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Resilient emergency medical systems for 21st-century complex world

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Abstract

The 21st-century global health landscape presents unprecedented challenges, such as antimicrobial resistance, mental health issues, and the rapid spread of infectious diseases due to urbanization and mobility. The Sendai Framework and initiatives such as Singapore's analytics in combating dengue exemplify the push for disaster risk reduction and advanced preparedness. The recent pandemic has underscored the vulnerabilities of health systems, highlighting the need for telehealth and improved emergency response capacities. Military-civilian partnerships and psychological support for healthcare workers have emerged as some critical components. Embracing an all-hazard approach and prioritizing environmental and psychological resilience are key to a robust, culturally sensitive global health strategy, emphasizing the importance of open-access research for comprehensive global preparedness.

Keywords: 21st-Century health challenges, Civil-military collaboration, Disaster resilience, Emergency medical systems, Resilient health systems, Sendai Framework

Introduction

The transformation of global health in our intricately connected world is marked by complexities that demand innovative, patient-focused, and resilient strategies, as anticipated by organizations like the United Nations and World Health Organization (WHO). They foresee health threats in the 21st century as being unprecedented, necessitating collaborative efforts that span the public and private sectors.[1–3]

Given the ever-evolving nature of global health challenges, it is imperative to emphasize the role of cutting-edge technology and innovation in reshaping emergency medical systems. The rapid advancements in digital health, artificial intelligence, and mobile health technologies are not just ancillary tools but pivotal in enhancing the efficiency and reach of emergency responses. This technological revolution offers promising avenues for real-time health monitoring, rapid diagnostics, and seamless communication across various health networks. The integration of such technologies is crucial in creating a more agile and responsive health system, capable of adapting to the dynamic and unpredictable nature of modern health emergencies. By harnessing the power of these innovations, we can bridge critical gaps in emergency preparedness and ensure a swift, coordinated response to health crises.

The ongoing global crisis has brought to light a pervasive fear of potential new crises. It is now abundantly clear that the current state of preparedness for multifactorial events and emerging risks is inadequate. There is an urgent need for innovative tools and strategies to augment existing preparedness efforts by pinpointing gaps and deficiencies within the current system, as extensively discussed in recent literature.[4]

Moreover, the management of diverse events needs genuine collaboration among a spectrum of agencies. As these stakeholders in the emergency management ecosystem grow more acquainted with their roles and responsibilities, they naturally progress toward a state of readiness to pool their resources, encompassing both personal and material assets. However, this state of coordination must evolve into a higher form of cooperation, one that aspires to formulate comprehensive guidelines and directives. These instruments serve as navigational aids for each agency, delineating the operational and tactical facets of emergency management with precision and clarity.[5,6]

Although most emergencies may be adequately addressed through these initial steps, there exist extraordinary situations, exemplified by the global response to the coronavirus disease 2019 (COVID-19) pandemic, wherein all agencies are collectively mobilized toward a singular objective—the eradication of the root cause of the incident. These exigencies demand a level of collaboration that seeks to oversee the situation following a structural process, ensuring that all partners are aligned toward a shared goal. This coordinated approach, illustrated by the international efforts to combat the pandemic, underscores the critical importance of synchronized action to effectively manage complex, large-scale emergencies.[5]

Adopting an all-hazards paradigm

The Sendai Framework for Disaster Risk Reduction, adopted in Sendai, Japan, in 2015, embodies a collective approach to mitigating health risks associated with disasters. Its vision encompasses reducing fatalities, enhancing population well-being, and ensuring the integrity of health facilities. By addressing disaster risks on multiple fronts, it aims to curtail new risks, diminish current ones, and

