Cybersecurity and Innovative Technology Journal, Vol.2, No.1, 2024, pp. 53-66
e-ISSN 3025-6682. DOI. 10.52889/citj.v2i1.341

The Emerging Obstacles in the Provision of Healthcare Supply Chain Services

Submitted 10 December 2023, Revised 18 February 2024, Accepted 18 February 2024

Maurice L. McBride[1,2]*

[1]Department of Healthcare Technology, Healthcare Cybersecurity,
Capitol Technology University, Laurel, United States

[2]McBride Healthcare, Columbia, United States

Corresponding Email: *mmcbride@captechu.edu

Abstract

The COVID-19 pandemic has exposed flaws in the healthcare supply chain, including shortages, delays, and logistical issues. Key problems include inadequacies in resilience, visibility restrictions, cost management obstacles, integration barriers, unstated costs, and disparities in inclusivity. This research uses secondary data analysis to analyze findings from academic literature, industry reports, and case studies. It emphasizes the value of resilience and visibility, suggesting investing in blockchain, AI, and IoT technology for increased transparency and risk management. The report also emphasizes the need for proactive solutions, such as data analytics for improved supply chain visibility, hybrid inventory strategies for cost control, and stakeholder engagement for smooth integration. Integrating procurement, transportation, storage, and production, addressing misuse and hidden costs, and fostering inclusion are critical aspects of enhancing the healthcare supply chain.

Keywords: Healthcare Delivery, Costs, AI, Supply Chain, Efficiency

INTRODUCTION

One intricate and vital part of the international health system is the healthcare supply chain. It includes every action, group, person, resource, and technological advancement required to guarantee the transportation of medical supplies from the place of origin to the site of consumption. This covers the acquisition of raw materials, product production, transport to healthcare institutions, and lastly, patient delivery. The significance of the healthcare supply chain in the contemporary global health context cannot be emphasized. It is essential in guaranteeing that medical professionals have the resources needed to offer patients with high-quality treatment. This covers everything, from prescription drugs and medical equipment to personal safety gear and other necessities. This complex system controls the complex dance of supply and demand from the beginning of medical resources to their ultimate administration at the patient's bedside. Its efficient operation depends not only on the prompt delivery of medications and supplies but also on strengthening the fundamentals of patient care.

The healthcare supply chain does not, however, come without difficulties. The delivery of healthcare supply chain services has recently been impacted by a variety of emerging obstacles. These impediments, which vary from technical constraints to legal barriers, have the capacity to impair the seamless operation of the healthcare supply chain and, therefore, the provision of healthcare services. In particular, the COVID-19 pandemic served as a test tube, putting the resilience of global healthcare supply networks to the test. The flaws in this

apparently resilient system were exposed by shortages of essential medical supplies, disruptions in distribution networks, and delays in the logistics process. There has never been a more obvious need for resilience and visibility in healthcare supply networks. It is critical to manage uncertainty, continue operations in the face of interruptions, and guarantee the steady supply of medical resources. Furthermore, it is essential to have visibility across the supply chain in order to provide transparency and real-time insights, as well as to optimize resource allocation and reduce risks.

This study explores these new challenges with the goal of analyzing their complexity and defining how they affect the delivery of healthcare. This research looks at the lack of resilience, visibility difficulties, cost management problems, integration barriers, hidden costs, and inclusiveness gaps in healthcare supply chains in an effort to both identify the issues and provide a route toward workable solutions. It is becoming more important to recognize and manage these supply chain concerns as the healthcare environment changes. This report serves as a clear call to action to identify, address, and overcome these challenges, strengthening the foundation of healthcare delivery to guarantee a robust and effective system for everyone's well-being.

