

The Role of Emerging Technology in Healthcare Emergency Planning and Response

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ABSTRACT

Disaster risk reduction is a pressing global concern. The frequency and severity of disasters have been increasing across the globe with millions of casualties each year. There are considerable gaps in knowledge and strategies to mitigate losses and optimize recovery efforts in health emergencies. Disasters pose unique challenges to health systems as resources are overwhelmed, infrastructure is damaged, and medical services are disrupted. Emerging technologies such as Artificial Intelligence represent promising next steps to guide disasters planning and response strategies. Artificial Intelligence algorithms have demonstrated the ability to forecast some disaster events including severe droughts, floods, wildfires, and earthquakes. These emerging technologies have the potential to revolutionize current disaster mitigation strategies by providing real-time and data-driven insights to aid decision-making before and during health emergencies. With the increasing impacts of climate change and increasing morbidity and mortality from disasters, it is a timely opportunity to explore the contribution that new technology tools may provide to disaster mitigation.

Keywords: Artificial intelligence, Emerging technology, Disaster planning, Disaster response, Disaster resiliency, Health emergencies

INTRODUCTION

Disaster risk reduction is a pressing global concern and is among the UN's Sustainable Development Goals (Parker 2020). Effective planning and response mechanisms are essential to mitigate losses and optimize recovery efforts for health emergencies (Lamsal and Kumar 2020). The emergence of new advanced technologies has introduced opportunities to strengthen and even revolutionize existing disaster management strategies. Technological tools such as Artificial Intelligence (AI), Internet of Things (IoT), remote sensing, and data analytics are increasingly being implemented to enhance the emergency planning and response to events such as floods, wildfires

and earthquakes (Munawar et al., 2022). AI has been described as machine algorithms performing tasks that were traditionally performed by humans (Seitzinger and Kalra 2022) and has been proposed as a particularly promising tool to address current pressing challenges in disaster planning and response (Gupta et al., 2022). These emerging technologies have the potential to revolutionize disaster mitigation by providing real-time decision-making tools due to their ability to analyze massive amounts of data from diverse sources such as historical trends, weather data, satellite imagery, and GPS data to provide data-driven insights and recommendations before and during health emergencies.

THE LANDSCAPE OF HEALTHCARE EMERGENCIES

The frequency and severity of disasters have been increasing across the globe (Ludwig et al., 2017). A disaster is defined as ‘a serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources’ (Cao 2023). These include natural disasters such as earthquakes, hurricanes, flooding and wildfires and human-made disasters such as accidents, chemical spills and terrorism. Each type of disaster poses unique challenges to the affected populations and health systems as resources are overwhelmed, infrastructure is damaged and medical services are disrupted. Learning from previous disasters including impacts on the most vulnerable portions of the population and health systems can inform adaptive disaster management strategies. Compared to men, women and children are 14 times more likely to die during disasters (Arora-Jonsson 2011). There are considerable gaps in knowledge and strategies for disaster planning and mitigation (Munawar et al., 2022). Sectors involved in pre and post-disaster management are placing great value on the contribution of technologies such as AI in disaster management (Kankanamge et al., 2021). With the increasing impacts of climate change and increasing morbidity and mortality from disasters, it is a timely opportunity to explore the contribution that new technology tools may provide in the endeavor to mitigate the effects of disasters.

ARTIFICIAL INTELLIGENCE IN EMERGENCY PLANNING

Planning for disasters is a complex task that requires multi-modal methods of data collection. Disaster resiliency requires pre-emptive allocation of resources, public awareness and preparation and detailed response strategies adapted to the circumstances of the event and affected population. Key challenges to disaster planning include data availability, data accuracy and efficiency of analyses. There is a widely acknowledged need to forecast extreme events to prepare mitigation strategies (Adikari et al., 2021). AI algorithms have demonstrated the ability to recognize patterns and develop predictive models to anticipate the path, severity, and potential impacts of certain disasters. AI-driven models have demonstrated considerable capabilities and accuracy in forecasting events. AI systems have been used to predict

severe droughts to guide the allocation of critical water services (Adikari et al., 2021). These types of AI algorithms have been used to predict brushfires to prepare and evacuate affected individuals in the region (Halgamuge et al., 2020). Semantic analyses have been conducted by AI on Twitter posts, thereby calculating the center and trajectory of earthquakes, and designing early warning systems (Sakaki et al., 2013). These examples highlight the capabilities and potential applications of AI systems to strengthen early warnings, timely evacuations, and resource allocation.

