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Advances in pre-hospital emergency care: Enhancing outcomes through innovative practices and technology

Hatim Faihan Alotaibi
KSA, National Guard Health Affairs

Sultan Mohammed Alanazi
KSA, National Guard Health Affairs

Rakan Faisal Albasri
KSA, National Guard Health Affairs

Ibrahim Mohammed Alanazi
KSA, National Guard Health Affairs

***Abstract*---Background:** Emergency Medical Services (EMS) in the United States have evolved significantly since the 1960s, leading to a complex and diverse system that varies across regions. Despite the critical role EMS plays in pre-hospital care, there remains substantial confusion about its operations, structure, and effectiveness. This complexity has driven the need for innovative practices and technology to enhance pre-hospital care and patient outcomes. **Aim:** This article reviews recent advancements in pre-hospital emergency care, focusing on innovations and technological developments designed to improve EMS efficiency and patient outcomes. **Methods:** A comprehensive review of literature and current practices in pre-hospital care was conducted, examining advancements in technology, EMS curricula, and the integration of new tools and techniques into emergency medical practices. **Results:** Key innovations in pre-hospital care include mobile health technology, telemedicine integration, advanced diagnostic devices, automated external defibrillators (AEDs), wearable health sensors, drones for medical delivery, enhanced trauma care equipment, electronic patient care reporting (ePCR), portable ventilators, and simulation training. These advancements have improved real-time data collection, patient monitoring, diagnostic accuracy, and overall efficiency of emergency responses. **Conclusion:** The integration of innovative technologies and practices into EMS has substantially enhanced pre-hospital care. Mobile health technologies and telemedicine have improved communication and decision-making, while advanced diagnostic tools and enhanced trauma care equipment

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have increased the effectiveness of emergency interventions. Simulation training and virtual reality have further strengthened provider skills and preparedness. Despite these advancements, ongoing efforts are necessary to address regional disparities and ensure the widespread adoption of these innovations to optimize patient outcomes and system efficiency.

***Keywords*---**Emergency Medical Services, pre-hospital care, mobile health technology, telemedicine, diagnostic devices, trauma care, electronic patient care reporting, simulation training, innovation in EMS.

Introduction

The lack of standardization in Emergency Medical Services (EMS) across the United States has led to significant confusion among the public, legislators, and healthcare professionals regarding the roles and operations within the field. Each year, the 911 system handles over 37 million calls, resulting in roughly 28 million patients being transported to medical facilities [1, 2]. Despite these figures and the prominent presence of ambulances, the operational scope, system framework, and efficacy of EMS often remain opaque to those not directly experiencing a medical emergency [3]. EMS providers frequently encounter limited patient interaction and face markedly different conditions compared to other healthcare environments, contributing to the field's unique and sometimes enigmatic nature. This lack of understanding poses challenges for healthcare simulationists, who struggle to grasp the complexities of EMS care and find it difficult to involve EMS teams in simulation-based Interprofessional Education (IPE) activities.

Evolution of EMS in the United States and Its Provider Structure

The contemporary EMS framework in the United States emerged in the late 1960s, following the National Academy of Sciences's 1966 publication of the EMS White Paper, *Accidental Death and Disability: The Neglected Disease of Modern Society*. The White Paper, based on data from the Federal Department of Transportation (DOT), highlighted that highway trauma victims could be saved if military trauma care techniques were integrated into civilian practices. This federal initiative led to the development of an EMS system influenced by both public safety and healthcare sectors, with a pronounced paramilitary component shaping educational and procedural standards—a legacy still evident today. Over the decades, advanced military and hospital-based emergency care practices have been integrated into EMS, evolving from a system dependent on private entities, funeral homes, or hospitals for transportation to one with well-defined protocols and operational independence between prehospital and hospital care. This evolution resulted in a diverse and uneven EMS structure across the U.S., with some services based in fire departments, particularly in well-funded urban areas, while others remained civilian or healthcare-affiliated to mitigate costs. As demand for prehospital care grew, EMS systems continued to evolve towards a more autonomous healthcare delivery model, although significant variations still persist.