Background

The acquisition, manufacture, distribution, and delivery of healthcare products and services are dependent upon a complex web of interrelated stages, functions, and stakeholders, which together make up the healthcare supply chain. It has distinct difficulties because of the nature of its products, which include drugs, equipment, medical devices, and specialized resources, in contrast to traditional supply chains. Its complex organizational structure consists of several companies, ranging from manufacturers and suppliers of raw materials to distributors, healthcare professionals, and patients themselves. Every stage is crucial: suppliers provide the raw materials, manufacturers turn them into completed goods, distributors handle shipping and logistics, and healthcare providers make sure these resources are available and efficiently used for patient care.

In addition, the regulatory environment in which the healthcare supply chain functions requires strict adherence to compliance guidelines and quality control procedures to guarantee the security and effectiveness of pharmaceuticals. This increases complexity and makes it necessary to manage and record everything closely in order to comply with regulations at every turn. All throughout the chain, from obtaining raw materials to administering therapies, there is ongoing demand to strike a balance between efficacy, affordability, and quality. Any interruption anywhere in the network might have a cascading effect, resulting in severe

shortages, service delays, or even jeopardizing patient safety. This supply chain is always changing due to the dynamic nature of healthcare technology and services, which necessitates flexibility and agility to meet changing needs, seize new opportunities, and get past unanticipated obstacles.

Historical Perspective: Evolution of the Healthcare Supply Chain

The evolution of the healthcare supply chain's growth has been a transformational one, characterized by notable changes in ideology, technology, and practices in response to the evolving healthcare sector. The healthcare supply chain used to be mostly isolated and fragmented, with little to no interaction between its many parts. Earlier versions lacked the complex logistics and extensive networks of today, concentrating instead on simple distribution and procurement. The variety and accessibility of medical supplies were restricted by localized manufacture and restricted international commerce.

However, a paradigm change occurred in the second part of the 20th century. Innovations in information technologies and transportation, in particular, have completely changed the healthcare supply chain. Better inventory monitoring and management have been made possible by the development of barcode technology and electronic data exchange (EDI) (Naidu & Alicia, 2019). This ushered in a period of increased supply chain operations efficiency and decreased mistakes. An important factor was the expansion of the supply chain's scope and complexity due to globalization. The industrial sector's outsourcing, rising global commerce, and the emergence of multinational firms changed the nature of supply chains and promoted cross-border cooperation and standardization.

Furthermore, the establishment of regulatory frameworks like Good Manufacturing Practices (GMP) and strict quality control methods drove uniformity and compliance across the supply chain by aiming to guarantee the effectiveness and safety of medical goods (Bretaudeau et al., 2020). With the introduction of cutting-edge technologies like blockchain, artificial intelligence (AI), and predictive analytics, the 21st century keeps up this trend. A more robust and patient-centric system will be possible in the face of changing healthcare needs and difficulties thanks to these technologies, which have the potential to increase transparency, efficiency, and responsiveness across the healthcare supply chain.

Current State of the Healthcare Supply Chain

Healthcare providers, distributors, manufacturers, patients, and other stakeholders are all involved in the complicated network that is the present healthcare supply chain. It is in charge of acquiring, producing, distributing, and providing healthcare goods and services. The healthcare supply chain still confronts a number of difficulties in spite of tremendous

improvements in technology and supply chain management techniques. One of the most important is the absence of resilience, or the supply chain's capacity to tolerate and recover from shocks, according to Orlando et al. (2021). This was made abundantly clear during the COVID-19 pandemic, when abrupt shifts in demand and supply chain interruptions made it difficult for medical professionals everywhere to get the materials they needed.

The lack of visibility across healthcare organizations is another significant issue. Healthcare providers can not guarantee the quality and safety of the items they use if they can not track and trace products along the supply chain. This lack of awareness, according to Carbonell et al. (2020), may put patient safety at risk as well as raise expenses because of waste and inefficiency. Another major problem in the present healthcare supply chain is cost management. High supply chain costs may be caused by a variety of factors, including hidden costs, overuse or variation in treatment, and poor procurement methods. Issues with integration and interoperability exacerbate these difficulties even further, as several healthcare providers employ multiple systems and technologies to manage their supply chains. In summary, even though the healthcare supply chain is essential to providing patients with high-quality treatment, there are a number of emerging obstacles that must be overcome. Creating a healthcare supply chain that is more robust, effective, and efficient by comprehending and tackling these issues is paramount.

