

A Strategic Framework for Emergency Medical Services: Crisis Preparedness and Response Plans for Future Pandemics: Developed by Specialists in Health Information, Administration, Nursing, Radiology, Dentistry, and Sociology.

Saleh Amer Hamad Al Salem¹, Hussein Mohammed Ali Al-Yami², Muidh Farkhan Ali Alomar³, Ali Ahmad Hamad Al Sagrey⁴, Hassan Ayidh Mohammed Alyami⁵, Amal Gazi Almutar⁶, Mubarak Ateeq Hussain Alyami⁷, Mashhour Kareem Alruwaili⁸, Ibrahim Mohsen Hassan Al-Mardif⁹, Dr.Summer Farouk Khatib¹⁰, Abdullah Othman Algarbany¹¹, Saeed Saad Alghamdi¹²

1. *Nursing King Khalid Hospital Ministry of Health Najran*
2. *Emergency Medical Services Technician Male Jubail General Hospital General Department of Emergency, Safety and Ambulance Transport Eastern Region*
3. *Administration hospitals -Badr Al-Janoub General Hospital MOH Najran*
4. *x ray Technician King Khaled Hospital Najran*
5. *Nursing Assistant, Khabash General Hospital, Saudi Arabia*
6. *Nursing technician primary health care almuhammadiyah, Riyadh city*
7. *Sociology King Khalid Hospital in Najran*
8. *nursing technician Aljouf Health Cluster makalruwaili@moh.gov.sa*
9. *Health Assistantmistrey Minstrey of health*
10. *Consultant and head in Restorative Dentistry*
11. *HEALTH INFORMATION TECHNICIAN MINSTRY OF NATIONAL GUARD*
12. *HEALH ADMIN TECHNICIAN MINSTRY OF NATIONAL GUARD*

Abstract

This paper presents a strategic framework for enhancing the preparedness and response capabilities of Emergency Medical Services (EMS) during future pandemics and other large-scale health crises. The framework outlines the critical roles that EMS plays in the early stages of a pandemic, including triage, stabilization, and transportation of patients. It emphasizes the importance of interdisciplinary collaboration among healthcare professionals, including EMS teams, nurses, radiologists, sociologists, and dentists, in developing coordinated response strategies. The paper also explores the significance of effective resource management, communication, and training to ensure EMS readiness for crises. Furthermore, it examines the lessons learned from past pandemics, such as COVID-19, and highlights the importance of comprehensive planning, risk assessment, and psychological support for healthcare workers. The framework aims to foster a unified and resilient EMS response, ensuring that healthcare systems can mitigate the impacts of pandemics, minimize mortality, and optimize patient care.

Keywords: Emergency Medical Services, pandemic preparedness, crisis response, interdisciplinary collaboration, resource management, healthcare system, EMS training, crisis communication, psychological support, healthcare professionals.

1. Introduction

Introduction:

A. Overview of the importance of emergency medical services (EMS) in crisis situations

Emergency medical services (EMS) play a pivotal role in crisis situations by providing immediate care and stabilization to patients in emergencies, thus reducing morbidity and mortality rates. The effectiveness of EMS is largely dependent on well-planned and organized systems that ensure rapid response and coordination. Pre-crisis planning, including the allocation of resources, training, and simulation exercises, is essential to optimize EMS capabilities during high-pressure situations like pandemics, natural disasters, or mass casualty events (Brice, 2019). Effective EMS systems not only provide immediate care but also support the broader healthcare infrastructure, preventing system overload and maintaining the continuity of essential services (Bledsoe et al., 2020). The aim of this strategic framework is to develop comprehensive crisis preparedness and response plans, ensuring that EMS can effectively manage future pandemics and other health crises by leveraging a collaborative approach across various healthcare disciplines (Kahn et al., 2021).

B. Purpose of the Strategic Framework

The purpose of this strategic framework is to provide a structured approach to enhancing the preparedness and response capabilities of emergency medical services (EMS) during crises, particularly pandemics. The framework aims to develop clear, actionable plans for EMS teams to ensure rapid, coordinated, and efficient responses in times of crisis. By outlining essential strategies for crisis management, the framework seeks to improve the integration of EMS with other healthcare systems, optimize resource allocation, and enhance the capacity of healthcare professionals to address large-scale health emergencies (Bledsoe et al., 2020). Additionally, it aims to provide a collaborative model that brings together specialists from various healthcare fields, including nursing, radiology, administration, and sociology, to create a unified response strategy. This comprehensive approach will not only improve patient care and safety but also contribute to the overall resilience of the healthcare system in the face of future pandemics and other emergencies (Brice, 2019; Kahn et al., 2021).

