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Exploring the Role of Health Engineers in Pandemic Response

Tukamuhebwa Richard

Mechanical Engineering Kampala International University Uganda

Email tukamuhebwa@kiu.ac.ug

ABSTRACT

Health engineers, though historically underrecognized, are emerging as essential contributors to pandemic preparedness and response. This paper examines the multifaceted role of health engineers in planning, managing, and recovering from global health crises. Drawing lessons from the COVID-19 pandemic, it highlights how health engineers apply systems thinking, data modeling, informatics, and collaborative design to support health systems, law enforcement, policy-making, and community engagement. The study discusses real-world case studies, including the development of surveillance tools, health communication platforms, and inter-sectorial training programs. Despite facing challenges such as unclear professional roles, lack of specialized training, and institutional neglect, health engineers have demonstrated their capacity to innovate and coordinate across disciplines. The paper advocates for the formal integration of health engineering into academic curricula, health policy, and international health systems. It also emphasizes the need for user-centered technology, enhanced public health messaging, and resilient governance structures to better prepare for future pandemics.

Keywords: Health engineering, pandemic response, COVID-19, public health systems, emergency preparedness, data analytics, systems thinking, interdisciplinary collaboration.

INTRODUCTION

With outbreaks of viruses spreading around the world, understanding how susceptible people are to problems surrounding the outbreak is crucially important to not only make it past this problem, but to understand how to prevent a similar problem from occurring in the future. What should be understood, however, is how far that understanding can go to help. Although medical engineers may play a large part in understanding and benefiting from that system, health engineers use the knowledge they have in other systems that are closely or more distantly related to the problem. This more indirect application of health engineering solutions may not be the first step that is thought of by authority figures in situations like this. Therefore, it is important to take this initiative and bring it to the forefront to expose health engineering's ability to exploit situations that parameters on the subject may mislead people away from. After examining how health engineers can and should contribute to addressing problems caused by external systems, it is important to consider what problems are currently on the table and how to better expose health engineering's capability to support less-considered systems to the people putting their efforts into their direct consideration. It has already been said that the importance of understanding how human beings function is significant in handling pandemics. This understanding should extend to the understanding of social systems, however. To highlight the expanding effect of this, take the bias in negligence towards human factors in addressing a health crisis. The more either engineering group looks at a problem from an alternative system, the further investigation will pull them further away from an answer, and the more both engineering groups work on similar parameters. This should be considered when it comes to health engineers working with problem systems that are far-flung from health [1, 2].

Historical Context of Health Engineering

Health engineers, like their counterparts in other sectors, play vital roles throughout health emergencies: in planning and prevention, during mitigation, and in management and recovery. However, a century-long review of health emergencies reveals that health engineering roles often go unrecognized and unmet. Government agencies and healthcare providers typically manage health affairs, overlooking engineers' contributions and missing opportunities to alleviate pandemic impacts. Learning from the COVID-19 pandemic, which greatly affected global health, reveals significant albeit unofficial contributions from health engineers. They engaged in management planning, designed emergency-response systems, and supported healthcare logistics. Nonetheless, these contributions were not executed by trained health engineers, as the profession remains in its infancy in both academia and practice. Had health engineering been better established before the pandemic, responses could have led to enhanced management and improved global outcomes. The situation provided opportunities for health engineers to tackle health issues, including COVID-19, contributing to the profession's growth. This experience can guide future health emergency responses. Encouragingly, recognition of health engineering is gaining traction, promoting its establishment in academia and practice for improved health outcomes. Various recommendations can help the profession define its role in health emergencies. These include revisiting pandemic case studies for better understanding, particularly in developing countries, and creating educational programs to raise awareness of health engineering. By deploying engineers and equipment to frontline tasks, the profession can demonstrate its value while building capabilities and establishing a sustainable career path [3, 4].