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bolster resilience. In the pursuit of these targets, leveraging technology, such as data analytics and artificial intelligence, plays a crucial role in enhancing predictive capabilities and optimizing disaster risk management.[7] The embracement of an all-hazard paradigm, as a rubric for preparedness, avails a comprehensive framework that transcends discrete disaster typologies. Embedded within this paradigmatic rubric is the imperative of incorporating environmental and climatological considerations, given the palpable imprint of climate change on the frequency and ferocity of calamities. Multiagency disaster preparedness delineations, standard operating procedures, and legal frameworks are de rigueur in offering a holistic riposte. The psychological well-being of afflicted populations mandates prioritization, with a mosaic of strategies devised to furnish commensurate mental health support in tandem with physical health services in the aftermath of disasters.[5,8]

This holistic approach, as encapsulated by the all-hazard paradigm, necessitates a versatile response mechanism, adaptable to a wide array of disaster scenarios. The integration of environmental and climate considerations reflects a profound acknowledgment of the changing nature of global threats. The emphasis on multiagency coordination underscores the importance of seamless collaboration across various sectors. This multidisciplinary approach, combining technical expertise, environmental awareness, and legal infrastructure, forms a robust foundation for effective disaster risk management. In this context, the psychological impact of disasters on affected communities is increasingly recognized, necessitating the integration of mental health support into emergency medical systems. This shift marks a significant advancement in our understanding of comprehensive disaster response, where physical health and mental health are addressed with equal importance.[9–11]

Emerging health complexities

As we delve into the complexities of emergency responses in the 21st century, the roles of high-reliability organizations such as emergency medical services (EMS), rescue teams, and police become increasingly pivotal. These entities, often the first responders in crises, form the cornerstone of emergency management, ensuring public safety and welfare. The evolution of their collaboration models reflects the changing landscape of emergency response, where adaptability, efficiency, and synchronization are key. As such, understanding the nuances of these collaboration models—sequential, parallel, and synchronized—provides valuable insights into the effectiveness and challenges of modern emergency response systems. This understanding is crucial in addressing emerging global health challenges, where a coordinated and comprehensive approach is essential for effective crisis management.[12,13]

In an emergency response, the pivotal role played by 3 high-reliability organizations cannot be overstated. Over time, the collaboration between these organizations has evolved, particularly in some countries, progressing through different stages of collaboration models, from sequential to parallel, and ultimately culminating in synchronized collaboration.[8,12–16]

Sequential collaboration, a prevalent approach in many countries, entails specialists or agencies working in a linear sequence, with each entity taking charge in a predetermined order, and no overlap in their operational timelines. This model, although well-established, may at times prove less adaptable to the dynamic and rapidly evolving nature of emergencies.[8,12,13,15,16]

Parallel collaboration, on the other hand, represents a paradigm shift toward simultaneous action. Here, 2 or more specialists or agencies work concurrently, albeit with distinct objectives or areas of focus. Although this approach signifies progress in terms of efficiency and resource utilization, it may still fall short of achieving the highest level of synergy.[8,12,13,15,16]

Synchronized collaboration, the pinnacle of emergency response coordination, epitomizes seamless teamwork. In this model, specialists or agencies work in concert, pooling their expertise, resources, and efforts toward a shared objective. This unified approach not only optimizes the use of resources but also enhances the overall effectiveness of the emergency response. It ensures that all stakeholders are aligned in purpose and work in harmony to mitigate the crisis at hand.[8,12,13,15,16]

To illustrate the importance of synchronized collaboration, we can look at pressing global health challenges such as the rise of antimicrobial resistance and the surge in mental health issues. These multifaceted issues demand a comprehensive and integrated response from various stakeholders. By working together in synchronized collaboration, organizations such as EMS, rescue teams, and police can collectively address these challenges with greater efficacy and impact, ultimately safeguarding public health and well-being.[15]

Antimicrobial resistance

The specter of antimicrobial resistance, wherein microorganisms evolve mechanisms to withstand the therapeutic effects of antimicrobial agents, is emblematic of a profound contemporary health challenge. A prime illustration is Singapore's response to the dengue outbreak, where predictive analytics were deployed to identify potential hotspots, enabling targeted interventions before the situation escalated.[17]