C. Relevance of Pandemic Preparedness for the Healthcare System

Pandemic preparedness is crucial for ensuring that healthcare systems can respond effectively to large-scale health emergencies. The COVID-19 pandemic underscored the importance of having robust, well-prepared healthcare infrastructures capable of managing surges in patient numbers, maintaining continuity of care, and minimizing the long-term effects of pandemics on public health (Kahn et al., 2021). Preparedness involves planning and coordinating resources, training healthcare personnel, and establishing protocols to handle increased patient loads while maintaining high-quality care (Bledsoe et al., 2020). The relevance of pandemic preparedness extends beyond medical treatment to include strategies for public health communication, resource allocation, and the psychological support of patients and healthcare workers (Brice, 2019). By

investing in proactive planning, healthcare systems can enhance their capacity to manage the complexities of pandemics, reduce the strain on emergency services, and ensure rapid recovery. Effective preparedness can also foster greater trust among the public and healthcare providers, ensuring a more cohesive response during future health crises.

Aims

The primary aim of this strategic framework is to enhance the crisis preparedness and response capabilities of emergency medical services (EMS) to effectively address future pandemics and other large-scale health emergencies. The framework seeks to:

1. **Develop a Comprehensive Crisis Response Plan:** Establish clear, actionable plans for EMS teams to ensure a coordinated and efficient response during emergencies (Brice, 2019).
2. **Improve Healthcare System Integration:** Facilitate collaboration between EMS and other healthcare sectors, such as hospitals, public health departments, and emergency response teams, to create a unified crisis response strategy (Bledsoe et al., 2020).
3. **Enhance Resource Management:** Outline strategies for optimal resource allocation, including personnel, medical supplies, and equipment, ensuring readiness during health crises (Kahn et al., 2021).
4. **Strengthen Training and Preparedness:** Equip healthcare professionals, including EMS staff, nurses, radiologists, and other specialists, with the necessary skills and knowledge to respond to pandemics and crises effectively (Bledsoe et al., 2020).
5. **Ensure Sustainability and Resilience:** Develop strategies that ensure the healthcare system's ability to withstand and recover from the challenges posed by pandemics, with a focus on maintaining essential services (Brice, 2019).
6. **Foster Public and Provider Confidence:** Promote trust and communication between healthcare providers and the public, which is crucial for effective crisis management and ensuring compliance with health directives (Kahn et al., 2021).

Methodology

2. Understanding Pandemics and their Impact on Emergency Medical Services

A pandemic is defined as an outbreak of a new infectious disease that becomes very widespread and affects a whole region, a continent, or the world due to a susceptibility of the population to the infection. Pandemics have occurred since the beginning of human history and were often aggravated by war or natural disaster. These events were often referred to as plagues, based on the known characteristics of local diseases. The Spanish Influenza pandemic at the end of World War I is seen as the greatest medical holocaust in history and led to the development of a formal public health research, surveillance, and response system as part of the World Health Organization in 1946.

Pandemics affect almost all aspects of EMS planning, management, and operations. They are characterized by large numbers of patients concentrated in a short period of time; handling limited resources; lack of external help; risks of contamination of the scene, providers, and personnel; difficulties or impossibilities in delivering needed care and essential functions; inadequate facilities; and complex command and managerial

obligations. Pandemics are disruptive by design: they require sick or possibly sick people to congregate for treatment or evaluation within healthcare facilities or alternative health delivery systems, which are subsequently overwhelmed by the concentrated patient demand. Beyond the dramatic health impacts of pandemics, they are also associated with additional stresses related to social impacts and the economic impacts on the countries and regions affected, including health system and healthcare facility crashes caused by excess patient loads. They can also increase preexisting social, economic, and health disparities by differentially affecting or weakening the most vulnerable across many domains including socioeconomic stratification, race/ethnicity, mental capacity, physical weakness, or age and gender. They require a management structure that supports collaborative and adaptive operational and healthcare delivery strategies, as well as strategic public perception management. Adaptive strategies are essential to address the increase in overall EMS caseloads as well as the changing caseload diagnosis mixture. The strategies described are applicable to the medical aspects of any pandemic. (Arslan et al.2021)(Obrenovic et al.2020)