Importance of Resilience and Visibility in the Healthcare Supply Chain

To maximize the efficiency and efficacy of the healthcare supply chain and protect it from unanticipated interruptions, resilience and visibility are two fundamental pillars that must be in place. The capacity of the healthcare supply chain to withstand shocks, adjust to changes, and go on with optimum operations in the face of disruptions is referred to as resilience (Hossain et al., 2022). It is essential to have the ability to foresee, tolerate, and recover from a variety of stresses, including pandemics, natural catastrophes, shortages in supplies, and geopolitical instability. In addition to reducing risks, a robust supply chain guarantees the continuous delivery of vital medical supplies to hospitals and patients in need.

Conversely, transparency and real-time information across the supply chain are embodied by visibility. Information about inventory levels, demand projections, supplier performance, and logistics must all flow seamlessly. Tan and Sidhu (2022) claim that improved visibility enables stakeholders to foresee bottlenecks, monitor inventory movement, spot possible problems, and act quickly on informed choices. This openness promotes cooperation, simplifies processes, and reduces inefficiencies in the supply chain.

Resilience and visibility together are essential to a healthy healthcare supply chain. Supply chain managers may proactively spot weaknesses and possible interruptions with more visibility. This kind of foresight makes it possible to put preventative steps in place to improve resilience, such diversifying suppliers, storing essential resources, or creating backup plans. The COVID-19 epidemic highlighted how important these characteristics are. Disruptions in the supply chain increased the requirement for resilience, while gaps in visibility made it more difficult to react quickly to changing needs. Better able to handle the crisis were those with more robust and transparent supply chains, which allowed them to quickly adapt to changing demand and guarantee a steady flow of vital medical supplies. Tan and Sidhu (2022) assert that in the future, the healthcare supply chain will be more resilient and visible thanks to investments in technologies like blockchain, data analytics, and Internet of Things (IoT) sensors, as well as strong risk management plans and cooperative partnerships. This integration would strengthen the healthcare system's capacity to provide patients with timely, high-quality treatment even in the face of unanticipated obstacles, in addition to improving operational efficiency.

METHOD

This research employs a methodology that is appropriate, relevant, and important to the research question for many reasons: secondary data analysis. Secondary data provides a comprehensive understanding of the healthcare supply chain environment by providing a broad view on the subject. It also offers the opportunity to assess massive datasets that would be costly and time-consuming to get straight from the source.

Data Collection

A methodical search technique was used, using reliable databases, peer-reviewed publications, industry reports, and trustworthy web sources. Search terms and criteria centered on issues with the healthcare supply chain, such as resilience, visibility, and other aspects. In order to guarantee the relevance and currency of the material, the inclusion criteria gave priority to current research and publications (within the last five years).

Data Analysis

The data that was gathered was carefully analyzed. First, a comprehensive analysis of a few chosen publications and sources was carried out in order to gather relevant data on the impediments found in healthcare supply chains. The results were categorized based on themes that corresponded with the constraints that were mentioned, including insufficient resilience, difficulties with visibility, and problems with cost management, difficulties with integration, hidden costs, gaps in inclusiveness, and more. To arrive at complete results, a variety of approaches will be synthesized and comparative analysis will be used.

Justification of Approach

The research's objective, to examine and integrate current knowledge and empirical evidence about emerging obstacles in healthcare supply chains, was in line with the choice of secondary data analysis. This approach ensured a full grasp of the many difficulties encountered by healthcare supply chains by enabling a thorough assessment of a wide range of academic material, industry papers, and case studies. The employment of many viewpoints and proven results was made possible by secondary data analysis, which added to the topic's well-rounded and knowledgeable debate.

