(REVIEW ARTICLE)

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Healthcare management in a post-pandemic world: Lessons learned and future preparedness: A review

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Abstract

This review paper examines the profound impacts of the COVID-19 pandemic on healthcare management, highlighting lessons learned and proposing strategies for future preparedness. It explores the immediate challenges healthcare systems face, such as resource allocation and staff shortages. It discusses the rapid adaptations and innovations that emerged, including the expansion of telehealth and digital health technologies. The paper also reviews policy and management adjustments. It applies theoretical frameworks like organizational change, crisis management, and health systems resilience to understand these changes. Key findings emphasize the importance of resilience, flexibility, and innovation in healthcare management. Recommendations for practice and policy focus on enhancing public health infrastructure, investing in digital health, and fostering international cooperation. The paper concludes with directions for future research, including the evaluation of digital health interventions and strategies to address healthcare disparities, underscoring the need for a robust, adaptive, and equitable healthcare system in the post-pandemic world.

Keywords: COVID-19 pandemic; Healthcare management; Digital health technologies; Crisis management theory; Healthcare system resilience

1. Introduction

The COVID-19 pandemic, emerging in late 2019 and was declared a global pandemic by the World Health Organization (WHO) in March 2020, has unprecedentedly impacted global healthcare systems (Leite, Lindsay, & Kumar, 2020; Sohrabi et al., 2020; Stawicki et al., 2020). Characterized by its high transmissibility and significant mortality rate, especially among vulnerable populations, the pandemic stressed healthcare infrastructures, challenged medical supply chains, and necessitated rapid shifts in healthcare delivery models. Countries worldwide grappled with surges in patient volumes and shortages of personal protective equipment (PPE), ventilators, and critical care resources, highlighting existing vulnerabilities and resilience in global healthcare systems (Ciotti et al., 2020; Lone & Ahmad, 2020). The pandemic also accelerated the adoption of digital health technologies, including telemedicine and electronic health records, reshaping patient care delivery. Additionally, it underscored the importance of public health policies, workforce management, and cross-sectoral collaboration in managing health crises (Mbunge, Muchemwa, & Batani, 2021; Sust et al., 2020).

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This review aims to synthesize and analyze the significant changes in healthcare management during and after the COVID-19 pandemic, focusing on identifying lessons learned and how these insights can guide future preparedness and policy-making. It seeks to understand the dynamic responses of healthcare systems to the pandemic, including immediate adaptations and long-term transformations. By examining the evolution of healthcare management practices, policy changes, technology adoption, and workforce management strategies, this review provides a comprehensive overview of the shifts in healthcare paradigms prompted by the pandemic. The ultimate goal is to distill actionable insights and recommendations that can enhance the resilience and responsiveness of healthcare systems against future global health threats.

The scope of this review is broad, encompassing various dimensions of healthcare management affected by the pandemic. It will cover policy changes enacted to address immediate public health needs and to bolster healthcare systems, the accelerated adoption of technology and digital health solutions, and strategies for effective workforce management amid crisis conditions. The review will also examine the impact on healthcare access and delivery, patient safety, quality of care, and healthcare workers' mental health. By exploring these areas, the review aims to provide a holistic understanding of the multifaceted impacts of the pandemic on healthcare management.

The significance of this review lies in its potential to inform future healthcare planning, policy-making, and preparedness strategies. The COVID-19 pandemic has been a stark reminder of the global interconnectedness of public health and the need for robust, agile healthcare systems that respond to health crises with resilience and efficiency. Understanding the changes in healthcare management, the lessons learned, and the best practices developed is crucial for building healthcare systems better equipped to handle future pandemics or similar global health emergencies. This review aims to contribute to the academic discourse on healthcare management in the post-pandemic world. It provides practical insights for healthcare administrators, policymakers, and stakeholders in healthcare delivery and reform. Through a comprehensive analysis of the pandemic's impacts and the subsequent responses, this paper endeavours to chart a path forward for healthcare systems aiming to achieve greater resilience, equity, and quality in patient care in the face of future challenges.