3. Key Components of Crisis Preparedness Plans

Systematic health information management and its availability at the appropriate time can support decision-makers in their activities. It is more important in a crisis situation where the decision derived from the right data could save lives. The effectiveness of this data is based on the strategy of leadership and administration working together to make decisions that influence the chain. Nursing, radiology, dentistry, and sociology with a practical approach are the main components of patient care. In crisis conditions involving a pandemic, these components are as important as for routine activities, but the way of patient care should be adapted according to their role in the pandemic. This strategy could help guide stakeholders in the formulation of an emergency response and crisis preparedness plan. This line of thought introduces a balanced plan between the components that can help control public health. For public health and emergency purposes, following the practical approach, the preparedness plans for future pandemics or crises connected to public healthcare should have the same reliance on radiology and dentistry imaging. Preparedness plans cannot be effective in either a public health crisis or patient care without these important diagnosing and managing tools. The energy required as part of the response for any crisis pandemic from dentistry is necessary to manage aerodigestive infectious diseases as part of a comprehensive healthcare system that includes radiology. Sociology in engaging the public, community, and patients is equally important and explains the role of sociology and psychology in this strategic plan. The preparedness plans can be based on perspectives or the proposed plan to integrate the difficult activities, which is detailed below. In Box 3.1, we consider components. (Srivastava et al.2020)(Alsanee et al.2024)(Coulthard et al.2020)(Eastgate et al.2020)(Sghaireen & Alam)(Cavallo & Forman, 2020)(Nuzzo & Gostin, 2022)

3.1. Health Information Management

Data collection plays a critical role in an effective crisis response. Timely, accurate data are necessary to understand the number of cases and the evolving landscape of a pandemic or other widespread health emergency. Data management is necessary to consolidate that data and produce accurate reports. Information systems such as electronic health records, which often store patient demographic and clinical details, can be integrated with electronic

laboratory information systems to provide real-time syndromic surveillance and reporting. These systems all need to be interoperable with the state-led systems for case reporting, and regional and national sharing of data, to avoid duplication and ensure a real-time picture is available to the authorities. During the recent events in Southeast Asia, a number of countries had severe struggles with health information management and communication between health authorities and central government, including a lack of seamless reporting and surveillance. (Udegbe et al.2023)(Ijeh et al.2024)(Khorram-Manesh et al.2024)(Khorram-Manesh et al.2024)(on Data Needs to Monitor the Evolution of SARS-CoV-, 2020)(Ibrahim et al., 2020)(Sheng et al.2021)(Ling-Hu et al.2022)

During pandemics in the early 21st century, the collection of patient-specific data was a concern due to unintentional disclosure of patient privacy, legal protection, and cybersecurity issues. Security and patient privacy have been a driving force in limiting data sharing across sectors and in public health-related fields. The distribution of data and sharing of systems can present complications due to the variety of clients and different sectors that own and operate health information technologies. In general, without cooperation between the EMS system, hospitals, and other pre-hospital emergency services, effective crisis response is difficult. Many local agencies have become siloed, primarily providing an emergency response that operates on a separate track from other services. Effective information technology can facilitate decision-making by commanders even if operating in a chaotic situation. A significant investment is needed in this area as it has often been neglected. (Hamilton et al., 2022)(De et al.2023)(Farcas et al.2021)(Bahrami et al.2020)(Tušer et al., 2023)

3.2. Administration and Leadership

Administration EMS agencies play an essential role in everyday life and in crisis situations. In any organization, administrative leadership is critical from the deployment of day-to-day operations to disaster response. The administrator sets the tone for the department by promoting pride and dedication in the staff. They also focus on developing a strategic plan that encourages a vision for the future. Vision statements give a sense of direction and mission; values are fundamental beliefs, and operational objectives are results-driven. (Mohammadi et al.2021)(Rowland et al.2021)(Oostlander et al.2020)(Kamrujjaman et al.2023)(Khazaei et al.2024)

Administration is an integral part of EMS strategic planning and deployment. At the outset of an emergency, the role of administrative leaders is to provide direction. This might include deploying team members and formulating a strategy. During the crisis, administrative leaders use the command structure to direct response efforts to the affected areas. After the event, a comprehensive review of the outcomes should be completed. Strategic forecasting by administrative leaders to maintain order through resource allocation might help prevent damage related to threats. A projection of the resources required to respond to the full scale of the emergency will help in making vital financial decisions to provide a lasting operational effect. Administrative or senior staff leaders should be visible at the local level. City councils, chambers of commerce, hospitals, and volunteer groups should all be sought out. Community support may be garnered by forging relationships with these agencies and individuals. Post-incident response is coordinated by the administrators of EMS. Performance data may be shared with these groups to raise awareness of the influence of EMS in the region. (Thaher & Jaaron, 2022)(Shabani & Jerie,

2023)(Alkhodary2023)(Mabrouk & Ibrahim, 2021)(Kasych et al., 2020)(Shafiullah et al.2022)(Ibenrissoul et al.2024)