Understanding Pandemic Response

Pandemics are events that impact a large number of people and spread across several countries or continents. The study of pandemics takes several areas in health research, including epidemiology, treatment response, and drug development, public health, and health equity. Inherent in understanding pandemics is an understanding of preparedness and responses. Emerging threats of infectious disease outbreaks have been a focus of research since before the SARS outbreak in 2003. The emergence of more recent outbreaks and epidemics, many with specific pandemic potential, to date, has highlighted the importance of preparedness and response to health crises at the local, national, and international levels. Public health responses to contain outbreaks of novel infectious disease strains or other health crises are typically chaotic and organized affairs that can appear arduous and confusing. Much of this is uncharacteristic of the analogous well-oiled machines found in fields like military response to warfare or chemical response to chemical spills and pollution. An understanding of the multilateral and holistic aspects of pandemic responses is necessary in order to participate in this world. The complex assembly of actors from all levels of society, government, and science responds utilizing varied tools based on differing institutional philosophies, capacities, and strengths. The philosophical bases on which these actors and tools are constructed are set at a broad level by various international agreements and treaties. Within this architecture, nations mobilize a host of actors and responses to manage pandemics at the local, national, regional, and international level [5, 6].

The Role of Health Engineers

The COVID-19 pandemic highlighted the demand for health-related technologies, whether it be for the diagnosis, treatment, or management of the disease. This enabled a coordinated pandemic response from the engineering perspective. Communication tools were deployed by the health engineers of different countries to connect various stakeholders globally and discuss the challenges they faced in managing the pandemic. Several small-scale technology-based projects were formed under this umbrella to collect and share knowledge across the globe. Access to the latest knowledge in health technology enabled a quicker response from countries worldwide to manage the pandemic. The tools and knowledge-sharing platforms were also instrumental in meeting the content and delivery format requirements for regulatory approval in different regions, allowing technologies to be deployed more widely. Once the need for health technology was addressed by several projects, different models were developed to strengthen health engineering education and ensure continued knowledge sharing among different countries. This was important groundwork by health engineers of several countries to rise to the challenge posed by the COVID-19 pandemic. It is important to learn from these lessons and build on this groundwork to maintain the momentum brought by the pandemic and accelerate the sharing of health technology expertise [7, 8].

Collaboration with Healthcare Professionals

During pandemics, there is a unique opportunity for health engineers to contribute to stakeholder conversations through engagement with healthcare professionals who use their creations and designs. This collaboration facilitates timely and efficient access to human-centered research methods and tools to address health systems challenges to frontline provider safety and efficiency. Health engineers can initiate conversations in the health system to identify areas of usefulness and can do so in collaboration with healthcare professionals. During the COVID-19 pandemic, health engineers in research settings began partnerships with healthcare administrators to better co-create solutions for end-user problems, including fatigue in personal protective equipment during aerosol-generating procedures, asking patients about their aerosol-generating procedure history, and the efficient analysis of electronic health records for case counts. Exploratory studies afforded time to co-create novel and impactful data visualization tools that were quickly adopted by state and institutional health departments. Partnerships with station-centric care coordinators were also formed during crises such as COVID-19 case surges. Health engineers had the opportunity to contribute to team-centered processes by building out task allocation processes through stakeholder engagement to clarify proactive response actions and barriers to execution. These processes were distributed to cohorts of 230 care coordinators and healthcare professionals receiving and providing the information dissemination service. Compatibility with preexisting care coordinator operations was emphasized in tooling proposals to gain buy-in, and data visualizations of COVID-19 case counts were co-created with healthcare professionals [9, 10].