In 2007, the Institute of Medicine (IOM) released a comprehensive report titled *The Future of Emergency Medicine: Crossroads of Emergency Medical Service Care*, which analyzed EMS care as an extension of emergency medicine and proposed a model to elucidate the complex nature of EMS operations [4]. This model characterized EMS as a hybrid service encompassing elements of public health, emergency medicine, and public safety (Fig. 19.1). The dynamic nature of this structure has contributed to ongoing confusion about the role, practice, and objectives of EMS. The confusion surrounding the classification of EMS within the healthcare spectrum is compounded by misunderstandings about the roles and designations of EMS personnel. The current federal EMS system comprises four provider tiers designed to deliver a comprehensive prehospital care system: Emergency Medical Responder (EMR), Emergency Medical Technician (EMT), Advanced Emergency Medical Technician (AEMT), and Paramedic. Historically, these tiers were labeled differently, such as EMT-Basic and EMT-Paramedic, leading many to inaccurately refer to all EMS personnel as "EMTs" without recognizing the distinctions among various levels of care. Additionally, states may not offer all levels of EMS licensure, opting instead for a mix of these levels based on local needs and demographics, sometimes including additional levels to align with state-specific medical practices. The nationally recognized levels of care (EMR, EMT, AEMT, and Paramedic) ensure that providers are trained in contemporary emergency medicine techniques and meet national credentialing standards. The educational framework for these levels builds upon prior knowledge, skills, and abilities (KSAs) to ensure optimal lifesaving interventions are administered promptly at the emergency scene.

An EMR typically arrives first at an emergency scene before an ambulance, often being a police officer or firefighter capable of performing critical initial interventions such as cardiopulmonary resuscitation (CPR), defibrillation, and medication administration for overdoses or anaphylaxis. EMTs provide an additional layer of care, equipped with devices for automatic CPR and bleeding control, supporting EMR providers. Paramedics offer advanced care akin to what is provided in hospital emergency departments, often managing patients for extended periods in rural areas due to longer transport times. AEMT providers, when present, offer enhanced patient assessment and triage capabilities, operating between the roles of EMT and Paramedic. While EMTs are generally first responders, paramedics may work from various vehicles depending on the region. Aeromedical units, which include critical care RNs, respiratory therapists, paramedics, and physicians, assist in providing urgent care and reducing transport times in rural areas. Regardless of their vehicle, EMS providers share the common goal of delivering life-saving interventions and expanding emergency care capabilities.

EMS Curricula

Despite some regional similarities to 1970s practices, the field of Emergency Medical Services (EMS) has made substantial advancements, leading to increased effectiveness and efficiency. EMS has significantly elevated its approach to disaster response, management, and mitigation, recognizing the importance of having highly skilled and confident EMS providers. The demand for advanced patient care and improved technology has driven the evolution of EMS curricula,

which have become longer and more comprehensive to accommodate advancements in out-of-hospital care. Currently, EMS curricula employ a competency-based framework with rigorous performance outcomes for knowledge, skills, and abilities (KSAs) [5]. Higher-level EMS providers are required to complete more extensive training, including both coursework and clinical or field experience, with Paramedics needing the most extensive KSA assessments. This increased requirement aligns with the complex scope of practice expected of Paramedics. However, the growing demands of curricula may contribute to a decline in EMS volunteers nationwide [6, 7]. This curriculum expansion responds to healthcare trends such as rising disease acuity, earlier hospital discharges, increased home care, efforts to reduce emergency department visits, and the emphasis on managing patients at home with referrals to specialty or primary care providers. These trends have influenced the development of the Mobile Integrated Healthcare (MIH) model, discussed in the Emerging Trends section.

EMS Regional Structure

At its inception, the EMS operational structure varied significantly across states, and this diversity continues to impact EMS design and development. The 1972 television series *Emergency* showcased paramedic services and had a substantial influence on the industry, highlighting a fire-based service model. Today, states permit varying EMS service structures tailored to local needs, resulting in a mix of private, fire, government, or hospital-based services that may not always operate in concert. The EMS system designs from the 1970s and 1980s lacked the current treatment models, quality assurance standards, fiscal responsibilities, and scope of practice guidelines. Efforts at the national level aim to standardize and streamline treatment and system models through curriculum-based instruction, federal oversight, and national accreditation to enhance patient care, safety, provider competence, and EMS system deployment. Nevertheless, while EMS models may be similar, each system is distinct, and its effectiveness depends on regional requirements.