2. Healthcare Management Before the Pandemic

2.1. Pre-pandemic State of Healthcare Systems

Before the advent of the COVID-19 pandemic, healthcare systems worldwide exhibited diverse characteristics, strengths, and vulnerabilities shaped by economic, cultural, and political factors unique to each region. Many healthcare systems operate under immense pressure due to increasing healthcare costs, ageing populations, and the rising prevalence of chronic diseases. There was a significant reliance on traditional, in-person healthcare delivery models, with varying degrees of investment in public health infrastructure and digital health technologies (Aljukhadar, 2022; Tang et al., 2022; Vallée, 2023). Some of the strengths of pre-pandemic healthcare systems included advanced medical technologies, highly trained healthcare professionals, and, in some regions, comprehensive healthcare coverage that facilitated access to a range of services. For example, countries with universal healthcare systems boasted high accessibility and preventive care services, aiming to reduce healthcare disparities.

Despite these strengths, numerous vulnerabilities were evident. Healthcare systems often face challenges related to resource allocation, including shortages of healthcare workers, limited bed capacity in hospitals, and inadequate medical equipment supplies. Financial constraints further exacerbated these issues, limiting the ability of healthcare systems to invest in necessary infrastructure and innovation (Etando et al., 2021; Zahlan, Ranjan, & Hayes, 2023). Moreover, public health surveillance and response systems were frequently underfunded, undermining the capacity for early detection and containment of infectious diseases. The integration of digital health technologies was in its nascent stages in many areas, with significant barriers to adoption, including regulatory hurdles, privacy concerns, and lack of infrastructure.

2.2. Previous Pandandemic Preparedness Plans

The effectiveness and limitations of pre-existing pandemic preparedness strategies varied widely across different regions. Prior experiences with epidemics and pandemics, such as SARS, MERS, H1N1, and Ebola, heavily influenced them. These experiences prompted some countries to develop and refine their pandemic preparedness plans, focusing on surveillance, stockpiling essential medical supplies, and establishing emergency response frameworks (Chahley, Reel, & Taylor, 2021; Mohammadpour et al., 2021; Roychoudhury et al., 2020).

In countries with recent experiences of outbreaks, such as those in East Asia, pandemic preparedness plans were relatively more developed, featuring robust surveillance systems, public health infrastructure, and community engagement strategies. These systems were designed to detect and isolate cases rapidly, trace contacts, and effectively implement social distancing measures. However, the COVID-19 pandemic exposed significant limitations in global pandemic preparedness. Many preparedness plans underestimated the scale and transmissibility of a potential pandemic, focusing on specific pathogens rather than preparing for a range of scenarios. There was a general lack of international coordination and information sharing, which hampered the global response. Additionally, most plans did not adequately address the need to rapidly scale healthcare services or integrate digital health solutions to support remote care and public health measures. The supply chain vulnerabilities revealed by the pandemic, particularly for personal protective equipment and critical medical supplies, underscored the inadequacy of stockpiling and logistics planning (An & Tang, 2020; Haldane et al., 2021; Tambo, Djuikoue, Tazemda, Fotsing, & Zhou, 2021).

In summary, while specific strengths in pre-pandemic healthcare systems and preparedness plans provided a foundation for the response to COVID-19, the unprecedented scale and impact of the pandemic highlighted critical vulnerabilities and limitations. The experience has underscored the necessity for comprehensive, flexible, and resilient healthcare and public health systems that can adapt to the challenges presented by future pandemics and health crises.

3. Impact of the Pandemic on Healthcare Systems

The COVID-19 pandemic has exerted unprecedented pressure on global healthcare systems, unveiling significant challenges, driving rapid adaptations and innovations, and necessitating a reevaluation of policy and management strategies. These responses have reshaped the landscape of healthcare delivery, with long-term implications for the sector.

3.1. Immediate Challenges

The COVID-19 pandemic brought critical challenges in healthcare management, particularly allocating essential resources. Healthcare systems globally were pressed to their limits trying to accommodate the surge in demand for medical supplies, hospital beds, and ventilators. This overwhelming need led to care rationing in certain instances, putting healthcare workers at an increased risk of infection due to inadequate personal protective equipment (PPE). Concurrently, the virus's rapid spread placed an unprecedented strain on healthcare professionals, with staff shortages becoming a critical issue. These shortages were further intensified by high infection rates among healthcare workers, mandatory quarantine measures, and the significant physical and mental toll exerted by the pandemic, culminating in burnout and a reduced capacity to deliver care (Dar, Swamy, Gavin, & Theodore, 2021; Steier & Moxham, 2020).