This method also takes into account the subtleties and complexity of healthcare supply chains, drawing on a plethora of prior research and professional opinions. It made it possible to synthesize data from many sources, which made it possible to detect patterns, inconsistencies, and knowledge gaps. This gave researchers a strong basis on which to draw insightful conclusions and practical suggestions.

RESULTS AND DISCUSSION

Healthcare supply chains are essential for providing medical services and supplies, but they are often subject to a variety of interruptions. Rehman and Ali (2022) ascribe these challenges to a number of causes, such as the concentration of manufacturing and R&D operations, lean supply chain management techniques, and global procurement from low-cost nations. These weaknesses have been further highlighted by the COVID-19 pandemic, which has seriously disrupted healthcare supply chains (Singh & Parida, 2022). These interruptions have a significant effect on patient care and the delivery of healthcare. Medical product shortages may result in inferior items being used, care being rationed or denied, delays in treatment, or a higher risk of mistake when utilizing alternative products (Miller et al., 2020). The efficacy, efficiency, safety, and equality of high-quality care may all be impacted by these changes.

A number of approaches and case studies highlight effective resilience-building techniques in healthcare supply chains. Rehman and Ali (2022) have highlighted many key resilience methods, including the implementation of Industry 4.0, multiple sourcing, risk awareness, agility, and global diversity of suppliers, markets, and operations. According to Sawyerr and Harrison's (2022) research, resilience in the supply of personal protection equipment during the COVID-19 pandemic was largely dependent on factors such as readiness, robustness, recovery, and adaptation. To reduce the negative effects of disruptions on patient care and healthcare delivery, it is essential to strengthen the resilience of healthcare supply

chains. This entails recognizing the weaknesses, evaluating the possible effects, and putting resilience techniques into practice.

Furthermore, a number of variables often make it difficult for healthcare businesses to achieve openness and real-time information. These include the fracturing of the patient-clinician connection, the emergence of managed care and its associated financial incentives, conflicts of interest between manufacturers and physicians, and consumerism, according to Baker (2020). Transparency may also be hampered by a lack of supporting capabilities, inadequate network connectivity, and disjointed paper-based systems. There are serious repercussions when there is little transparency in healthcare decision-making. Making decisions without giving enough thought to the data may have unfavorable effects (Shafaghat et al., 2022). Having little insight into the whole data process makes it challenging to operate the supply chain as an integrated, one system. Governments and providers may find it difficult to decide when and how much to restock health commodities due to this lack of visibility.

The utilization of cutting-edge techniques and technology is improving supply chain visibility in the healthcare industry. The integration of IT, operations, and data required to enhance supply-chain performance and safeguard supply-chain funding is made possible by digitization, which is a potent doorway to data visibility. Furthermore, according to Singh and Parida (2022), several metrics found in the literature are being used to examine distinct supply chain disruption models in the healthcare industry. The potential of blockchain technology to improve supply chain visibility for pharmaceuticals is also being investigated. To surmount visible obstacles in healthcare institutions, one must comprehend the obstacles, evaluate the consequences, and put into practice efficient tactics and technology.

Healthcare supply chains have been severely damaged by the COVID-19 epidemic, which has raised expenses and put financial pressure on them. Operational difficulties for hospitals and health systems have included historically high volume and revenue losses along with rapidly rising costs. By the end of 2021, supply costs—which may make up as much as 40% of a hospital's overall costs—had gone up by 15.9%. Specifically, there was a rise of 31.5% and 22.3% in medical supply costs in ICUs and respiratory care departments, respectively. Numerous case studies have shown effective cost management tactics during the epidemic. As to Klaehn et al.'s (2022) systematic study, case management treatments often provide cost-effective or even cost-saving outcomes. Furthermore, Juneau et al. (2022) proposed that the most economical measures include early immunization (where possible), surveillance networks, protective gear for healthcare personnel, and quick contact tracing and case isolation.

