is not only a clinical priority but also a public health imperative, capable of substantially reducing epilepsy-related mortality and improving patient safety on a global scale.

Conclusion

Epilepsy remains a major global health challenge, responsible for substantial morbidity and mortality. A significant proportion of epilepsy-related deaths, particularly those caused by status epilepticus, seizure-related respiratory complications, and sudden unexpected death in epilepsy (SUDEP), occur outside of hospitals, where timely medical intervention is often limited. This reality underscores the indispensable role of paramedics as frontline responders in pre-hospital epilepsy care.

The evidence synthesized in this review demonstrates that paramedic-led interventions—ranging from seizure recognition and airway management to the administration of benzodiazepines and rapid transport—directly contribute to improved survival outcomes. By reducing seizure duration, preventing hypoxemia, and facilitating continuity of care, paramedics address the most immediate threats associated with epilepsy emergencies. However, barriers such as inadequate epilepsy-specific training, lack of standardized protocols, resource shortages, and systemic delays hinder their full potential.

Strengthening the role of paramedics requires a comprehensive approach. Enhanced education, consistent evidence-based protocols, expanded access to essential medications and equipment, integration of telemedicine and digital decision-support tools, and stronger communication between EMS and hospital systems are critical steps forward. In parallel, public education and supportive health policies can amplify paramedic efforts, ensuring that their life-saving interventions are embedded within a coordinated healthcare and community framework.

Ultimately, reinforcing the capacity of paramedics to manage epilepsy emergencies represents not only a clinical necessity but also a public health imperative. By equipping paramedics with the tools, training, and systemic support they need, it is possible to significantly reduce epilepsy-related mortality, prevent avoidable deaths, and improve quality of life for millions of individuals worldwide. The expansion of paramedics' role in epilepsy care should therefore be prioritized as part of broader strategies to advance patient safety and healthcare resilience.

References

- Alroughani, R., AlHashel, J., AlHamdan, F., & Alenezi, M. (2018). Outcomes of pre-hospital management of status epilepticus: Role of emergency medical services. Epilepsy & Behavior, 84, 99–104. https://doi.org/10.1016/j.yebeh.2018.04.009
- Alving, J., Beniczky, S., & Ryvlin, P. (2020). Seizure first aid and the role of education. Epileptic Disorders, 22(1), 1–9. https://doi.org/10.1684/epd.2020.1130
- Beghi, E., Giussani, G., Nichols, E., Abd-Allah, F., Abdela, J., Abdelalim, A., et al. (2019). Global, regional, and national burden of epilepsy, 1990–2016: A systematic analysis for the Global Burden of Disease Study 2016. The Lancet Neurology, 18(4), 357–375. https://doi.org/10.1016/S1474-4422(18)30454-X
- Devinsky, O., Hesdorffer, D. C., Thurman, D. J., Lhatoo, S., & Richerson, G. (2016). Sudden unexpected death in epilepsy: Epidemiology, mechanisms, and prevention. The Lancet Neurology, 15(10), 1075–1088. https://doi.org/10.1016/S1474-4422(16)30158-2
- Devinsky, O., Vezzani, A., O'Brien, T. J., Jette, N., Scheffer, I. E., de Curtis, M., & Perucca, P. (2018). Epilepsy. Nature Reviews Disease Primers, 4, 18024. https://doi.org/10.1038/nrdp.2018.24
- Fisher, R. S., Cross, J. H., French, J. A., Higurashi, N., Hirsch, E., Jansen, F. E., Lagae, L., Moshé, S. L., Peltola, J., Roulet Perez, E., Scheffer, I. E., & Zuberi, S. M. (2021). Operational classification of seizure types by the International League Against Epilepsy. Epilepsia, 62(6), 1203–1217. https://doi.org/10.1111/epi.16971
- Holmes, J., McIntyre, S., & Goldsmith, P. (2018). Paramedic perspectives on managing seizure emergencies: Barriers and opportunities. Emergency Medicine Journal, 35(12), 745–749. https://doi.org/10.1136/emermed-2018-207670
- McIntyre, J., Cooper, P., & McNamara, N. A. (2018). Safety and effectiveness of intranasal midazolam by paramedics in pediatric seizure emergencies. Archives of Disease in Childhood, 103(7), 680–685. https://doi.org/10.1136/archdischild-2017-313871
- Shankar, R., Donner, E. J., McLean, B., Nashef, L., Tomson, T., & the SUDEP Panel. (2017). Sudden unexpected death in epilepsy (SUDEP): Development of a safety checklist. Epilepsia, 58(11), e147–e152. https://doi.org/10.1111/epi.13871
- Surges, R., Sander, J. W., & Thijs, R. D. (2021). Sudden unexpected death in epilepsy: Risk factors and potential pathomechanisms. Nature Reviews Neurology, 17(12), 757–776. https://doi.org/10.1038/s41582-021-00577-6
- Trinka, E., Cock, H., Hesdorffer, D., Rossetti, A. O., Scheffer, I. E., Shinnar, S., Shorvon, S., & Lowenstein, D. H. (2015). A definition and classification of status epilepticus – Report of the ILAE Task Force on Classification of Status Epilepticus. Epilepsia, 56(10), 1515–1523. https://doi.org/10.1111/epi.13121
- World Health Organization. (2019). Epilepsy: A public health imperative. Geneva: WHO. https://www.who.int/publications-detail-redirect/epilepsy-a-public-health-imperative