Staffing Models

Staffing for EMS units is similarly region-specific, with some areas using an EMT paired with a Paramedic, while others employ two Paramedics. Many communities use a multi-tiered response system involving various agencies with different levels of EMS care providers responding to emergencies. Alternatively, some systems staff a single emergency response vehicle with a mix of healthcare providers, including EMRs, physicians, RNs, or other hospital-based providers like respiratory therapists. In addition to managing EMS models and staffing, agencies face challenges from the rise of critical care transport vehicles, which provide hospital-level ICU care in a mobile setting. Staffing for these specialty vehicles is regulated by state EMS offices and is based on patient acuity. The crew may resemble traditional EMS configurations or include additional specialists such as respiratory therapists, RNs, or physicians. Some regions staff these units with providers capable of handling both emergency and critical care transport requests. Patient transfers involve complex documentation and procedures to ensure safety, with frequent conflicts between sending and receiving facilities.

Understanding industry trends can help address these challenges and improve educational and procedural processes.

Air Medical EMS

The air medical component of EMS, encompassing both rotor and fixed-wing aircraft, is highly visible to the public. The use of aircraft in civilian EMS evolved from military trauma care methods, initially used in 1926. By the Korean War, rotor-wing evacuation had become standard. It was not until 1972 that the first civilian rotor-wing service was established at St. Anthony's Hospital in Denver, Colorado. Rotor-wing services are utilized for emergency scene flights, interfacility transports, search and rescue missions, and organ transport. Fixed-wing aircraft can cover long distances, including intercontinental flights. Air medical flights typically staff two Paramedics or a Paramedic and a Flight Nurse, with additional personnel as needed based on patient requirements, such as neonatal care teams for premature infants. Today, air medical services serve a variety of purposes, with approximately 400,000 rotor-wing and 150,000 fixed-wing transports annually in the United States [9].