3.3. Nursing and Patient Care

Nursing encompasses the largest healthcare workforce sector, and nurses are the backbone of the nation's response to a disaster. Patient care nursing during a pandemic is not business as usual. Nursing practices, policies, and procedures implemented during a pandemic should enhance existing protocols and be continually revised to incorporate new data, guidelines, and directives. Nurse training should not only address traditional emergency response and infection control techniques but also the need to manage resources in a catastrophic situation such as a pandemic. Implementation of emotional and psychological support programs and educational offerings may provide additional critical incident stress management to build resilience. These programs should include training for both nurse leaders and direct care nurses in stress prevention, stress management, resiliency-based stress treatment, and other support protocols. (Iserson, 2020)(Fletcher et al.2022)(Loke et al., 2021)(Said & Chiang, 2020)(Harrell et al.2020)(Alan et al.2022)(Alomrani, 2021)

The role of nurses in triaging should include aggressive on-scene and transfer interventions for those patients with potential illness progression. Psychosocial nursing in the emergency department is a priority, given the crisis nature of the emergency department and the community impact. The provision of care to a sick emergency department patient may re-confer a sense of hope in relation to altruistic dimensions of nurse-patient relationships. Surveillance of patients who leave without a medical disposition should be considered a triage area. Interprofessional collaboration is important for comprehensive patient care and efficient service delivery. Attitude, stressors, and stress relievers for their fellow colleagues are important components of disaster hospitals. Such attitudes can lead to positive social profiling and the realization that assistance can be related to a community of the willing. Ensuring the supply of resources to remain a nurse leader is important in the maintenance of effective disaster care provision. (Phillips and Maurano2020)(Hughes et al.2021)(Saidinejad et al.2023)(Spoelder et al.2022)(Spelten et al.2022)(Eiamla-Or et al.2020)

3.4. Radiology and Diagnostic Imaging

Radiology and diagnostic imaging play very important roles in the diagnosis and management of infectious diseases. In emergency cases, performing a suitable radiological examination with both speed and accuracy is the first step in managing patients with suspected transmission diseases. The role of radiological services to support clinical decisions and operational plans for the management of patients with highly contagious diseases has been underestimated for a long time. Radiology as a science requires some time to perform the appropriate diagnosis; in addition, the radiologist must evaluate the images and provide at least one report. In the case of a pandemic, substantial and fast changes can occur, and more effective and quicker diagnostic tools are needed. (Huang et al.2020)

The ongoing outbreak of COVID-19 has marked a turning point in health care across the world. The key technological innovation that was introduced for medical imaging is, of course, telemedicine and telematics. Such developments have really revolutionized the new way of consulting and providing reports. High workload and a rapid increase in medical diagnostic imaging usually mean that the utilization of equipment is executed in a

nonconventional and frantic way, with no time to perform usual standard and decontamination processes. Unlike the usual radiological activity, a pandemic involves a significant increase in fees for radiology procedures. During the pandemic, it was necessary to compile specific recommendations on safety procedures for the management and treatment of patients. These recommendations aimed to define all the safety procedures necessary to limit the risk of exposure not only to the patients but also to the radiological staff. (Yang & Lo, 2021)(Mhazo & Maponga, 2023)(Madouni, 2020)

The importance of not letting clinical goals mark the procedural agenda is essential, but it should always be ensured that the patient is secure during all his bed sitting, especially when the radiological procedure needs to be done bedside. Data that can be extracted from an X-ray, a CT, or an MR must be quickly analyzed, and any changes have to be communicated to the rest of the care team. One problem that has not yet been adequately addressed is the communication system. In most health clusters, it will be necessary to insert some technological applications that allow communication between the diagnostic radiologist and the radiologist who is at home. Normally, independent of the literature on this discipline, it has not yet been completely integrated into any EMS framework. (Bharathi et al.2020)