Case Studies of Health Engineering in Action

Health Engineers worked with police and law enforcement to develop training for COVID-19 health specifications for enforcement officers. The health specifications provided COVID-19 prevention strategies and engineering controls that could be implemented and enforced in homes, businesses, and public places. Health Engineers gathered and synthesized previously developed engineering controls and adaptation measures to develop the training for law enforcement officers and municipal leaders. Health specifications were vetted by multiple groups of stakeholders and piloted and revised before formal rollout. In the course of this engagement, new collaborations were formed and groups began to work together to better align multifaceted services for prevention and compliance. Each group took ownership to follow up with the next steps based on their organizational capacity. In this instance, Health Engineers recruited and trained meaningful community stakeholders to educate and empower residents where disproportionate impact was seen. Their work also spurred the city to seek funding for additional surveillance and study efforts and highlighted the important role of Health Engineers with the capacity to synthesize efforts across diverse disciplines. Health Engineers partnered with public health to inform the development and rollout of a regional COVID-19 health monitoring platform. Resources were available to municipalities, schools, and workplaces to ask questions about COVID-19 mitigation strategies. To track responses and health-related effects of mitigation strategy implementation, a series of surveys was developed, publicized, and distributed. Health Engineers partnered in developing a long-term plan to collect data from responses and process and report metrics to stakeholders. These metrics were designed to inform future resource allocation and the deployment of Health Engineers toward the nearest areas with the greatest need. Partnerships with health systems and the comparative Western culture, and under-utilization of public health, encountered barriers to using existing publicly available, assimilated data. The regional focus of health monitoring resources made it possible to utilize Health Engineers' expertise to develop and support data management and analytics. Health Engineers collaborated with the state department and public universities in the design and rollout of a statewide COVID-19 mitigation policy database. Considerable time was spent with state department leadership and data analysts to categorize governmental policy-level database fields and develop a categorization toolkit. COVID-19 public policy databases were available and analyzed by academic research teams from jurisdictional and policy target foci, but were difficult for members of the public to use or even find. A subsequent assistance pilot broadened partnerships with organizations that help underrepresented groups obtain services from health systems or disentangle regulatory compliance requirements [11, 12].

Challenges Faced by Health Engineers

The pandemic has significantly challenged global health systems, revealing vulnerabilities. In this crisis, health engineers are crucial for emergency management, including surveillance and evaluation. As health systems recover, ensuring resilience to future shocks is essential. It is important to understand threats like natural disasters and civil unrest, and how health engineering can help assess and mitigate these risks. However, the concept of health engineering is often unclear, raising questions about practitioners, their activities, and training. Viewed through a systems-thinking lens, health engineering combines informatics and bio-systems informatics, utilizing quantitative and qualitative methods to find solutions for biological issues. Health engineers work collaboratively to design models and infrastructures that evaluate data from medical systems as they evolve. In developing nations like Ethiopia, health engineers are vital in addressing the pandemic's challenges through innovative systems-based applications. Nonetheless, there are uncertainties about their roles compared to existing health workers and broader scientific disciplines. While health systems typically focus on national policy, an engineering perspective prioritizes biomedical modelling and information dynamics. Health engineers generate health solutions but often lack recognition compared to other scientific fields due to limited specialized training in health systems. Their roles remain poorly defined, and while awareness workshops exist, capacity and job profiles are still ambiguous, potentially hindering a systems-focused approach. The exclusion of health engineers is perplexing, given their training in information systems design, regardless of their expertise. In some regions, insufficient exposure and advocacy hinder their integration into larger health systems. Aside from limited funding for certain initiatives, health engineers often work in informal roles that do not align with health or data relevance. This lack of recognition and integration globally challenges the development of local solutions [13, 14].

Future Directions for Health Engineering

This study highlights several directions for future research. First, human resources management should focus efforts on supporting and training healthcare professionals, as the strain of crises can have long-term effects on the health of professionals, employees, and even healthcare systems. This includes other aspects, such as hiring and training new professionals, health programs, wellness initiatives, and workload management strategies. Additionally, it is worth understanding the long-term impacts of the COVID-19 pandemic on public health. For instance, how will the COVID-19 consequences affect healthcare infrastructure, health behaviors of society over the years, and the effects on the mental health of healthcare professionals, employees, and society? Also, it would be interesting to study governance models to prevent such crises in the future, and how global health governance could be different, promoting more collaboration and information sharing among countries. Moreover, it is worth investigating user-centered technology solutions that take diverse population segments into consideration. Protecting the end-user perspective is crucial for health technologies, whether providing innovative health solutions or approaches to preventative measures. In this sense, evaluating the diversity of the population is essential for technology solutions to be successful and equitable for everyone. Finally, the efficiency of health roadmaps as guiding tools for public health strategies could be assessed through various lenses. This includes evaluating the adaptability of roadmaps to unforeseen challenges, such as the COVID-19 pandemic, assessing their efficiency in steering actions on a multi-actor level, and evaluating how they can contribute to improving health systems in the long term, as they should not just represent a product, but also a process to achieve better public health [15, 16].