ARTIFICIAL INTELLIGENCE IN EMERGENCY RESPONSE

The pillars of disaster response are minimizing losses and optimizing recovery strategies (Lamsal and Kumar 2020). To accomplish these goals, vast amounts of data must be collected, analyzed, and summarized to inform appropriate response strategies. Traditionally, these tasks overwhelm already stretched resources during disasters, leaving disaster response personnel to make critical decisions based on incomplete information. AI presents a tool to process large quantities of data quickly and accurately to provide disaster managers with actionable insights during response efforts. Studies have shown these AI-augmented response strategies to amplify the accuracy of response strategies, streamline key interventions and decrease overall costs (Moitra et al., 2022). AI systems have been implemented to analyze social media posts to identify trapped victims and optimize rescue strategies (Yang et al., 2020). These types of AI algorithms have been implemented to minimize fatalities and guide evacuation plans and optimize the quantity delivered and optimal transportation routes of essential supplies (Zarghami and Dumrak 2021). In these ways, AI has optimized resource allocation by analyzing real-time data from various sources, guiding the distribution of medical supplies, emergency personnel, and logistical support to where they are most needed. By providing real-time information and strategic recommendations, AI systems facilitate coordinated response efforts and resource management during disasters.

ETHICAL AND SOCIAL CONSIDERATIONS

The integration of AI into disaster planning and response strategies carries important ethical implications. Addressing these challenges proactively is essential to ensure the equitable, and safe deployment of these new AI technologies. Bias mitigation should be an integral and ongoing component of implementation strategies to prevent potentially inequitable and biased outcomes. For example, without bias mitigation, strategies to analyze social media images and posts to inform response efforts introduce a bias toward subsets of the population that have access to smartphones (Yang et al., 2020). In disaster scenarios, even small decisions and errors can have drastic outcomes. These decisions are often made based on partial and incomplete information. While AI may provide a more complete perspective with data-driven insights, perfect accuracy is not attainable (Seitzinger et al., 2021). Understanding the role and limitations of tools and information sources

is a key component in addressing questions of accountability (Kalra and Seitzinger 2022). Privacy concerns are a central concern when collecting and analyzing data during health emergencies. While this information is essential in acute situations, safeguards should be put in place to ensure the data provided is not used for ancillary purposes. Navigating these challenges and finding an appropriate balance of addressing pressing needs with safeguarding privacy and ensuring equity are essential components of successfully incorporating AI into disaster response.

FUTURE DIRECTIONS

The growing capabilities of AI technology provide valuable opportunities for the future of disaster management. These novel tools are anticipated to continue to inform potential prediction models, deliver data-driven response recommendations, and enhance disaster resilience. The implementation of these capabilities into existing disaster response systems has the potential to mitigate considerable morbidity and mortality. Recognizing the capabilities, limitations, and roles of these tools in disaster response efforts will require continuous adaptation and re-evaluation. Appropriate implementation will require interdisciplinary collaboration between AI experts, government and non-governmental organizations, and disaster management teams to ensure the right tools are implemented at the right time and in the right way.

CONCLUSION

Planning for disasters is an important and complex endeavour that requires the best available AI technologies to assist affected populations. These new tools have the potential to prevent injuries and minimize fatalities. Realizing the potential advantages of AI in disaster management requires sustained collaboration, adaptability, and ethical implementation. Disaster resilience can only be achieved through a symbiosis of human resources and emerging technological advances (Lamanna et al., 2012). By leveraging emerging technology and AI, we have the opportunity to revolutionize disaster management practices and enhance our ability to respond effectively to health emergencies.

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