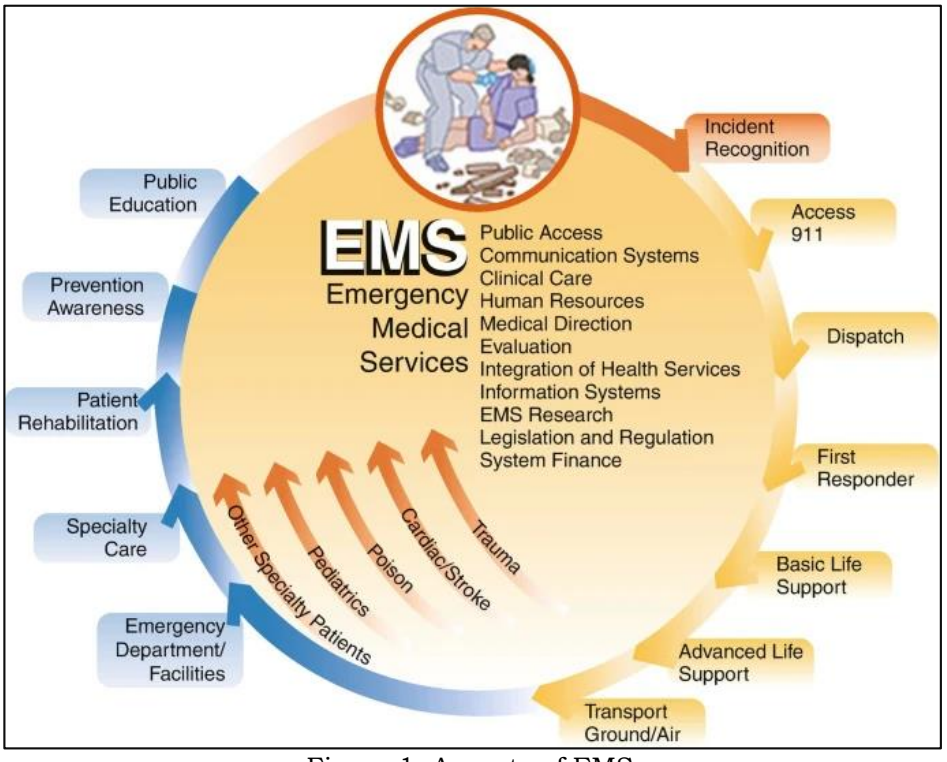

Figure 1: Aspects of EMS

Emerging Trends

A notable advancement in prehospital medicine is the implementation of EMS providers in managing various aspects of healthcare within the patient's environment. This patient-centered approach enhances the availability of

healthcare resources in a mobile context, enabling EMS providers to assist with chronic disease management, offer education, and follow up with patients post-hospital discharge. This development represents a significant advancement for EMS, termed Mobile Integrated Healthcare and Community Paramedicine (MIH-CP). As illustrated in Figure, MIH-CP integrates into health systems, though it has not yet achieved universal adoption. Despite this, its recognition is growing, and systems are seeking ways to overcome fiscal constraints to advance MIH-CP programs. These programs are tailored to the patient population and regional needs, focusing on proactive interventions to prevent hospital readmissions and emergency department visits by directing patients to urgent care, primary care, or specialty services. MIH-CP programs integrate EMS providers with other healthcare professionals—such as nurses, pharmacists, social workers, and ancillary services—to collaboratively address prehospital needs that do not meet 911 emergency criteria.

Federal agencies, including The Joint Commission and the Centers for Medicare & Medicaid Services (CMS), set patient safety goals and benchmarks for hospitals. While EMS primarily provides prehospital care, it significantly impacts these quality benchmarks. The establishment of MIH-CP programs may highlight the need to extend quality and safety goals from hospital settings to prehospital environments. An optimal approach involves collaboration between healthcare systems and EMS services, ensuring that the entire healthcare system meets the needs of patients, families, and communities. Collaborative efforts can enhance benchmarks such as time to definitive care. Organizations should strive to avoid working in silos and foster interprofessional relationships to improve the competence, confidence, and capability of care teams, ultimately benefiting patient and family care.

The Role of a Dispatch Center

A centralized dispatch center, typically routed through a single number, is crucial for ensuring consistent emergency response. Some dispatch centers solely handle 911 calls, while others manage local critical care transport or non-emergency patient transfers. Emergency Medical Dispatchers play a vital role in EMS, responsible for gathering, sharing, and prioritizing information for both emergency and non-emergency responses, and coordinating with other agencies to ensure the safety of the response team. Despite their critical role, Emergency Medical Dispatchers are often overlooked in Interprofessional Education (IPE) design. Similar to the varied EMS system designs across local and state agencies, dispatch centers are not uniformly structured. Unplanned calls typically follow Emergency Medical Dispatch (EMD) criteria, using evidence-based algorithms to determine response levels based on civilian input. Planned non-emergency calls are scheduled for patient transfers or post-discharge transport. Occasionally, unplanned calls may be managed non-emergently, such as those activated by MIH-CP providers. These scenarios are governed by criteria set by local, state, and federal agencies to ensure medical necessity for transport.

Emergency Call Location and Influence

Emergency calls are classified by geographic areas: urban, suburban, and rural, each with distinct call patterns. Urban areas often experience the shortest response and patient contact times, resulting in quicker completion of care interventions [11]. Suburban environments can have both short and extended response times, influenced by hospital locations. Rural areas, in contrast, face the longest response and contact times, requiring EMS providers to manage both simple and complex cases for extended periods. This demands proficiency in a broad range of medications and procedures and a deep understanding of pathophysiology, disease management, and critical patient care.

Patient Interactions

EMS providers are trained to handle patients of all ages and must adapt to diverse environments, family dynamics, and cultural or religious needs. When patients or families refuse interaction, EMS providers must use environmental clues to facilitate communication and care. Providers may encounter multiple patients at a scene or face large-scale emergencies that exceed available resources, leading to mass casualty incidents (MCIs) and heightened response levels. Despite the challenges, EMS providers are trained to manage various illnesses and injuries, ensuring patients and their families are well-informed.