Recent pandemics have laid bare the vulnerabilities of emergency medical systems worldwide, propelling the need for robust preparedness and adaptive responses.[18] The pandemic's onslaught has amplified the demand for healthcare and exposed inequities, especially in underserved regions. It underscored the necessity for a coordinated global response and the potential of national defense forces to reinforce strained health systems.[19] The ethical considerations that have emerged, particularly the difficult choices healthcare workers must make when resources are scarce, have sparked a global dialogue on refining medical ethics and protocols in emergencies.[20] The pandemic has also underscored the critical role of telehealth, which emerged as a linchpin for uninterrupted healthcare delivery.[21] Telemedicine bridged the care continuum when traditional healthcare pathways were disrupted.[18,22,23]

The rapid urbanization and increased global mobility add another layer of complexity, as they can accelerate the spread of infectious diseases. Our emergency medical systems must evolve to keep pace with the changing epidemiological landscape, ensuring swift containment and treatment. These challenges require a sophisticated understanding of health systems and the interplay between human behavior and disease.[22]

Mental health versus the interplay of environmental, warfare, demographic, and economic factors

Environmental calamities, warfare, demographic shifts, and economic challenges intertwine, affecting nations, particularly those with limited resources, thus disrupting developmental strides in health systems. Panoply of intricate determinants, including environmental perturbations, geopolitical conflicts, demographic transitions, and economic vicissitudes, converges to sculpt the contours of global health. Environmental exigencies, ranging from natural disasters to anthropogenic ecological perturbations, precipitate cascading health ramifications. Simultaneously, demographic shifts, marked by aging populations and epidemiological transitions, augur distinct health profiles.[24] All these factors have a decisive impact on the mental health of

populations, including EMS staff. As these events require staff, stuff, space, and system, the 4 S of surge capacity, effort must be put into achieving diverse strategies, aiming to guarantee resource availability in all possible scenarios. Without an educated and willing staff, there is no chance of overcoming an incident successfully.[14]

Amid the challenges of antimicrobial resistance, the interplay of rapid urbanization and global mobility demands heightened vigilance.[25] As urban centers grow and people travel more frequently, the risk of rapid disease spread increases. Emergency medical systems must therefore focus not only on direct medical responses but also on proactive measures like urban health planning and international disease surveillance. These efforts should aim to preemptively identify and contain potential outbreaks, ensuring rapid response capabilities are in sync with the pace of global mobility and urban growth. This proactive stance is essential for mitigating the far-reaching impacts of antimicrobial resistance in our interconnected world.[18]

Enhancing EMS

The intersection of mental health with environmental, warfare, demographic, and economic factors presents a complex tapestry of challenges. These interrelated dynamics significantly strain EMS, emphasizing the need for a multifaceted approach to healthcare. Addressing mental health in this context is not merely an add-on but a fundamental component of comprehensive health strategies.[26] The emergency response systems must thus be equipped to handle the psychological aftermath of crises, ensuring mental health support is as readily available as physical health care. This approach necessitates a broadened understanding of emergency medicine, recognizing that the psychological resilience of both the affected populations and emergency responders is pivotal in navigating through these multifaceted crises. To enhance EMS, surge capacity for large-scale disasters is imperative. This encompasses augmenting emergency and intensive care facilities, mobilizing healthcare personnel, and ensuring the readiness of medical supplies.[27] An essential aspect of surge capacity is the cross-disciplinary training of medical staff. This flexibility allows healthcare systems to deploy a versatile workforce capable of managing diverse medical emergencies. Innovative strategies, like the conversion of nontraditional spaces into care areas and the deployment of mobile hospital units, have been instrumental.[28] Equally crucial is the psychological preparedness of healthcare workers. Developing their mental resilience through training and establishing support systems is essential to sustain the workforce during and after crises.[5,14,29]

Interagency collaboration is vital when facing catastrophic events. Essential services need to act in concert to ensure effective healthcare delivery amid infrastructural damages and resource limitations. A unified communication platform that prevents misinformation is equally critical, as the spread of false information can hinder effective response and recovery efforts.