3.5. Dentistry and Oral Health

During pandemics, the state of dental health often becomes an overlooked aspect of a broader intersectional approach to emergency medical preparedness and systemic challenges. Oral health directly influences a range of overall health outcomes during medical, environmental, and public health crises. Dental practices may have unique challenges. For example, they use equipment such as respirators during treatment where the risk of exposure or cross-infection from respiratory secretions is relatively high. The effect of a pandemic on practitioners and patients may be alleviated if all healthcare staff, including dentists, are trained in revised scheduling protocols for emergency situations, in addition to a plan to schedule patients effectively in an unexpectedly high patient load due to transfers, system bypasses for alternate care sites, and referrals within a regional network of medical and dental professionals for a variety of services provided in a more intentional distribution pattern across times and sites, including in alternate care sites. Dentists and their offices are uniquely positioned and qualified to be contributors in preparing for a pandemic and thereby enhancing and leveraging the best health outcomes for communities. During public health crises, regional public health departments frequently ask dentists to be a part of the crisis or disaster response team to assist in message distribution, leadership, volunteerism, and capturing of dental-provided urgent/emergent physical assessments as part of a triage process. Many first responders work in an environment where there are dental providers on staff, or with which they interact for meetings, networking and planning, continuing education, and other collaborative activities. Additionally, a significant function of emergency medical services is impacting medical control and system capacity. There are communities where dental care is included within a more holistic model of service or healthcare system. Emergency medical services must address matrixed and interrelated issues, whatever they may be, from which disaster or pandemic medical system impacts evolve for them, as well as all incidents and daily medical responses. Dental health and oral health must be a part of this approach for fires and other incidents. Also, ill oral health interplays with worsening communications and creates

misunderstanding. Emergency medical services, working with medical providers and leaders, promotes the prevention steps for events or illness. Included in many lists of prevention measures or steps for these public health issues are very emergency medical services-like approaches such as good nutrition and exercise, vaccination, and sleep, which are basic day-to-day processes that promote good health. Regular dental and oral examinations may not be, but their value is not in dispute. (Northridge et al., 2020)(Dickson-Swift et al., 2022)(Stennett & Tsakos, 2022)(de et al.2021)

3.6. Sociology and Community Engagement

During any health emergency, from a localized disaster through a major infectious disease outbreak, understanding the social consequences and drivers of decision-making is important for better preparedness. The introduction of sociological insights in this section encompasses the dual role of interaction between community and health system: effectively accessing the community's enormous, and often underutilized, resources is a yet-to-be-realized adjunct to community trust and cooperation that health services must have in order to work well during a crisis. The concept of community collaboration (pre-event) and resilient and adaptive communities (post-event) is integral to emergency services, with more being found in the next section. Strategies for interacting with diverse communities to ensure that all residents of a defined area receive an equitable share of available emergency medical services also figure here. (Bardosh et al.2020)(Alolabi et al., 2021) Culturally competent care is so closely regulated — with such variations from one community to another — that these protections are crucial for workforce and community safety as well. Moreover, an effective public health response to a novel pathogen will necessitate a knowledgeable and willing populace, that is, a health-literate community. For the community pulse can change, listening to residents through efficient feedback mechanisms is also a critically important “best practice,” both because it guarantees buy-in and because it enhances the public health capacity for continual improvement in the prevention of disease and health promotion efforts. This improved communication specifically aids vaccination campaigns, through which the community impact can quickly reach sufficient numbers to, at least, slow down the transmission of fast-moving, low-symptom infectious agents. (Calleja et al.2021)(Maljkovic et al.2020)(Chatterjee et al.2020)(Vraga & Jacobsen, 2020)(Khorram-Manesh et al.2024)(Alshahrani et al.2022)(Pereira et al., 2021)

4. Lessons Learned from Past Pandemics

During the last century, several pandemics took the world by surprise, resulting in serious global health, social, and economic consequences. In the aftermath of such crises, valuable lessons were learned and certain successes achieved. However, failures were also reported in terms of response management, particularly with emergency medical services called up to face new challenges. The complex backgrounds and established emergency medical services systems of the countries threatened by pandemics have commonly been reviewed and revealed operational aspects that healthcare planners and politicians must consider when addressing a new pandemic. Although still in effect, a review of successful management solutions created up until 2020 is a valuable approach in threat preparedness for the future. These solutions should be continuously reconstructed, using the re-evaluation of crisis aftermath to effectively capacitate threat mitigation strategies that are directly reflected within statutory and emergency medical services strategies.

Adapting proposed best practices, sometimes in conjunction with strategic steps, legislators can ensure that the failures of 20th-century pandemics are not repeated. Shared national and international responses strive to establish reaction strategies comprising immediate and sustainable solutions that are provided based on the correct exchange of all relevant information, efficient use of resources, timely provision of medical care, and openness. Let us review the recent past and showcase the lessons learned for future strategic crisis and operational planning and resource management. Compliance with these important principles has been displayed in the past during such threats as Severe Acute Respiratory Syndrome, avian influenza, and the Ebola outbreak. A review of pandemics and threats is necessary to evaluate all implemented strategies. This approach should be practiced on a continuous basis post-crisis in order to develop an effective rhythm for policies based on the findings—a procedure catalyzed by the establishment of the International Health Regulations. (Mayhew et al.2021)(Matuvanga et al.2022)(Pyone et al.2020)(Jegade et al.2020)(Ryan et al.2022)