Interprofessional Discipline Overlap and Simulation

EMS providers frequently collaborate with other disciplines during patient care. Overlaps often occur with dispatch, public safety personnel, MIH-CP providers, and healthcare facilities. Simulation activities can enhance patient outcomes by focusing on these interdisciplinary interactions. For example, police training on managing a diabetic patient exhibiting unusual behavior can improve their ability to recognize medical conditions such as hypoglycemia. Simulations involving scenarios like excited delirium or active shooter events can benefit EMS providers by preparing them for complex situations. Effective public emergency responses require coordinated efforts among police, fire, and EMS dispatch agencies to achieve optimal patient outcomes [12]. When a patient is transferred to a healthcare facility, effective communication between providers—such as EMS and RN, RT, or attending physician—is essential for a smooth transition of care. Regional industrial factors, like confined space rescue or hazardous materials decontamination, further influence EMS patient care, requiring interprofessional teamwork to ensure safe patient transfer to definitive care.

EMS and IPE Simulation Considerations

Successful EMS responses depend on a team-based approach that leverages each member's roles and capabilities to achieve positive outcomes. Training in simulated environments helps build team performance and individual skills, addressing real-world complexities. Simulation-based education allows healthcare professionals to engage in realistic scenarios, improving their effectiveness and collaboration. Well-designed IPE simulations enhance the capabilities of providers, strengthen systems, and improve care quality.