Training and Education for Health Engineers

Even the most profound and sincere thoughts are meaningless weapons in the absence of a miraculous solution to render them explicit. The success of biopreparedness education depends as much upon educational research as it does upon biopreparedness initiatives, if not more. Investment should be made in enhancing the means of measurement and analysis. The path forward is to embark upon a transition from mere metabolic biopreparedness to a cyclical biopreparedness of education, policy-making, scientific/economic development, engagement, and enactment. Metrics for assessment of capabilities, credible expectations, and risk assessments should be common at the smooth interface between health systems science and human science and should be translatable into actions and outcomes at an individual and organizational level. The information revolution and technological advances should be employed for inter-institutional comparisons of gaps using bibliometrics, patents, business cases, and HRH needs forecasting of the next generational workforce. The unsolicited demand for engagement should be met with sincere efforts at education, advisement, and human development. Needs assessment of educational content and formats should address naive health users and potential service providers. Pandemic bioevent preparedness should translate the genuine optimism of biosciences and innovation into credible expectations of heroic engagement. Planning (needs) and visioning (bounds) should precede defining a model (conceptual and conceptual/organization) of the federation of a special operations health workforce. On this firm and sage foundation, instances and exercises of enhancement of mediation, design decision-metrics, design and educational research for scientists, business and civic professionals, and teenagers' informatics should be bred mutually [17, 18].

The Importance of Public Health Messaging

One of the biggest lessons learnt during the COVID-19 pandemic was the need for consistent and clear public health messaging. Experts recommend investing in a public health communication workforce around the world as this would ensure the global investment in preparation and response to future pandemics, or health emergencies more broadly, is matched with strong public health, should there be a need to respond. At all stages of a health emergency, communication (not just the issuing of directives but an intention to encourage awareness of understanding of potentially far-reaching decisions) was seen to be critical. It was also a profession upon which little public health effort and investment, nationally or globally, had occurred before COVID-19, despite the proven significance of communication for supporting health outcomes. Without a strong public health communication workforce, countries would be vulnerable to poor public trust in the measures taken to protect populations during health emergencies, in addition to the associated health risks. Public health communication should be brought in from the sidelines and enshrined as the fourth pillar of public health, in parallel with epidemiology, statistics, and laboratory science. All public health agencies, particularly those at senior levels, should ensure they have communicators (in-house or outsourced), equal to scientists and academics, to reach the general public with regular, credible, understandable, clear and simple, and consistent communications about measures taken and progress made. Public health authorities across nations, particularly the WHO, the highest authority for public health, should lead global communication and advocate for biomedical research outcomes to be issued with fast-tracking communications available to all public health authorities to develop their own consistent, clear, and strong messages clustering with the biomedical news. Governments should establish or strengthen governance of 'disinformation', particularly in social media. Governments should also make the cooperation of technology giants a condition for a given license to operate [19, 20].