Additionally, the pandemic severely disrupted the continuity and quality of care for patients not infected with COVID-19. Elective procedures and routine care were often postponed or cancelled, adversely affecting those with chronic conditions or in need of regular medical interventions. Moreover, it unveiled the vulnerabilities of specific demographic groups, such as the elderly and individuals with pre-existing conditions, thereby spotlighting the existing disparities in healthcare access and outcomes (Dehghani Tafti et al., 2023; Organization, 2020).

3.2. Adaptations and Innovations

The COVID-19 pandemic catalyzed a significant transformation in healthcare delivery, prominently through the rapid expansion of telehealth services. This shift allowed healthcare providers to deliver care remotely, playing a crucial role in maintaining the continuity of care while reducing the risk of virus transmission. Telehealth proved to be a vital tool for triaging patients, offering mental health support, and managing chronic conditions, thereby marking a paradigm shift in the delivery of healthcare services. The ease and efficiency of telehealth have facilitated immediate care and paved the way for its integration into the future healthcare model.

In parallel, the adoption of digital health technologies saw an unprecedented acceleration. Mobile applications for contact tracing, symptom checking, and vaccine management became integral to the public health response, enhancing the ability to monitor and control the spread of the virus. Furthermore, Electronic Health Records (EHR) systems were significantly enhanced to support collecting and sharing COVID-19 related data, improving care coordination and enabling a more robust public health response. These advancements underscored the potential of digital technologies in transforming healthcare management and public health surveillance (Madhavan et al., 2021; Ros et al., 2021).

Moreover, healthcare facilities across the globe adapted to the challenges posed by the pandemic by implementing new patient care protocols. These adaptations included stringent infection control measures, creating COVID-19 specific units, and revising triage procedures to manage patient flow efficiently and minimize exposure. Innovations in patient

care, such as adopting prone positioning for ventilated patients and repurposing medications for COVID-19 treatment, were rapidly integrated into practice, reflecting the healthcare sector's agility in responding to emergent evidence. These changes improved patient outcomes during the pandemic and offered valuable insights into enhancing healthcare protocols for future challenges (Ness, Saylor, Di Fusco, & Evans, 2021; Peiffer-Smadja et al., 2020).

3.3. Policy and Management Adjustments

In response to the unprecedented challenges posed by the COVID-19 pandemic, governments and healthcare authorities worldwide implemented various policy changes to mitigate the impact on healthcare systems and the wider community. These policies included emergency funding to bolster healthcare resources, regulatory adjustments to augment the healthcare workforce—such as enabling retired professionals to return to practice—and public health mandates for mask-wearing and social distancing to curb the spread of the virus. Additionally, policies were crafted to promote equitable access to COVID-19 testing, treatments, and vaccines, ensuring that these crucial resources were distributed fairly and efficiently across populations (Kahn et al., 2020; National Academies of Sciences & Medicine, 2020; Wouters et al., 2021).

Concurrently, healthcare management strategies rapidly evolved to effectively navigate the pandemic's dynamic challenges. This evolution encompassed the formation of specialized crisis response teams, the adoption of real-time data analytics to inform decision-making processes, and the establishment of partnerships with private sector entities to enhance supply chain capabilities. To address workforce challenges, healthcare leaders implemented flexible staffing models, including cross-training personnel to fulfill multiple roles and engaging volunteers and military personnel to bolster healthcare delivery efforts. These strategic adjustments were crucial in maintaining healthcare services during the pandemic (Wang, Su, Zhang, & Li, 2021).

Furthermore, the pandemic highlighted the critical role of adaptive leadership and clear communication in crisis management within the healthcare sector. Leaders were confronted with the daunting task of navigating through uncertainties, making tough decisions on resource allocation, and sustaining the morale of staff facing unprecedented levels of stress and burnout. The crisis underscored the need for leaders capable of fostering collaboration, driving innovation under pressure, and communicating effectively with healthcare professionals and the public. The successful navigation of these challenges demonstrated the importance of strong leadership in ensuring the resilience and adaptability of healthcare systems in the face of a global health emergency (Arslan, Golgeci, Khan, Al-Tabbaa, & Hurmelinna-Laukkanen, 2021; Santra & Alat, 2022; Sriharan et al., 2022).