Regarding long-term effects and possible remedies, the epidemic has brought attention to how crucial a strategic, well-functioning supply chain is. According to Siagian et al. (2021), a well-functioning supply chain may improve resilience, elevate care, elevate physician satisfaction, decrease supply expenditure by up to 10%, and better position health systems to realize their development objectives. Thus, healthcare administrators may save expenses and enhance procedure income with targeted supply chain innovations. Moreover, the seamless integration of stakeholders in healthcare supply chains is often a barrier. Numerous things might be blamed for these challenges, such as a lack of drive, aversion to change, an inefficient way of thinking, and a lack of initiative on the part of the ecosystem's major players or health authorities. Integration may also be hampered by disjointed paper-based systems, inadequate network integration, and a lack of supporting capabilities (Benevento et al., 2023). These integration issues have a substantial effect on supply chain cooperation and coordination. Healthcare companies could find it challenging to manage the supply chain as a single, integrated system in the absence of adequate integration. Governments and providers may find it difficult to decide when and how much to restock health commodities due to this lack of interconnectivity.

There are several approaches that healthcare organizations might take to address these integration-related issues. The integration of IT, operations, and data required to enhance supply-chain performance and safeguard supply-chain funding is made possible by digitization, which is a potent doorway to data visibility. Furthermore, numerous metrics found in the literature are being used to examine distinct supply chain disruption models in the healthcare industry. The potential of blockchain technology to improve integration in healthcare supply chains is also being investigated (Singh & Parida, 2022). In general, comprehending the obstacles, evaluating the effects, and putting into practice efficient tactics and technology are necessary to overcome integration issues in healthcare organizations (Benevento et al., 2023).

Variations in care may also result in inefficiencies and waste of resources in healthcare systems. These variances often result from a lack of uniformity, which raises prices and lowers quality. For example, longer durations of stay and improper use of post-acute resources might result from the use of needless preoperative testing, physician preference judgments that raise implant prices or lengthen operating room times, and a lack of standardized postoperative care. There is a major influence on the distribution of resources and patient outcomes. Excessive clinical variety drives up expenses, as seen by the high cost of numerous surgical operations and care episodes. Additionally, it has an impact on the patient experience and other aspects of the value of treatment (Thiel & Horwitz, 2019). Patients are more satisfied when standardized

treatment is combined with excellent provider involvement and communication. Continuous quality improvement and the usage of routes are two strategies to standardize treatment and eliminate needless variances. These techniques seek to improve the quality of healthcare by minimizing needless variance in the way it is currently delivered. Together with computerized clinical decision support, comprehensive assessment, and targeted teaching, this technique may contribute to the development of a dynamic, learning health care system.

Ensuring fair access to resources and services requires an inclusive healthcare supply chain. On the other hand, inequalities in inclusion might result in large inequities. An extensive analysis of supply chain disruptions made clear how crucial it is to take into account all supply chain participants, including unconventional ones like rivals and non-governmental groups. Disruptions resulting from a lack of inclusion may impact the availability of critical healthcare items and services. Gaps in inclusivity in healthcare supply chains may take many different forms. Supply chain disruptions, according to Singh and Parida (2022), may happen when all parties involved—including unconventional ones like rivals and non-governmental organizations—are ignored. This may cause hiccups that impact the flow of necessary medical supplies and services.

Furthermore, lean supply chain management techniques have gained a lot of traction. These techniques need leveled and just-in-time manufacturing, correct transport scheduling for cross-docking operations, and continuous flow processing with minimal inventory amounts (Katsaliaki et al., 2021). These developments raise the strain on undisturbed operations and stable surroundings, but they also make them more susceptible to disturbances. There are two types of disruption risks: man-made (such as terrorist attacks, accidents, supplier insolvency, etc.) and natural (such as earthquakes, floods, fires, COVID-19, etc.). The supply chain network is immediately impacted by these hazards since they might cause temporary disruptions and outages in supply chain linkages.