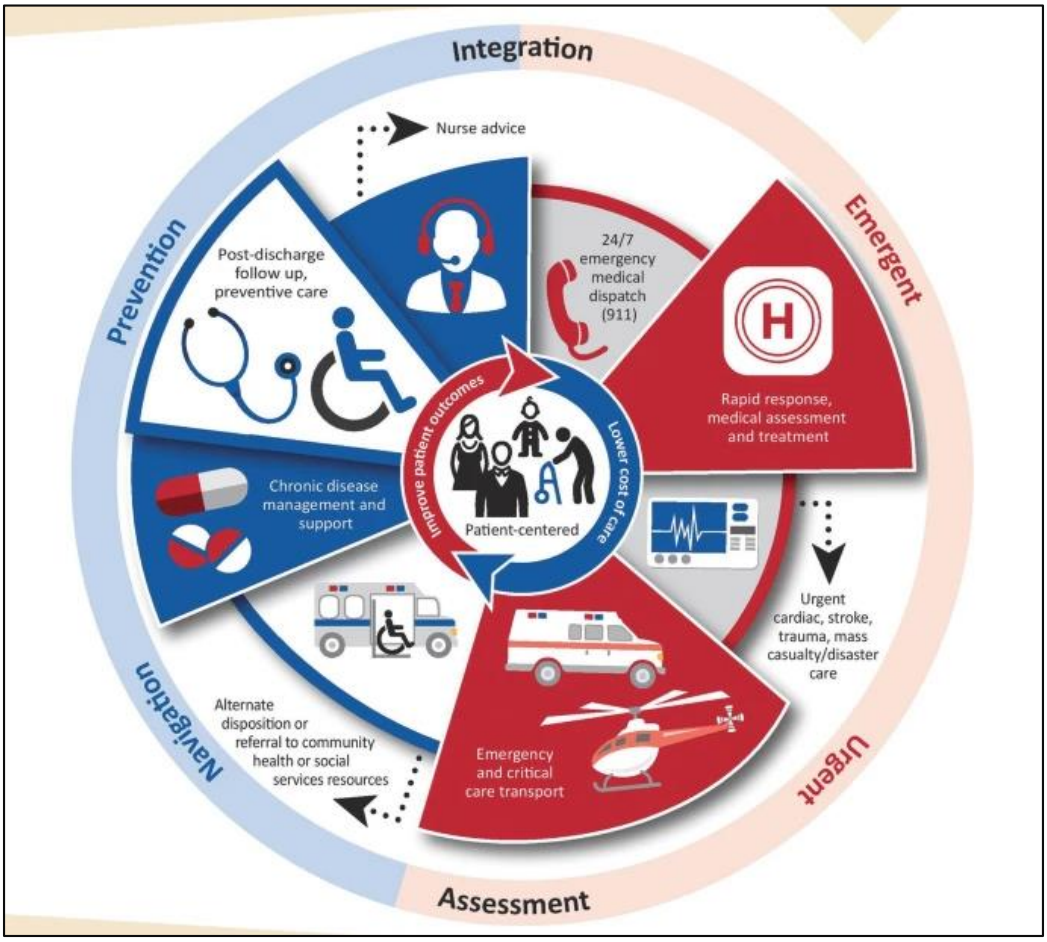

Figure 2: Integrative EMS

Other Pre-Hospital Care Techniques:

1. Advanced Airway Management: Advanced airway management techniques are crucial for securing the airway in patients with compromised respiratory function. Methods such as endotracheal intubation, laryngeal mask airway (LMA) insertion, and cricothyrotomy are employed by advanced EMS providers to ensure adequate ventilation and oxygenation. These techniques are typically used in critical situations where basic airway management is insufficient [13].

2. Advanced Cardiovascular Life Support (ACLS): ACLS involves a set of advanced procedures and protocols for managing cardiac emergencies, including the use of medications, defibrillation, and advanced resuscitation techniques. This technique focuses on treating patients with cardiac arrest, severe arrhythmias, and other life-threatening cardiac conditions. ACLS training is essential for paramedics and advanced care providers to effectively manage cardiac emergencies in the pre-hospital setting [14].

3. Trauma Care and Stabilization: Trauma care techniques aim to stabilize patients with traumatic injuries before they reach a hospital. This includes the application of tourniquets for severe hemorrhage control, splinting for fracture

stabilization, and the use of cervical collars to prevent spinal injuries. Pre-hospital trauma care also involves rapid assessment and triage to prioritize patients based on the severity of their injuries [15].

4. Pain Management: Effective pain management in pre-hospital care is essential for improving patient comfort and outcomes. EMS providers may administer analgesics such as opioids or non-opioid pain relievers, depending on the patient's condition and the nature of the pain. Techniques for pain management are tailored to the severity and type of pain, aiming to alleviate distress while ensuring patient safety [16].

5. Patient Assessment and Triage: Thorough patient assessment and triage are fundamental to pre-hospital care. EMS providers perform rapid assessments to identify life-threatening conditions and prioritize care based on the severity of the patient's condition. This involves evaluating vital signs, level of consciousness, and presenting symptoms to determine the appropriate treatment and transport plan [17].

6. Rapid Sequence Intubation (RSI): Rapid Sequence Intubation is a technique used to quickly secure the airway in critically ill patients who are at risk of respiratory failure. It involves the administration of sedatives and paralytics to facilitate endotracheal intubation while minimizing patient discomfort and the risk of complications. RSI is used in scenarios where immediate airway control is necessary [18].

7. Field Ultrasound: Field ultrasound technology allows EMS providers to perform non-invasive imaging to assess internal injuries or conditions. Portable ultrasound devices can help in the evaluation of traumatic injuries, fluid accumulation, and cardiac function. This technique enhances the diagnostic capabilities of pre-hospital care and informs treatment decisions [19].

8. Intravenous (IV) Therapy and Fluid Resuscitation: IV therapy is used to administer fluids, medications, and blood products directly into the patient's bloodstream. Fluid resuscitation is critical for managing shock and dehydration, especially in trauma patients or those with severe medical conditions. Proper IV access and fluid management can stabilize patients and improve outcomes before reaching a hospital [20].

9. Pediatric and Neonatal Care: Specialized techniques for pediatric and neonatal care address the unique physiological needs of infants and children. This includes age-appropriate resuscitation techniques, dosing of medications, and management of congenital conditions. EMS providers are trained to handle the specific challenges of caring for young patients in the pre-hospital setting [21].

10. Environmental and Wilderness Medicine: Pre-hospital care in remote or wilderness settings requires techniques adapted to environmental conditions. This includes hypothermia treatment, altitude sickness management, and care for injuries sustained in rugged terrain. Wilderness medicine techniques ensure that patients receive appropriate care despite challenging conditions [22].