4. Lessons Learned

The COVID-19 pandemic has been a crucible for healthcare systems worldwide, testing their resilience, adaptability, and capacity to manage an unprecedented global health crisis. Several lessons have been learned from this challenging period, highlighting effective responses and strategies that could shape future healthcare management, as well as shortcomings that need addressing to bolster preparedness for future health emergencies.

4.1. Effective Responses and Strategies

The pandemic has catalyzed the rapid adoption of telehealth and digital technologies, marking a significant shift in healthcare delivery. This transformation has proven especially effective in maintaining continuity of care during lockdowns, enhancing access for those traditionally facing barriers to healthcare services. The deployment of digital tools, such as mobile health apps for contact tracing and symptom monitoring, underscored the pivotal role of technology in orchestrating public health responses. In parallel, the crisis highlighted the necessity for flexible healthcare workforce strategies. Initiatives like cross-training staff, broadening scopes of practice, and incorporating retired professionals and students into the healthcare workforce have been instrumental in mitigating staff shortages and ensuring a more equitable workload distribution among healthcare workers (Chang et al., 2021; Shen, Chen, Yue, & Xu, 2021).

Moreover, the pandemic has underscored the importance of collaboration between the public and private sectors in addressing complex public health challenges. Partnerships focused on vaccine development and distribution, the expansion of manufacturing capabilities for personal protective equipment (PPE) and medical supplies, and the utilization of private laboratories for increased testing capacity have all highlighted the critical value of cross-sectoral collaboration. Additionally, implementing emergency preparedness policies, including the strategic stockpiling of essential supplies and establishing emergency operation centres, has played a vital role in some regions. These initiatives, supported by flexible regulatory frameworks that swiftly respond to evolving scenarios, have been fundamental in effectively managing the pandemic. These responses and strategic adjustments collectively represent a

multifaceted approach to navigating the challenges posed by the COVID-19 pandemic, emphasizing the importance of innovation, flexibility, and collaboration in strengthening public health resilience (Abayomi et al., 2021; Herstein, Schwedhelm, Vasa, Biddinger, & Hewlett, 2021).

4.2. Shortcomings and Areas for Improvement

The COVID-19 pandemic cast a spotlight on significant vulnerabilities within the global supply chains for medical supplies and pharmaceuticals, catching many healthcare systems unprepared and struggling with shortages of personal protective equipment (PPE), ventilators, and other critical supplies. This situation underscored the critical need for better strategic stockpiling and diversification of supply sources to mitigate future shortages. Concurrently, the pandemic exacerbated existing disparities in healthcare access and outcomes, particularly affecting marginalized communities and highlighting the urgent necessity for more equitable healthcare policies and practices to address these imbalances. Additionally, the crisis revealed a widespread insufficient investment in public health infrastructure and workforce, which limited the ability for effective testing, contact tracing, and isolation measures during the early stages of the pandemic. This deficiency underscores the importance of strengthening public health systems for improved surveillance, response, and management of future health threats.

Moreover, international coordination and information-sharing challenges significantly hindered the initial response to the pandemic, leading to fragmented efforts and inefficiencies in managing the virus's spread. This experience points to the critical need for enhanced international cooperation and transparent information sharing to manage future pandemics effectively. Lastly, the pandemic has placed immense pressure on healthcare workers, leading to high levels of burnout, stress, and mental health issues, revealing a glaring gap in the preparedness to provide adequate mental health support to frontline workers. This situation underscores the necessity for integrating comprehensive mental health services into the healthcare system's infrastructure, ensuring the well-being of those who serve on the front lines of health crises.

In conclusion, the COVID-19 pandemic has provided valuable lessons on the strengths and weaknesses of current healthcare management approaches. Effective responses, such as the rapid adoption of digital health technologies and flexible workforce strategies, offer models for future innovation. However, significant shortcomings, including supply chain vulnerabilities, healthcare inequities, and insufficient public health investment, highlight areas that require urgent attention and improvement. Addressing these issues will be crucial in preparing healthcare systems for future challenges, ensuring they are more resilient, equitable, and capable of responding to global health threats.