4.1. Case Studies and Best Practices

Subsections 4.1 through 4.4 provide a retrospective on recent historic pandemics, helping to diagnose possible future scenarios to prevent, as well as a multinomic approach to managing current and future pandemics in the U.S. The case studies presented are valuable, as they reveal the aftermath of the economic, humanistic, and political landscape once the inability to prepare was realized. This section presents case studies on the following pandemics: the 1918-1919 H1N1 pandemic; the 2000 Western African Ebola outbreak; the 2014-2016 Eastern Western African Ebola virus outbreak; and the 2009 H1N1 pandemic in the U.S. Common intervention strategies and approaches that contributed to outcomes and could be applied to EMS crisis preparedness and response plans addressed by this framework are as follows.

4.1.1. Public Health Interventions. A major aspect of the decision-making process that consistently proved to highly impact outcomes for the better is the ability to understand the complexity of the pathogen and recognize that a combination of strategies and practices suited to the various vulnerabilities and densities of populations and the technical capacity of agencies are required. Between 1918 and 1919, the U.S. Public Health Service enforced a range of containment measures that varied across geographic and demographic areas. Close monitoring over long durations and constant re-evaluation was a pivotal tool utilized in past planning scenarios. Public awareness and public willingness to work with the government, and more specifically at the community level, was also crucial. Each of the governmental leaders during the above-listed interventions took a personal, prominent role in informing the public of the threat at regular intervals and of the planned multi-departmental response. Public meetings were held, in many cases throughout new cases. These case studies also reveal common failures during pandemics, particularly when the strategy was 'too little, too late.' Scholars repeatedly showed that wasteful bureaucratic policy failures stemmed from a lack of data. For example, there was no global regulation in place to prevent air traffic from transporting infectious individuals to new parts of the world, but even so, the current generation of the Department of Homeland Security has not nurtured contacts with airlines to facilitate data access for predictive analytics. Furthermore, outdated EMS data are accompanied by slow and small budgets. For public announcements of the presence of epidemics, guidance for clinicians as well as

laboratories, the U.S. government today has just \$58 million in its budget for community terrorist infrastructure preparedness (down from the 2009 stimulus-sponsored number of \$515 million). In 1983, the World Health Assembly intervened with the creation of the International Health Regulations. The regulations, designed to ensure control of the international spread of infectious diseases, impose a legal duty on the part of the governments to retain capacity for public health and response, encouraging the building of core surveillance and response capabilities at the local level. All the established procedures and interventions should be reevaluated on a new disease basis in the U.S. after the creation of ICECBV. This part is discussed further in the framework's section on decision making. (Bauer & Levitt, 2020)(Wambua, 2022)(Laszcz-Davis et al.2021)(Prah and Chanimbe2021)(Hindiyeh et al.2021)(Schmid, 2021)(Haque et al.2023)

5. Developing and Implementing Response Plans for Future Pandemics

Developing and implementing response plans prioritizes the acquisition of the capacities needed for MSEEMS. Risk assessment and scenario planning will prove invaluable for developing response plans for prospective pandemics and other emergencies, and provide a foundation to begin developing tools that this cross-cutting application seeks to lay the groundwork for. Efforts that harness the expertise of interdisciplinary researchers can expeditiously promote the implementation of response plans in U.S. EMS. As families and communities are essential to response efforts, and fear can be the most disabling factor of an emergency, training programs that are cost-effective and empower households and healthcare workers must be a key area of investment. Innovations that have significantly changed and benefited emergency care in recent years include developments in visualization technologies and data science, monitoring and diagnostics technologies that enable data-driven medical and transport decisions, and large-scale patient information sharing and coordination tools. Clarifying the roles, protocols, and expectations of all stakeholders during a pandemic is a critical step toward operational improvements and patient outcome enhancements. Conducting a tabletop exercise to walk through an operational response based on a proposed plan will help solidify and clarify roles, as well as isolate problems or needs for which there are proposed technology-based tools. The standard response plan, following this exercise, will provide specific guidance on the types of situations for which these technical tools will be beneficial. While not covered in depth, the same level of clear communication, protocol, and integration of new evidence and guidelines should be included in the special projects to be completed over the following three years—in other words, the strategic research, evaluation, and implementation elements that are at the heart of MSEMMS, and that will keep the plan relevant in a rapidly changing world. (Anozie et al.2024)(Landoll, 2021)(Hohenstein, 2022)(Rozak et al.2021)(Chowdhury et al.2023)(Wang et al.2020)(Obrenovic et al.2020)