Global Health Engineering Initiatives

As the COVID-19 pandemic affected the world, the Faculty of Health Sciences at the University of Cape Town recognized the urgent need for reliable detection technologies in South Africa to manage large-scale screenings to curb the virus's spread. The Student Chapter utilized their Biomedical Engineering and Public Health training to develop a proposal for a multi-institution consortium, funded by the South African Medical Research Council and later the National Research Foundation. This consortium aimed to support the creation of rapid lateral flow immunoassay (LFIA) point-of-care devices to detect IgA, IgM, and IgG antibodies in blood and oral fluid. Collaborators received proposals, and weekly meetings were set up to define deliverables and individual roles. After organizing, students were assigned to various workstreams based on their expertise, with mini-meetings for idea sharing and resource coordination. Following a Budget and Resources Proposal meeting, the consortium advanced with support from researchers. As LFIA devices went through validation, dissemination of ideas and findings began, contributing to the rapid LFIA device technology field. The pandemic increased the reliance on technology in public health, leading to the emergence of Health Engineering, which aims to design and evaluate health-promoting technologies. This encompasses various areas, including tackling emerging diseases and improvements in telehealth to keep vulnerable patients out of hospitals during the pandemic [21, 22].

Regulatory Frameworks and Standards

The legal landscape within which health engineers work is constantly evolving, becoming increasingly complex and often directly influenced by the rapidly changing collection of events regarding infectious disease outbreaks. This changing legal environment requires below-ground and surge space construction permits to be taken from two to five years to three to six months, with emergency spaces built and ready to use in one year rather than four. The innovative safety protocols and tests imposed on hospital design are just some examples of how change in the pandemic mindset must be focused on infectious disease and should prompt a review of health engineering rules, regulations, code, and standards to create a more flexible and readily adaptable landscape acceptable to the definitions of historic and ongoing pandemics. Programmatic aspects of the local health infrastructure, with isolation centers as well as screening and intermediate triage, would be a key addition without proposing products, systems, or designs. The mega-disease center concept will be discussed along the health waterway's lesson of pestilence's destruction, reconstruction, and adaptation as a resource. The overreliance on a few global pharmaceutical companies on novel vaccines to suppress an ongoing pandemic is now seen as a stretch of pharmaceutical companies by some nations; some nations are now investing in traditional vaccine technology, and some companies are taking on old rules to generate interest in returning tax dollars. Safety processes used in the past to avoid needless deaths are being cut back in favor of quicker generation of health products, raising questions of international sufficiency, overseas safety standards, and intellectual property protection assumptions requiring careful re-evaluation. Beyond public health supplementation of local healthcare infrastructure as an antidote, guiding pharmaceutical acquisition and testing procedures is starting to become more relevant. This historic reality would seem to invite a new international consulting organization and agency to contrast with and supplement existing organizations and investigate product safety and distribution of local and imported pharmaceuticals, elevating globally inspired frameworks for acceptable and fail-proof products [23, 24].

Impact of Technology on Health Engineering

The majority of communication in IT focuses on Storage Solutions, primarily used by Governments and Companies in Cloud Computing. Healthcare Systems assess Cloud Technologies uniquely, conforming to the Government's Requirements. Factors such as Disposable Devices, Automation, Wireless Devices, AI Systems, and Robotics require special attention in Healthcare. Key concerns include Quality, Protection of Personal Data, and Security. Healthcare needs to align its systems with Cloud Technologies through Risk Assessment, Security Policies, and Compliance with Data Protection Laws. Existing standards and solutions address these issues, necessitating Security Planning, Risk Assessment, and Information Security Management Systems (ISMS) for Health Sector Cloud Technologies. Many hospitals rely on in-house Cloud Systems for Computerized Physician Order Entry (CPOE) and scheduling. While developed countries show visible Cloud infrastructure migration in Health Systems, adapted Cloud Solutions are scarce for Health Services. Developing nations must focus on aligning Application and Infrastructure Security requirements with existing systems, addressing Risk Assessment and Security Policies. Public health is influenced by health-seeking behaviors, with many services outside hospitals, including urgent care and rehabilitation, depending on hospitals for patient transport and monitoring. Hence, candidate cloud systems for health services were identified based on their implementation by public health organizations and usage by healthcare professionals beyond hospital settings. Serbian health services' candidate systems were prioritized at the secondary level for this analysis [25, 26].

