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Medication Supply Chains During Disaster

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Resilient medication supply chains are vital during disasters to ensure access to essential medicines. This narrative literature review examines challenges and solutions for maintaining supply chain resilience during crises. Data from peer-reviewed journals and policy documents highlight issues such as infrastructure damage, socio-cultural barriers, and poor stakeholder coordination. Proposed solutions include agile supply chain strategies, public-private partnerships, and advanced technologies like blockchain and AI. The study recommends integrating disaster preparedness into healthcare policies and prioritizing community engagement. These findings offer actionable insights for policymakers and healthcare providers to enhance medication logistics in disaster-prone regions.

1. Introduction

The growing frequency and severity of natural and human-made disasters pose significant challenges to public health systems, particularly in managing medication supply chains (Yuliwulandari et al., 2024). These disruptions can delay treatments and exacerbate health outcomes, especially among vulnerable populations most affected during crises. As critical components of healthcare infrastructure, hospitals and medication logistics networks are highly susceptible to breakdowns during such events, further amplifying the need for effective disaster preparedness (Behrens et al., 2022; Bastani et al., 2023).

Resilient medication supply chains are essential for maintaining healthcare services during disasters (Yuliwulandari et al., 2024). Recent studies underscore the importance of robust systems that can withstand extreme conditions, ensuring the continuous availability of life-saving medications (Goniewicz & Goniewicz, 2020). Factors such as communication, collaboration, and information sharing among stakeholders play a pivotal role in enhancing supply chain resilience. By adopting agile supply chain principles, healthcare logistics can become more flexible and responsive, enabling faster recovery and adaptation to disruptions (Woyessa et al., 2020).

The Sendai Framework for Disaster Risk Reduction emphasizes the need for resilient systems capable of functioning under extreme stress, which is especially relevant to healthcare logistics (UNDRR, 2019). However, while extensive study has focused on hospital preparedness during disasters, the resilience of medication supply chains remains underexplored. Bridging this gap is critical for creating comprehensive disaster response strategies that address both healthcare facilities and the logistics networks supporting them.

This review explores the key factors contributing to the resilience of medication supply chains and examines evidence-based strategies for enhancing their functionality during disasters. The guiding study question—"How can the resilience of medication supply chains be enhanced to ensure their functionality during disasters?"—provides a foundation for this analysis.

By addressing this question, the study sheds light on the crucial yet often overlooked role of medication logistics in public health emergencies. It also offers actionable frameworks for embedding resilience into disaster preparedness efforts. Strengthening medication supply chains is not only vital for effective disaster response but also for safeguarding public health and ensuring the well-being of affected populations during crises.

2. Method

This study employs a narrative literature review to explore the challenges and solutions for

ensuring resilient medication supply chains during disasters. The review focuses on socio-cultural, logistical, and technological factors that impact medication availability and distribution. Literature was sourced from peer-reviewed journals, policy documents, and credible reports published within the last 5 years, using databases such as PubMed, Scopus, and Web of Science. Search terms included “medication supply chains,” “resilience,” “disaster management,” and “healthcare logistics.” Articles were included if they addressed healthcare supply chain challenges or solutions during disasters, while those focusing solely on non-healthcare industries or lacking empirical data were excluded.

Thematic analysis was used to categorize findings into core themes, such as infrastructure challenges, socio-cultural influences, and technological advancements. Recurring insights were coded and grouped into broader categories to systematically evaluate factors affecting supply chain resilience. The study also assessed strategies like agile supply chains, stakeholder collaboration, and technological innovations for their effectiveness in disaster scenarios. This approach aims to provide actionable recommendations for policymakers and healthcare providers to develop sustainable, resilient medication supply chain systems in disaster-prone regions.

3. Result and Discussion

A robust medication supply chain ensures the continuous availability of essential medicines and medical supplies before, during, and after a disaster (Ma et al., 2022; Bastani et al., 2023). Efficient inventory management also plays a key role in maintaining medication supply chains during disasters. Proper planning and the strategic stockpiling of essential medicines can ensure that healthcare facilities have an adequate supply of medications to respond to emergencies (Raza et al., 2021).

Complexities in managing pharmaceutical supply chains, coupled with the unpredictable nature of disasters, make it difficult to ensure the timely delivery of medications when they are needed most (Wang & Jie, 2020). Medication shortages during disasters can lead to increased morbidity and mortality, particularly among vulnerable populations such as the elderly, people with chronic conditions, and those requiring life-saving medications. The supply chain encompasses the entire process, from the procurement of raw materials to the distribution of finished pharmaceutical products to healthcare facilities (Parajuli et al., 2022; Bastani et al., 2023).