5.1. Interdisciplinary Collaboration

A strategy for crisis preparedness of EMS systems involves developing tools to measure and evaluate them. Establishing crisis preparedness plans for EMS during pandemics requires cooperation among key aspects of healthcare organizations such as public health, primary care, disease control, inpatient services, and EMS to change established care pathways. This practice and change can be both an asset and a barrier in that the cooperation and integration of services may improve public health outcomes and utilize resources optimally. High-functioning and well-established teams draw from each of these

different fields, including all levels of medical care from lay responders to advanced nurses and occupational voices. Crisis readiness plans that are built on interdisciplinary research starting at the advanced level of a master's degree in the various medical and nursing fields may offer the best solutions in understanding the unique aspects of a pandemic, infectious disease, and outbreaks. (Farhat et al.2024)(Guo et al.2024)(Muqteet et al.2021)(Al-Sawalha et al.2024)

One strategy is built on a model or unified structure for developing outputs in an interdisciplinary manner, allowing participation of people from nursing and multiple disciplines. Case studies showcase interprofessional examples, including working together in a safe setting during pandemic disaster planning and response in the aftermath of a significant event. However, current research also reports barriers to true interprofessional education such as expense, administrative support for increasing budgets, costs and time, as well as competition for funds. Certifications that acknowledge a level of competency in interprofessional education have yet to be addressed. Building networks and relationships prior to disasters in the form of electives, research interest groups, research projects, and networking during interprofessional education events will enable productive communication to occur. This cooperation may likely solve some of the initial challenges to presenting these data in a social context. Including medical and nursing students in EMS issues and training will begin to reframe and understand the various roles of a healthcare team that focuses on creating a culture of safety for the patient as priority one. The life cycle approach of prevention, preparedness, response, and recovery when applied to all dangers identifies that in any community, something negative may happen. Preparing for all disasters means learning about predictable events, specific aspects of the populations, clusters of people with similar health conditions, systems and support utilized, and the resulting health outcomes that may not be facility or disease-specific. Much of the current research focuses on nurses and their role in occupational health in relation to disaster and bioterrorism. Nurses work in participation with other team members such as paramedics and medical technicians in communities across the globe to perform preventive services such as child exams, youth concussion prevention, care for victims of violence, and work from response to recovery for this increasingly diverse set of diseases, natural, human, or environmental disaster. In all instances, we work outside of hospital walls and the traditional acute care nursing role. This mass medical care in the community serves a baseline need of the public in a proactive manner prior to disaster or threat impact.

5.2. Training and Education Programs

Incorporation of crisis preparedness into professional development and training programs. A strategic framework for crises and pandemics should include educational sessions for a variety of personnel at varying levels of the healthcare system. Continued training, education, and refreshers should be part of ongoing program development and expansion to maintain levels of pandemic preparedness. Simulated exercises, or tabletop exercises, are one of the simulation modalities. This modality is usually conducted with the participation of key decision-makers and subject matter experts as a way to discuss complex and multi-faceted scenarios, as well as to understand likely outcomes of decisions, as a supplement to the findings of studies and more formal analysis. Simulated exercises, or workshops, and courses can be used as training tools to provide both academic and practical experience aimed at healthcare providers working to gain new skills or to refresh

old skills needed for responding to a pandemic, such as infection control precautions, vaccination, and supply chain logistics. (Aruru et al.2021)(Timmis & Brüssow, 2020)(Meghana et al.2021)(Shah et al.2020)

Community stakeholders should also be included in these programs, as public risk communication and stakeholder engagement are components of pandemic preparedness and response. The training program must be monitored and evaluated, then revised and re-implemented based on the evaluation findings. The lessons learned from previous pandemics or public health crises with emergency medical services clinical criteria can be incorporated into the training programs. Ongoing professional development includes didactics for educational information, which can include such modalities as lectures, webinars, and online or electronic courses. A variety of hands-on modalities can also be included, which can include, but is not limited to, simulations, exercises, and drills. Educational programs should include various stakeholders as part of the training, including EMS personnel, allied health professionals, community clinics and pharmacies, first responders, hospitals, long-term care, psychosocial mental health workers, public health, and patient monitoring from voluntary self-reporting and sentinel healthcare settings. Topics for educational programs should be tailored for a specific audience and can include, but not be limited to, clinical, general emergency management approaches, and emergency medical services law. It is well documented that any intervention, including educational, should be monitored, evaluated, and modified or altered based on the evaluation. This process allows for continuous quality improvement. (Tambo et al.2021)(Fissi et al.2022)(Khan et al.2022)(Zikargae, 2020)(Health Organization, 2020)