The Role of Data in Pandemic Response

The data ecosystem involves more than just data generation, collection, and maintenance. Data, models, and results are interconnected objects, making it crucial to untangle their relationships before considering data lifecycles and pipelines in infectious diseases. Effective data management depends on how data will be used; various applications of the same data may necessitate different representations and management strategies. Data is rarely homogeneous. Internal data models differ from data collected from the physical world, requiring distinct management approaches. Current pandemic models estimate SARS-CoV-2 transmission rates and the impact of public health interventions (PHIs) using data aggregated at various levels, from sub-national to national. Given the urgency of data requests during emergencies, these representations must be managed transparently and consistently. Fixed-input data for infectious disease modeling is diverse and complex, necessitating preprocessing for effective analysis and cross-model comparisons, especially under urgent conditions. The infectious disease modeling community requires consistent preprocessing and curation methods for this data. Additionally, much fixed-input data will remain relevant long after current outbreaks, thus necessitating substantial archival resources and better coordination, possibly with fields like climate science that have established similar data archival systems [27, 28].

Ethics in Health Engineering

Learning from the pandemic is an urgent call for engineers and computer scientists. Engineering and computer science students are getting involved in the COVID-19 response, but to what extent are they thinking about the ethical implications of their actions? Schools from around the world were asked to help collect, share, and disseminate knowledge so we could stop the spread of COVID-19 and maintain as much of normal life as possible. Students organized on their campuses and reached out to their schools outside their countries. The wide variety of projects is encouraging, but it was important to assess if students were thinking about the ethics behind these activities as they occurred. Different kinds of ethical issues arise with different kinds of projects. Traditionally, these boundaries focus on three spheres of ethics: technical, professional, and social. Technical ethical issues relate to a project's social and organizational context. Professional ethical issues concern a project's relationships with clients, stakeholders, and fields of expertise. Social ethical issues address a project's direct relationship with the public. Although the three spheres are rarely completely distinct from each other, they do result in condensed experiences and generally differing questions. Thinking only about technical or professional decisions in response to COVID-19 impairs mitigating public harm; thinking only about the social implications disregards the project's implementation or other forms of engagement. Learning remains incomplete without the corresponding considerations regarding ethical limitations and implications. The COVID-19 pandemic raised incredibly challenging questions in each sphere of ethics. Thinking about how models and designs could be misused or about the primary constituencies of a result's testing and implementation is fundamental to the protection of health, safety, and welfare. Equally important is understanding how, in the middle of all this chaos, to maintain quality professional oversight and public accountability; to advocate for in-process input by the relevant constituencies; and to ensure accessibility, privacy, informed consent, and more. How to balance the immense potential for good of these technologies with their troubling and tragic characteristics is an extreme but critical challenge for all involved [29-34].

CONCLUSION

The COVID-19 pandemic served as a critical turning point, revealing the indispensable yet often overlooked role of health engineers in managing and mitigating health crises. From designing robust data systems and facilitating global knowledge-sharing to co-creating solutions with healthcare professionals and community stakeholders, health engineers contribute vital capabilities that bridge technical and human-centered domains. However, the absence of structured training, clear job roles, and institutional acknowledgment limits their potential. To address future health emergencies effectively, there must be a concerted effort to institutionalize health engineering within health education, workforce planning, and policy frameworks. Building this foundation not only strengthens pandemic response but also promotes more equitable, efficient, and resilient global health systems. Recognizing and empowering health engineers as core agents of health security is no longer optional; it is imperative.