Most Common Pre-Hospital Care Innovations

1. Mobile Health Technology: Mobile health (mHealth) technologies, including smartphone applications and portable monitoring devices, have revolutionized pre-hospital care by enabling real-time data collection, patient monitoring, and communication. These tools allow EMS providers to track vital signs, manage

patient records, and communicate with medical teams remotely, enhancing decision-making and care delivery.

2. Telemedicine Integration: Telemedicine integration into pre-hospital care enables real-time consultation with medical professionals during emergencies. Through video calls and remote diagnostic tools, EMS teams can receive expert guidance and support, improving patient care and facilitating more accurate on-site decision-making.

3. Advanced Diagnostic Devices: The development of portable diagnostic devices, such as handheld ultrasound machines and portable ECG monitors, allows EMS providers to perform rapid and accurate assessments of patient conditions. These devices aid in identifying internal injuries, cardiac issues, and other critical conditions, leading to more informed treatment decisions.

4. Automated External Defibrillators (AEDs): AEDs have become a standard innovation in pre-hospital care, providing automated guidance for defibrillation in cases of cardiac arrest. Their increased availability in public spaces and EMS units has significantly improved survival rates for patients experiencing sudden cardiac events.

5. Wearable Health Sensors: Wearable health sensors that monitor physiological parameters such as heart rate, oxygen saturation, and glucose levels have become integral to pre-hospital care. These devices can provide continuous monitoring and early warning signs of critical changes in a patient's condition, enabling timely intervention.

6. Drones for Medical Delivery: The use of drones for delivering medical supplies, such as medications, blood products, and defibrillators, has emerged as a promising innovation. Drones can quickly transport essential resources to remote or inaccessible locations, enhancing the efficiency and effectiveness of pre-hospital care.

7. Enhanced Trauma Care Equipment: Advancements in trauma care equipment, including vacuum splints, advanced wound care products, and portable blood warmers, have improved the management of traumatic injuries in pre-hospital settings. These innovations help stabilize patients and prevent complications before they reach a hospital.

8. Electronic Patient Care Reporting (ePCR): Electronic Patient Care Reporting systems have streamlined the documentation process for EMS providers. ePCR systems facilitate accurate and comprehensive record-keeping, enhance data sharing with healthcare facilities, and improve overall patient care and follow-up.

9. Portable Ventilators: Portable ventilators have become an essential tool for EMS providers managing patients with respiratory distress. These devices offer advanced ventilation support in the field, allowing for more effective management of patients with severe respiratory conditions.

10. Simulation Training and Virtual Reality: Simulation training and virtual reality (VR) technologies are used to enhance the skills and preparedness of EMS providers. These tools offer realistic training scenarios and simulations, improving the ability to handle complex emergencies and perform procedures accurately.

Conclusion

The evolution of Emergency Medical Services (EMS) in the United States reflects a substantial shift towards more advanced, technology-driven practices aimed at enhancing patient care and operational efficiency. Since the foundational changes

initiated by the 1966 EMS White Paper, EMS systems have increasingly integrated sophisticated technologies and refined practices to address the diverse needs of pre-hospital care. Among the notable advancements, mobile health (mHealth) technologies and telemedicine have emerged as transformative forces in pre-hospital care. mHealth tools, such as smartphone applications and portable monitoring devices, have enabled real-time data collection and communication, facilitating better decision-making and continuity of care. Telemedicine has further enhanced this by allowing EMS providers to consult with medical professionals remotely, improving the accuracy and effectiveness of on-site care. The development of advanced diagnostic devices, including handheld ultrasound machines and portable ECG monitors, has significantly improved the ability of EMS providers to assess and diagnose critical conditions swiftly. These tools enable more informed treatment decisions and have proven invaluable in managing complex cases in the field. Similarly, automated external defibrillators (AEDs) have become a standard feature in both public spaces and EMS units, markedly increasing survival rates for patients experiencing sudden cardiac events. The rise of wearable health sensors and drones for medical delivery represents additional innovations that have expanded the capabilities of EMS. Wearable sensors offer continuous monitoring of vital signs, alerting providers to critical changes in patient conditions. Drones facilitate rapid delivery of essential medical supplies to remote or inaccessible areas, enhancing the overall efficiency of emergency response. Enhanced trauma care equipment, such as vacuum splints and portable blood warmers, has improved the management of traumatic injuries, while electronic patient care reporting (ePCR) systems have streamlined documentation and data sharing. Portable ventilators and simulation training technologies have also contributed to better respiratory support and provider preparedness. Despite these advancements, regional disparities in EMS systems and the ongoing challenge of integrating new technologies into diverse operational frameworks remain. Continuous efforts to standardize practices, address regional needs, and ensure broad adoption of these innovations are crucial for optimizing patient outcomes and improving the overall efficacy of pre-hospital care.