5.3. Technological Innovations in EMS

Apart from irritants, technological innovations present numerous opportunities and can transform current practices of Emergency Medical Services. As for pandemic and disaster management, breakthroughs in telehealth and new medicines can contribute significantly to increasing access to care, reducing facility-based care burden, concentrating efforts on providing care to the vulnerable elderly segment of the population, reducing casual shamanism, ensuring more equitable and continuous delivery of care and medicine, and ensuring a reliable supply of medication to the patient through e-prescription mechanisms. (Ye, 2020)(Shah et al.2020)(Lee and Yoon2021)(Tabatabai2020)(Alowais et al.2023)

Many countries have effectively used mobile health applications during the COVID-19 pandemic in a variety of complementary roles including self-assessment tools, contact tracing for infected patients, public health general support, and contact alerts. Many Emergency Medical Services have developed a number of solutions aimed at helping professionals decide on appropriate patient care or developing analytical solutions to utilize big data through electronic health records to perform patient tracking, generate automated alerts to control the flow of patients, track distributed resources such as ventilator availability, and develop specialized tracking and triage tools for clinical resources such as ventilators. Despite the opportunities, however, integrating any emerging technology requires several behavioral and adaptive challenges, especially regarding accessibility and the digital divide. Currently, poor or vulnerable populations may not possess the technology required for integration or greater accessibility. Additionally, adapting to the operation and troubleshooting of these technologies often requires new training. (Singh et al., 2020)(Williams et al.2020)(Ming et al.2020)(Alsahli and Hor2024)

One of the trends in recent decades is the development of nanotechnology and its integration into healthcare. The potential value of these nano/microelectromechanical systems has been demonstrated in many studies through the engineering of relevant sensors or devices for detecting various potential biomarkers. The value of this technology in medical diagnosis can be understood perfectly in the potential for early biomarker warning mechanisms for systemic diseases that can undergo pandemic transitions. These non-invasive detection programs can be carried out in environments where wide availability of resources does not exist. Recent transitions from 4G into 5G and the growing ability of the Internet to support a large degree of automation and autonomy can contribute significantly to optimizing response. However, investing in the continuous evolution of 6G design should also be seen as a forward-planning investment, with a large number of resources aimed at conducting research and development in coordination with several other essential technical and non-technical stakeholders. Technological support is equally important to support the change in cardiopulmonary resuscitation guidelines, including buffering the ventilator limitations in secluded settings, and in technological innovation in the equipment essential for operations and procedures. With a new focus on the role of emergency medical services, new research themes and problem-solving needs might emerge. This provides an opportunity for new ideas and feasible paths leading to both concurrent research and innovation for application in real crises/disasters and development in readiness for any pandemic. (Kwong et al.2021)(Hung et al., 2020)(Li et al.2023)(Schöll et al.2024)(Pickkers et al.2021)

6. Conclusion and Recommendations

The COVID-19 pandemic has resulted in catastrophic consequences for healthcare infrastructures, economies, and societies around the world. We have learned a great deal about the response to infectious diseases over the last year, and these lessons can be utilized to improve responses to future similar events. Better education and training will result in better preparation, better strategies, and more resilience should we face additional waves of the current pandemic or future sporadic outbreaks of this coronavirus or others. Utilizing a systems approach to draw upon all the resources of the healthcare infrastructure, including those currently dormant in the private sector and communities, can further increase preparedness. We recommend additional resources be committed to the strategies proposed in the consensus statements generated from the numerous studies now being conducted on national and local responses to the pandemic. Crisis response and time-sensitive decision-making can be instrumental in effectively treating mass casualty patients anywhere at any time.

The Prioritizing Assessment Tool can fill critical gaps outlined in this strategic framework analysis conclusion by incorporating the recommendations of experts, healthcare workers, and stakeholders as they are generated. Additionally, the Planning Triangle over Time Assessment Tool will allow for integration and validation of research, experts, and recommendations in advance, addressing issues of mitigation, planning, value of concepts, and organizational stewardship. Future research will continue to advance our growing understanding of how to balance competing commitments such as maintaining standards of care in crises and accommodating for empirical and ethical concerns with managing the resources needed for the management of the COVID-19 pandemic. Collaborative research across sectors and disciplines is necessary to seek potential solutions to these tough

questions as well as those that will present themselves in future pandemics. Continuing to work together to develop solutions will ensure we make the morally sound application of available guidelines and mutual aid during future pandemic crises.

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