REFERENCES

1. Alin P. Toward an Engineering Research Program on Pandemic Management. Available at SSRN 4874024. 2024 Jun 23.
2. Chen AP, Hansoti B, Hsu EB. The COVID-19 Pandemic Response and Its Impact on Post-Pandemic Health Emergency and Disaster Risk Management in the United States. Sustainability. 2022 Dec 6;14(23):16301.
3. Shaw C, Janeway H, Preston-Suni K, Ryus CR. Exploring the complexity of homelessness in emergency medicine: Dissecting myths, evidence, and solutions. AEM Education and Training. 2025 Apr;9:S108-15. wiley.com
4. Stolero N, Elkady S, Labaka L, Verlin J, Branlat M, Adini B. Using social media in disaster management: The perceptions of emergency responders versus the public. Risk, hazards & crisis in public policy. 2024 Jun;15(2):128-61. wiley.com
5. Haileamlak A. Pandemics will be more frequent. Ethiopian journal of health sciences. 2022 Mar;32(2):228.
6. Coccia M. The relation between the length of lockdown, the numbers of infected people and deaths of Covid-19, and economic growth of countries: Lessons learned to cope with future pandemics similar to Covid-19 and to constrain the deterioration of the economic system. Science of The Total Environment. 2021 Jun 25;775:145801.
7. Ugwu CN, Ugwu OP, Alum EU, Eze VH, Basajja M, Ugwu JN, Ogenyi FC, Ejemot-Nwadiaro RI, Okon MB, Egba SI, Uti DE. Sustainable development goals (SDGs) and resilient healthcare systems: Addressing medicine and public health challenges in conflict zones. Medicine. 2025 Feb 14;104(7):e41535.
8. Wang Q, Su M, Zhang M, Li R. Integrating digital technologies and public health to fight Covid-19 pandemic: key technologies, applications, challenges and outlook of digital healthcare. International Journal of Environmental Research and Public Health. 2021 Jan;18(11):6053. mdpi.com
9. Ogbuke N, Yusuf YY, Gunasekaran A, Colton N, Kovvuri D. Data-driven technologies for global healthcare practices and COVID-19: opportunities and challenges. Annals of Operations Research. 2023 Jul 1:1-36. uclan.ac.uk
10. Rachmad YE. MediVerse: Challenges And Development Of Digital Health Transformation Towards Metaverse in Medicine. Journal of Engineering, Electrical and Informatics. 2022 Jun 20;2(2):72-90. stie-trianandra.ac.id
11. Amjad A, Kordel P, Fernandes G. A review on innovation in healthcare sector (telehealth) through artificial intelligence. Sustainability. 2023 Apr 14;15(8):6655.