Moreover, the inclusion of community organizations in emergency planning and response efforts is vital. Their grassroots presence and trust within localities can be leveraged to amplify the effectiveness of disaster management initiatives. A federal governing body, backed by legislation and funding, can spearhead such efforts, facilitating cooperation among various stakeholders.[30]

The WHO's Emergency Medical Teams Initiative, born out of the 2010 Haiti earthquake aftermath, represents a global alliance of medical teams poised for prompt emergency response. Their self-sufficiency and adherence to quality standards underpin their mission to assist affected populations and support local health systems. To bolster this initiative, standardizing training and response protocols across different countries is vital for a synchronized and effective international disaster response. A global registry of healthcare professionals, ready for deployment, could further streamline international aid, ensuring timely and organized emergency medical assistance where it is most needed.[31]

Civilian-military collaboration

Military partnerships bring to the table advanced trauma care capabilities, essential in large-scale disaster scenarios. Such preexisting alliances can lead to swift, coordinated action during crises, translating military expertise to civilian applications. The logistics and supply chain expertise that the military offers can greatly enhance the efficiency and effectiveness of civilian disaster response efforts. Although the integration of military resources in civilian emergencies offers vast potential, it is imperative to consider the ethical frameworks governing such engagements to maintain trust and protect vulnerable populations.[32–35]

In the United States, adopting an all-hazard paradigm streamlines preparedness for various emergencies, fostering a unified approach that transcends specific disaster types. Within this paradigm, incorporating environmental and climate considerations is paramount, as climate change is a significant factor that influences the frequency and severity of hazards. Multiagency disaster preparedness plans, standard operating protocols, and legal frameworks are pivotal for a comprehensive response. The psychological well-being of affected populations must also be a priority, with strategies in place to provide mental health support alongside physical health services in the aftermath of disasters.[36]

Some other nations have explored the concept of disaster resource hospitals, centralizing expertise, and resources for a coordinated response to massive disasters.[37] These efforts are complemented by international partnerships and the sharing of best practices among disaster resource hospitals, fostering a global network of preparedness. Political leadership, robust policy-making, and stable financing are the cornerstones of these initiatives, ensuring their effectiveness and longevity. For disaster resource hospitals to be effective, they require resilient infrastructures, such as advanced Information Technology (IT) systems for managing patient data and reliable backup power sources to ensure continuous operation during crises.[38]

Collaboration with communities

The integration of community-based organizations into the schema of emergency planning and response represents an axiomatic exigency. These entities, rooted in the grassroots fabric of localities, proffer an invaluable conduit for amplifying the efficacy of disaster management initiatives. A federally sanctioned governing entity, buttressed by legislative mandate and allocational largesse, assumes a catalytic role in shepherding such initiatives, thereby facilitating harmonized cooperation among an array of stakeholders.[39]

During the COVID-19 pandemic, several collaborative projects with communities were conducted globally[40–42] In Bangkok, Home Isolation Centers were created by locally active physicians and nurses, who use local resources for caring for infected patients, preventing emergency admission to the overloaded hospitals. A common communication app, "LINE," was used to communicate with suspect cases. After registration and confirmation of the sickness, the tests were carried out by offering free test kits to the patients. If the test result was positive, the patient was offered a pulse oximeter and medication if necessary. All materials were given to the patients free of charge and financed by donations. Logistics were managed by local staff and voluntary companies and organizations. For 6 months, these centers managed over 6000 patients and prevented unnecessary

admissions to the hospital. Only 3 patients had to be admitted due to the deterioration of their medical condition.[29] This study is indicative of the use of community resources, telehealth, and local logistics.