5. Future Preparedness in Healthcare Management

The COVID-19 pandemic has underscored the critical need for robust, agile, and resilient healthcare systems capable of responding to global health emergencies. As we look to the future, lessons learned from the pandemic must inform strategies for strengthening healthcare systems, incorporating technology and innovation, and enhancing policies and governance frameworks. These efforts must focus on building healthcare systems that are not only prepared to manage future pandemics but are also sustainable and equitable.

5.1. Strengthening Healthcare Systems

The COVID-19 pandemic cast a spotlight on significant vulnerabilities within the global supply chains for medical supplies and pharmaceuticals, catching many healthcare systems unprepared and struggling with shortages of personal protective equipment (PPE), ventilators, and other critical supplies. This situation underscored the critical need for better strategic stockpiling and diversification of supply sources to mitigate future shortages. Concurrently, the pandemic exacerbated existing disparities in healthcare access and outcomes, particularly affecting marginalized communities and highlighting the urgent necessity for more equitable healthcare policies and practices to address these imbalances. Additionally, the crisis revealed a widespread insufficient investment in public health infrastructure and workforce, which limited the ability for adequate testing, contact tracing, and isolation measures during the early stages of the pandemic. This deficiency underscores the importance of strengthening public health systems for improved surveillance, response, and management of future health threats.

Moreover, international coordination and information-sharing challenges significantly hindered the initial response to the pandemic, leading to fragmented efforts and inefficiencies in managing the virus's spread (Jit et al., 2021). This experience points to the critical need for enhanced international cooperation and transparent information sharing to manage future pandemics effectively. Lastly, the pandemic has placed immense pressure on healthcare workers, leading to high levels of burnout, stress, and mental health issues, revealing a glaring gap in the preparedness to provide adequate mental health support to frontline workers. This situation underscores the necessity for integrating

comprehensive mental health services into the healthcare system's infrastructure, ensuring the well-being of those who serve on the front lines of health crises.

5.2. Incorporating Technology and Innovation

The COVID-19 pandemic has catalyzed the rapid expansion of digital health technologies, underscoring the necessity to continue this momentum and further integrate innovative solutions into healthcare management. The adoption of telehealth, remote monitoring, and digital triage systems has proven instrumental in enhancing access to care, alleviating the burden on healthcare facilities, and ensuring uninterrupted care for patients with chronic conditions. Beyond these advancements, the potential of Artificial Intelligence (AI) and big data analytics to revolutionize healthcare management cannot be overstated. These technologies offer promising avenues for improving diagnostic accuracy, forecasting disease outbreaks, optimizing the allocation of healthcare resources, and tailoring patient care to individual needs. Investment in AI research and the incorporation of AI tools into both clinical practice and public health surveillance are crucial steps towards bolstering pandemic preparedness and enhancing the overall response capabilities of healthcare systems (Allam, 2022; Khan & Alotaibi, 2020; Lee & Yoon, 2021).

Moreover, further integrating telemedicine and mobile health applications into healthcare delivery frameworks represents a significant opportunity to streamline care provision, collect vital health data, and improve patient communication (Organization, 2022). To realize the full potential of these technologies, supportive policies and infrastructure, including viable reimbursement models and robust data privacy regulations, are essential. Such measures will facilitate the widespread adoption of telemedicine and mobile health solutions and ensure that digital health innovations continue to play a pivotal role in transforming healthcare for the better, making systems more resilient, accessible, and patient-centred in the face of future health challenges.

5.3. Policy and Governance Enhancements

Enhancing policy and governance structures is critical in fortifying global defences against health emergencies, as underscored by the COVID-19 pandemic's widespread impact. Central to these enhancements is the need for bolstered international cooperation, essential for effectively managing global health threats. This involves reinforcing the capacity and authority of international health bodies, such as the World Health Organization, to facilitate better sharing of information and resources, coordinate research efforts globally, and establish robust international standards for pandemic preparedness and response. Alongside international collaboration, a significant increase in public health investment is imperative to strengthen the infrastructure and workforce dedicated to public health. This encompasses funding for public health laboratories, epidemiological research, vaccine development, and comprehensive health education campaigns, all crucial for the surveillance, early detection, and containment of infectious diseases.

Furthermore, developing and refining governance frameworks are vital for enhancing coordination and response efforts across various levels of government and sectors. This includes reviewing and updating legal and regulatory frameworks to ensure they support rapid and effective responses to pandemics, encompassing emergency declarations, data sharing practices, and implementing public health measures. These policy and governance enhancements are foundational to building a more resilient and responsive global health system capable of addressing current and future health crises with greater efficacy and equity.