12. Ros F, Kush R, Friedman C, Gil Zorzo E, Rivero Corte P, Rubin JC, Sanchez B, Stocco P, Van Houweling D. Addressing the Covid-19 pandemic and future public health challenges through global collaboration and a data-driven systems approach. 2021 Jan.
13. Lenert LA, Ding W, Jacobs J. Informatics for public health and health system collaboration: applications for the control of the current COVID-19 pandemic and the next one. Journal of the American Medical Informatics Association. 2021 Aug 1;28(8):1807-11. oup.com
14. Wooldridge AR, Carman EM, Xie A. Human Factors and Ergonomics (HFE) applications in responses to the COVID-19 pandemic: Lessons learned and considerations for methods. Applied Ergonomics. 2022 Jul 1;102:103733.
15. Ongesa TN, Ugwu OP, Ugwu CN, Alum EU, Eze VH, Basajja M, Ugwu JN, Ogenyi FC, Okon MB, Ejemot-Nwadiaro RI. Optimizing emergency response systems in urban health crises: A project management approach to public health preparedness and response. Medicine. 2025 Jan 17;104(3):e41279.
16. Zemedkun A, Melaku G, Shumye S, Gube AA, Mulugeta H. Hospital Readiness and Perceived Health Professional Challenges to Prevent Pandemics in Gedeo Zone, Ethiopia: A Mixed-Method Study. Journal of Healthcare Leadership. 2023 Dec 31:231-9.
17. Anwar G, Abdullah NN. The impact of Human resource management practice on Organizational performance. International journal of Engineering, Business and Management (IJEBM). 2021;5.
18. Aboramadan M, Karatepe OM. Green human resource management, perceived green organizational support and their effects on hotel employees' behavioral outcomes. International Journal of Contemporary Hospitality Management. 2021 Oct 20;33(10):3199-222. [HTML]
19. Gilbert GL, Kerridge I. What is needed to sustain improvements in hospital practices post-COVID-19? a qualitative study of interprofessional dissonance in hospital infection prevention and control. BMC Health Services Research. 2022 Apr 14;22(1):504.
20. Nolan NS, Promer K, Tang M, Wooten D. Training the Next Generation of the Human Immunodeficiency Virus Workforce: Needs, Challenges, and Opportunities. Infectious Disease Clinics. 2024 Jul 8.
21. Eidelman G, Hachard T, Cabaj J, Fierlbeck K, Loh L, McLaren L, Watson-Creed G, Rosalle R. The Municipal Role in Public Health. Institute on Municipal Finance and Governance; 2022 Nov 17. scholaris.ca
22. Wenham C, Stout L. A legal mapping of 48 WHO member states' inclusion of public health emergency of international concern, pandemic, and health emergency terminology within national emergency legislation in responding to health emergencies. The Lancet. 2024 Apr 13;403(10435):1504-12.
23. Frenk J, Chen LC, Chandran L, Groff EO, King R, Meleis A, Fineberg HV. Challenges and opportunities for educating health professionals after the COVID-19 pandemic. The Lancet. 2022 Oct 29;400(10362):1539-56. thelancet.com
24. Sixsmith A, Horst BR, Simeonov D, Mihailidis A. Older people's use of digital technology during the COVID-19 pandemic. Bulletin of Science, Technology & Society. 2022 Jun;42(1-2):19-24. sagepub.com
25. Nyamboga TO, Ugwu OP, Ugwu JN, Alum EU, Eze VH, Ugwu CN, Ogenyi FC, Okon MB, Ejemot-Nwadiaro RI. Biotechnological innovations in soil health management: a systematic review of integrating microbiome engineering, bioinformatics, and sustainable practices. Cogent Food & Agriculture. 2025 Dec 31;11(1):2519811.
26. Ericson CA. Concise encyclopedia of system safety: Definition of terms and concepts. John Wiley & Sons; 2011 Apr 12.
27. Sabry M, Khalifa M. The Future of Engineering: Adapting to Legal and Political Changes. In2024 International Conference on Decision Aid Sciences and Applications (DASA) 2024 Dec 11 (pp. 1-6). IEEE. [HTML]
28. Sachdeva S, Bhatia S, Al Harrasi A, Shah YA, Anwer MK, Philip AK, Shah SF, Khan A, Halim SA. Unraveling the role of cloud computing in health care system and biomedical sciences. Heliyon. 2024 Apr 15;10(7). cell.com
29. Ugwu CN, Ugwu OP, Alum EU, Eze VH, Basajja M, Ugwu JN, Ogenyi FC, Ejemot-Nwadiaro RI, Okon MB, Egba SI, Uti DE. Medical preparedness for bioterrorism and chemical warfare: A public health integration review. Medicine. 2025 May 2;104(18):e42289.

30. Xu J. The current status and promotional strategies for cloud migration of hospital information systems in China: strengths, weaknesses, opportunities, and threats analysis. JMIR Medical Informatics. 2024 Feb 5;12(1):e52080.
31. Gonzalez-Parra G, Martínez-Rodríguez D, Villanueva-Micó RJ. Impact of a new SARS-CoV-2 variant on the population: A mathematical modeling approach. Mathematical and Computational Applications. 2021 Mar 27;26(2):25. mdpi.com
32. Liu Y, Morgenstern C, Kelly J, Lowe R, Jit M. The impact of non-pharmaceutical interventions on SARS-CoV-2 transmission across 130 countries and territories. BMC medicine. 2021 Dec;19:1-2.
33. Khan ZH, Abid MI. Distance learning in engineering education: Challenges and opportunities during COVID-19 pandemic crisis in Pakistan. The International Journal of Electrical Engineering & Education. 2021 Jan 24:0020720920988493. [HTML]
34. Ahmed V, Opoku A. Technology supported learning and pedagogy in times of crisis: the case of COVID-19 pandemic. Education and information technologies. 2022 Jan;27(1):365-405.

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