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التطورات في رعاية الطوارئ قبل المستشفى: تحسين النتائج من خلال الممارسات والتقنيات المبتكرة

الملخص:
الخلفية :تطورت خدمات الطوارئ الطبية في الولايات المتحدة بشكل كبير منذ الستينيات، مما أدى إلى نظام معقد ومتنوع يختلف عبر المناطق. على الرغم من الدور الحيوي الذي تلعبه خدمات الطوارئ الطبية في الرعاية قبل المستشفى، لا يزال هناك قدر كبير من الالتباس حول عملياتها وهيكلها وفعاليتها. هذه التعقيدات دفعت الحاجة إلى ممارسات وتكنولوجيا مبتكرة لتعزيز الرعاية قبل المستشفى ونتائج المرضى.
الهدف :تستعرض هذه المقالة التقدمات الأخيرة في رعاية الطوارئ قبل المستشفى، مع التركيز على الابتكارات والتطورات التكنولوجية المصممة لتحسين كفاءة خدمات الطوارئ الطبية ونتائج المرضى.
الطرق :تم إجراء مراجعة شاملة للأدبيات والممارسات الحالية في الرعاية قبل المستشفى، حيث تم فحص التقدمات في التكنولوجيا، مناهج خدمات الطوارئ الطبية، ودمج الأدوات والتقنيات الجديدة في الممارسات الطبية الطارئة.
النتائج :تشمل الابتكارات الرئيسية في الرعاية قبل المستشفى تكنولوجيا الصحة المتنقلة، دمج الطب عن بعد، الأجهزة التشخيصية المتقدمة، أجهزة الصدمات الكهربائية التلقائية(AEDs) ، أجهزة استشعار الصحة القابلة للارتداء، الطائرات بدون طيار لتوصيل الأدوية، معدات رعاية الصدمات المحسّنة، تقارير رعاية المرضى الإلكترونية(ePCR) ، أجهزة التهوية المحمولة، والتدريب على المحاكاة. هذه التقدمات قد حسّنت جمع البيانات في الوقت الفعلي، ومراقبة المرضى، ودقة التشخيص، وكفاءة الاستجابة للطوارئ بشكل عام.
الاستنتاج :أدت دمج التكنولوجيا والممارسات المبتكرة في خدمات الطوارئ الطبية إلى تحسين كبير في الرعاية قبل المستشفى. لقد حسّنت تكنولوجيا الصحة المتنقلة والطب عن بعد الاتصال واتخاذ القرارات، بينما زادت الأدوات التشخيصية المتقدمة ومعدات رعاية الصدمات المحسّنة من فعالية التدخلات الطارئة. كما عزز التدريب على المحاكاة والواقع الافتراضي مهارات واستعداد مقدمي الخدمات. على الرغم من هذه التقدمات، تظل الجهود المستمرة ضرورية لمعالجة الفجوات الإقليمية وضمان التبني الواسع لهذه الابتكارات لتحسين نتائج المرضى وكفاءة النظام.
الكلمات الرئيسية :خدمات الطوارئ الطبية، الرعاية قبل المستشفى، تكنولوجيا الصحة المتنقلة، الطب عن بعد، الأجهزة التشخيصية، رعاية الصدمات، التقارير الإلكترونية لرعاية المرضى، التدريب على المحاكاة، الابتكار في خدمات الطوارئ الطبية.