6. Theoretical Frameworks for Understanding Post-Pandemic Healthcare Management

6.1. Organizational Change Theory

Organizational change theory offers valuable insights into how healthcare institutions adapt to external shocks and internal pressures. Kurt Lewin's Change Management Model provides a lens to view healthcare organizations' rapid adaptations during the pandemic with its stages of unfreezing, changing, and refreezing. This theory underscores the importance of readiness for change, implementing change, and stabilizing new practices within organizations (Caldwell, 2023; Karanika-Murray, Whysall, Liu-Smith, Feltbower, & Challans-Rasool, 2023).

6.2. Crisis Management Theory

Crisis management theory, which includes the Pre-Crisis, Crisis Response, and Post-Crisis phases, is particularly relevant to understanding healthcare management during the pandemic. This framework emphasizes the importance of preparedness, effective response mechanisms, and learning from the crisis to improve future resilience. The pandemic has highlighted the need for healthcare systems to develop robust crisis management plans that include clear

communication strategies, stakeholder engagement, and flexibility in response to unforeseen challenges (Wu, Shao, Newman, & Schwarz, 2021; Wut, Xu, & Wong, 2021).

6.3. Health Systems Resilience Theory

This theory focuses on the ability of health systems to prepare for, respond to, and recover from shocks while maintaining core functions and reorganizing if conditions require it. Resilience theory emphasizes adaptability, self-organization, and learning in the face of disruptions. The COVID-19 pandemic has tested the resilience of healthcare systems globally, revealing both strengths in adaptability and areas for improvement in system robustness and flexibility (Biddle, Wahedi, & Bozorgmehr, 2020).

The pandemic has necessitated rapid organizational changes within healthcare, pushing the boundaries of traditional change management theories. The concept of agile and responsive change, rather than the more linear models of the past, has become increasingly relevant. This includes the need for healthcare organizations to remain in perpetual readiness to adapt to new information and challenges, suggesting modifications to the traditional unfreeze-change-refreeze paradigm.

The pandemic experiences have underscored the importance of integrating health equity and community engagement into crisis management frameworks (Alberti, Lantz, & Wilkins, 2020). Effective crisis response extends beyond institutional boundaries to include partnerships with communities and an understanding of the social determinants of health. This broader approach to crisis management emphasizes the need for inclusive planning and response strategies that address the needs of diverse populations. The pandemic has contributed new insights into the operationalization of resilience in healthcare systems, highlighting the importance of digital health technologies, flexible workforce models, and cross-sectoral collaboration in enhancing system resilience. The concept of resilience has evolved to encompass the capacity to withstand shocks and the ability to transform and innovate in response to long-term challenges.

7. Conclusion

The COVID-19 pandemic has been a defining global health crisis, testing the limits of healthcare systems worldwide and accelerating changes in healthcare management. Key lessons from the pandemic include the critical importance of resilience, flexibility, and innovation within healthcare systems. Effective strategies have emerged, such as the rapid adoption of telehealth, the integration of digital health technologies, and the development of flexible workforce models. However, the pandemic highlighted significant challenges, including supply chain vulnerabilities, healthcare access and outcomes inequities, and the need for enhanced public health infrastructure and international cooperation.

For healthcare managers, the findings underscore the necessity of embracing digital transformation, investing in workforce development, and fostering a culture of continuous learning and adaptation. Policymakers are urged to prioritize investments in public health infrastructure, strengthen supply chain resilience, and address healthcare disparities through equitable policies. For all stakeholders, there is a clear imperative to build collaborative networks that span sectors and borders, enhancing the global capacity to respond to health crises.

The pandemic has opened new avenues for research, particularly in understanding the long-term impacts of COVID-19 on healthcare systems and societies. Further studies are needed to evaluate the effectiveness of digital health interventions, the psychological effects of the pandemic on healthcare workers, and strategies for addressing health inequities exacerbated by the crisis. Research into innovative healthcare delivery models, such as hybrid in-person and digital care models, and the implications of artificial intelligence and big data for public health surveillance are also critical. Additionally, exploring the dynamics of international health policy coordination and crisis response mechanisms will provide valuable insights for managing future global health threats.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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