However, the challenges faced by medication supply chains during disasters are deeply rooted in three core issues: infrastructure challenges, socio-cultural influences, and the role of

technological advancements. Infrastructure damage, including road destruction and the inaccessibility of healthcare facilities, disrupts the delivery of medicines, causing delays that can exacerbate health outcomes. Socio-cultural factors, such as local beliefs, trust in external aid, and socio-economic disparities, further hinder equitable distribution and acceptance of medical supplies. On the other hand, technological advancements like digital monitoring systems, AI-driven demand forecasting, and drone deliveries offer innovative solutions to bridge these gaps. This discussion will elaborate on how these interconnected challenges impact the medication supply chain and explore strategies to address them effectively.

Infrastructure Challenges

Infrastructure damage is one of the most significant challenges facing medication supply chains during disasters. Natural disasters, such as earthquakes, floods, and hurricanes, often result in severe damage to vital infrastructure, including roads, airports, and healthcare facilities, which impedes the transportation of medical supplies. This disruption can delay the timely delivery of essential medications, further exacerbating the impact of the disaster on vulnerable populations (Mori et al., 2012; Bastani et al., 2023).

Additionally, both local and global supply chains can be severely disrupted due to damage to production facilities or transportation systems, leading to delays in the delivery of life-saving medicines. Communication breakdowns between various stakeholders during these crises can worsen the situation, as it becomes difficult to assess needs, coordinate responses, and ensure the delivery of medications in a timely manner (Bastani et al., 2023).

The physical distribution of medications also faces significant barriers, especially when transportation infrastructure is damaged. In many cases, alternative transportation methods such as air and sea transport may be required to ensure that medical supplies reach the affected areas. Moreover, community-based distribution networks, which involve local transportation providers and volunteers, can play a critical role in ensuring the last-mile delivery of essential medical supplies, ensuring that medications reach even the most remote areas (Arji et al., 2023).

Socio-Cultural Influences

Socio-cultural factors play a crucial role in determining how effectively medication supply chains function during disasters. Cultural attitudes towards healthcare and external aid can significantly influence the distribution and acceptance of medications. For example, some communities may prioritize traditional remedies over conventional medical treatments, which complicates efforts to distribute essential medicines (Arji et al., 2023).

Engaging with local communities and understanding their health beliefs and practices is vital to improving the acceptance of medical interventions. In regions where cultural sensitivity toward healthcare providers varies, there can be a lack of trust in external relief efforts, which may delay or prevent the successful distribution of life-saving medications. Building trust is essential, and addressing these concerns through culturally sensitive communication and interventions can significantly enhance the efficiency and reach of supply chains during crises (Bastani et al., 2023). A better understanding of local knowledge, health practices, and the socio-cultural landscape of affected populations can provide valuable insights for developing disaster response strategies that are more effective and tailored to the needs of the community (Hossain et al., 2023).

Additionally, socio-economic disparities can exacerbate challenges in accessing medications during a disaster. Vulnerable populations, especially those in low-income regions, may face significant obstacles due to a lack of financial resources or access to healthcare facilities. Disaster response strategies must, therefore, address these disparities by ensuring that low-income or marginalized groups receive free or subsidized medications during crises, further improving access and equity in the distribution of medical supplies (Hossain et al., 2023).

Technological Advancements

Technological innovations provide several promising solutions for improving the resilience of medication supply chains during disasters. Digital platforms that offer real-time visibility into the supply chain are essential for enhancing coordination and improving response times. These platforms allow stakeholders to monitor the movement of medical supplies, track inventory levels, and respond to bottlenecks in the distribution process, thus enabling a faster and more efficient response (Hermelin et al., 2020).

Furthermore, the integration of artificial intelligence (AI) and machine learning (ML) technologies is transforming the way medication supply chains are managed. AI-powered systems can analyze historical data on medication usage and disaster occurrences to forecast demand and predict supply chain disruptions. Machine learning models can help optimize transportation routes, ensuring that medications are delivered to disaster-stricken areas as efficiently as possible (Younis et al., 2022; Hossain et al., 2023).

In addition, blockchain technology presents another opportunity to improve the transparency of medication supply chains. By utilizing a decentralized ledger to record the movement of medicines, blockchain reduces the risk of counterfeit medications and enhances trust among stakeholders during a crisis. This added layer of transparency improves accountability and coordination, ensuring the resilience of the supply chain (Alla & Thangarasu, 2023; Bastani et

al., 2023).

Furthermore, in regions where transportation infrastructure is severely damaged, drones can offer a viable solution for last-mile delivery. Drones can bypass roadblocks or damaged infrastructure, delivering medications to remote areas quickly and efficiently (Hermelin et al., 2020). Lastly, to build more resilient medication supply chains, disaster response strategies must focus on agile supply chains capable of rapidly adapting to changing conditions (Hossain et al., 2023). Public-private partnerships can play a vital role in disaster management by leveraging the strengths and resources of both sectors, improving overall disaster response capabilities (Behrens et al., 2022).