Beyond the successful case of Bangkok's Home Isolation Centers, the principle of community engagement has proven vital in diverse global contexts.[40–42] The integration of local knowledge, resources, and networks into emergency response frameworks can significantly amplify their effectiveness. For instance, in rural areas, leveraging local community leaders and organizations can aid in disseminating critical information and organizing grassroots-level response efforts. This community-based approach fosters a sense of ownership and responsibility among local populations, leading to more sustainable and effective disaster management practices. Emergency response planners must recognize and harness these local capacities, tailoring interventions to fit the unique sociocultural fabric of each community.[43]

Empirical research and cultural sensitivities

Finally, empirical research and data-driven insights are critical to evolving disaster response strategies. Institutionalized learning from past events shapes future preparedness, whereas global solidarity and shared knowledge strengthen the collective capability to face emerging global health challenges by becoming more proactive in acting and decision-making. In this spirit, it is essential to acknowledge and integrate cultural sensitivities and diverse perspectives in global health strategies to ensure that the response is not only effective but also culturally respectful.[44] This vision of cooperation and preparedness was echoed by the emergency and critical care community during a conference at Shandong University (China), advocating for a united front against the dynamic landscape of global health threats.[45] An instance of a culturally nuanced strategy was seen in Japan, where disaster response incorporated local customs into evacuation procedures, thereby ensuring community compliance and preserving cultural dignity.[46] International bodies need to fund disaster medicine research and advocate for open-access policies to research findings. This approach will democratize knowledge and foster global preparedness.[47]

The integration of cultural sensitivities in disaster response is not just about respect and compliance; it is about effectiveness and efficiency. Cultural awareness can significantly influence the success of emergency interventions. For instance, understanding local communication styles, social norms, and religious practices can greatly impact the acceptance and success of health initiatives during crises.[48] Empirical research in disaster medicine should therefore prioritize studying these cultural dynamics, ensuring that response strategies are not only scientifically sound but also culturally congruent. This approach enhances the relevance and acceptance of emergency interventions, ultimately leading to more successful outcomes.

As we draw this discussion to a close, it becomes increasingly evident that the landscape of emergency medical systems in the 21st century is one marked by profound complexity and unprecedented challenges. This communication has sought to illuminate the multifaceted and interconnected nature of these challenges, ranging from the persistent threat of antimicrobial resistance to the emergent issues shaped by environmental, demographic, and economic shifts. It is clear that the traditional paradigms of emergency response are no longer sufficient; we must pivot toward more innovative, adaptable, and culturally nuanced strategies to keep pace with these evolving demands.

The case studies and examples cited herein, such as the innovative community-led Home Isolation Centers in Bangkok, demonstrate the immense potential and efficacy of grassroots collaboration in enhancing disaster management.[39] These initiatives are not only commendable for their immediate impact but also serve as beacons, guiding us toward a more inclusive and community-oriented approach in emergency medicine. Furthermore, the evolution in the collaborative dynamics among key emergency response entities, such as EMS, rescue teams, and police, reflects a significant and necessary shift toward more synchronized and cohesive action in times of crisis.

This communication has highlighted the indispensable role of cultural sensitivities and empirical research in formulating effective emergency response strategies. The integration of these elements ensures that our approaches not only are scientifically robust but also resonate with the diverse cultural tapestries of the communities we serve. As the global health landscape continues to evolve, our emergency response systems must be not only reactive but also proactive, anticipating challenges and preparing for them with a comprehensive understanding of the cultural and social contexts in which they operate.

In conclusion, this communication advocates for a paradigm shift in approaching emergency medical systems, a shift that embraces a proactive stance, values the power of community engagement, and recognizes the critical need for cultural sensitivity. As we face the challenges of the 21st century, let us commit to building emergency medical systems that are not only resilient and robust but also compassionate and culturally attuned. Such an approach will not only enhance the efficacy of our current systems but will also lay a solid foundation for a more responsive and resilient healthcare framework, capable of addressing the myriad challenges that lie ahead in our interconnected world.

Conflict of interest statement

The authors declare no conflict of interest.

Author contributions

All authors contributed to conceptualizing, literature review, manuscript writing, reviewing, and final approval of the manuscript.

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