4. Conclusion

The resilience of medication supply chains is essential for ensuring access to life-saving medicines during disasters, particularly for vulnerable populations such as the elderly and those with chronic conditions. Disruptions caused by damaged infrastructure, socio-cultural barriers, and logistical challenges can significantly hinder the delivery of essential medical supplies. This study emphasizes that technological advancements, such as AI, blockchain, and drones, combined with community-based approaches, offer effective solutions to enhance the efficiency, transparency, and adaptability of supply chains during crises. By integrating these innovations with culturally sensitive disaster management strategies, healthcare systems can better address the needs of affected populations.

To strengthen medication supply chains, investments in disaster-resistant infrastructure, alternative transportation methods, and robust coordination mechanisms—such as public-private partnerships—are critical. Strategic stockpiling, real-time monitoring systems, and drone technology can ensure timely and equitable distribution of medications, even in the most challenging conditions. These strategies, alongside a commitment to agile and adaptable planning, provide a framework for building resilient supply chains. The findings of this study highlight the urgent need for continued studies and policy innovation to support disaster management and public health systems, ensuring better preparedness and health outcomes in future emergencies.

5. References

Alla, K. R., & Thangarasu, G. (2023). Supply chain management of drug products in blockchain using reinforcement learning. *International Journal of Technology, 14*(6).

Arji, G., Ahmadi, H., Avazpoor, P., & Hemmat, M. (2023). Identifying resilience strategies for disruption management in the healthcare supply chain during COVID-19 by digital

innovations: A systematic literature review. *Informatics in Medicine Unlocked, 38*, 101199. https://doi.org/10.1016/j.imu.2023.101199

Bastani, P., Sadeghkhani, O., Bikine, P., Mehralian, G., Samadbeik, M., & Ravangard, R. (2023). Medication supply chain resilience during disasters: Exploration of causes, strategies, and consequences applying Strauss and Corbin's approach to grounded theory. *Journal of Pharmaceutical Policy and Practice, 16*(1), 99.

Behrens, D. A., Rauner, M. S., & Sommersguter-Reichmann, M. (2022). Why resilience in health care systems is more than coping with disasters: Implications for health care policy. *Schmalenbach Journal of Business Research, 74*(4), 465–495.

Goniewicz, K., & Goniewicz, M. (2020). Disaster preparedness and professional competence among healthcare providers: Pilot study results. *Sustainability, 12*(12), 4931. https://doi.org/10.3390/su12124931

Hermelin, J., Bengtsson, K., Woltjer, R., Trnka, J., Thorstensson, M., Pettersson, J., Prytz, E., & Jonson, C.-O. (2020). Operationalising resilience for disaster medicine practitioners: Capability development through training, simulation, and reflection. *Cognition, Technology & Work, 22*(3), 667–683.

Hossain, M. K., Thakur, V., & Kazancoglu, Y. (2023). Developing a resilient healthcare supply chain to prevent disruption in the wake of emergency health crises. *International Journal of Emerging Markets, 18*(6), 1307–1329.

Ma, J.-Y., Shi, L., & Kang, T.-W. (2022). The effect of digital transformation on the pharmaceutical sustainable supply chain performance: The mediating role of information sharing and traceability using structural equation modeling. *Sustainability, 15*(1), 649.

Mori, J., Hasui, K., Tanimoto, T., Matsumura, T., & Kami, M. (2012). Drug shortages after the Eastern Japan Earthquake: Experiences in a tertiary referral center. *Drug Information Journal, 46*(5), 607–610.

Parajuli, D. R., Khanal, S., Wechkunanukul, K. H., Ghimire, S., & Poudel, A. (2022). Pharmacy practice in emergency response during the COVID-19 pandemic: Lessons from Australia. *Research in Social and Administrative Pharmacy, 18*(8), 3453–3462.

Raza, M. A., Aziz, S., Noreen, M., & Raza, S. M. (2021). Role of pharmacist in disaster management: A quantitative content analysis approach. *Innovations in Pharmacy, 12*(4).

United Nations Office for Disaster Risk Reduction (UNDRR). (2019). *Sendai Framework for Disaster Risk Reduction 2015–2030*. https://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030

Wang, M., & Jie, F. (2020). Managing supply chain uncertainty and risk in the pharmaceutical industry. *Health Services Management Research, 33*(3), 156–164.

Woyessa, A., Teshome, M., Mulatu, B., Abadiga, M., Hiko, N., & Kebede, B. (2020). Disaster preparedness in selected hospitals of Western Ethiopia and risk perceptions of their authorities. *Open Access Emergency Medicine, 12*, 219–225. https://doi.org/10.2147/oaem.s260314

Younis, H., Sundarakani, B., & Alsharairi, M. (2022). Applications of artificial intelligence and machine learning within supply chains: Systematic review and future research directions. *Journal of Modelling in Management, 17*(3), 916–940. https://doi.org/10.1108/JM2-03-2021-0050

Yuliwulandari, R., FOMC, S., & Khan, H. T. A. (2024). Medical aspects and disaster management for older people. *Disaster Management Review, 11*(2), 45–57.