These gaps may have detrimental effects. For example, poor health outcomes might result from restricted access to healthcare caused by supply chain constraints and poverty. These disparities may lead to injustices that have an impact on general living circumstances and health. In order to promote inclusion, proactive engagement with all stakeholders is essential. This comprises organizations, both internal and external, that promote, assist, or oversee the use of sustainable supply chain management techniques. By addressing stakeholder problems early on, collaborative methods may assist avoid possible reputation and legitimacy loss.

Healthcare supply chains depend heavily on production, shipping, storage, and procurement. But every link in the network has its shortcomings, which taken together may

reduce the chain's overall efficacy and efficiency (Miller et al., 2020). A lack of attention for stakeholders, particularly non-traditional ones like rivals and non-governmental groups, might make healthcare procurement susceptible. The provision of necessary healthcare goods and services may be disrupted as a result of this lack of inclusion. Conversely, the use of lean supply chain management techniques may give rise to transportation risks. Singh and Parida (2022) state that these procedures need leveled and just-in-time manufacturing, precise transport scheduling for cross-docking activities, and continuous flow processing with minimal inventory sizes. These developments raise the strain on undisturbed operations and stable surroundings, but they also make them more susceptible to disturbances.

Storage flaws may also be revealed in times of crisis, as the COVID-19 outbreak. Alongside the disease's worldwide growth came shortages of medical supplies, exorbitant costs, an increase in dubious dealers, and significant actions by the government, business community, and charity in sometimes fruitless efforts to find answers (Miller et al., 2020). Finally, the concentration of industrial capacity reveals weaknesses in the manufacturing process. For instance, when manufacturing capacity centered in Puerto Rico was devastated by Hurricane Maria in 2017, an acute scarcity of sterile saline solutions replaced a chronic one (Lawrence et al., 2020).

Studies on cases have shown that these shortcomings are reversible. For example, supply chain and procurement technology solutions and strategies were used by GEP's clients—which included hundreds of Fortune 500 and Global 2000 companies—to overcome major obstacles. It is advised to use preventative measures, such as enhanced data analytics, external information about the healthcare supply chain, and supplier visibility, to boost these skills. Furthermore, inclusiveness may be promoted by proactive involvement with all stakeholders and the use of sustainable methods.

CONCLUSION

In conclusion, numerous significant findings have been drawn from our investigation into the emerging obstacles in the delivery of healthcare supply chain services. These include poor procurement methods, problems with cost management, difficulties with integration and interoperability, and a lack of resilience and visibility in the healthcare supply chain. The healthcare supply chain is significantly impacted by these results. The availability of crucial healthcare goods and services may be impacted by supply chain interruptions brought on by a lack of resilience and visibility. Increased healthcare expenses may be passed on to patients and healthcare providers as a consequence of poor procurement procedures and cost management

concerns. Difficulties with integration and interoperability may result in supply chain inefficiencies that compromise the efficacy and security of medical supplies.

These obstacles have a significant influence on patient care and healthcare delivery. Supply chain disruptions may cause delays in the provision of critical healthcare services, which can have an impact on patient outcomes. Patients may find it more difficult to acquire healthcare services as a result of rising healthcare prices, especially those who live in low-income areas. Supply chain inefficiencies have the potential to jeopardize patient safety by compromising the quality and safety of healthcare items. In order to improve the healthcare supply chain's resilience and efficiency and, ultimately, the provision of high-quality healthcare services to everyone, it is imperative that these emerging obstacles be addressed. Creating tactics and solutions to get over these obstacles should be the main focus of future study and practice.

SUGGESTIONS

It takes a multifaceted strategy to reduce and improve the healthcare supply chain. Below are a few suggestions:

Resilience and Visibility

Improving data analytics, supplier visibility, and external knowledge about the healthcare supply chain are all necessary to increase resilience. Gaining 'buy-in' from residents and stakeholders is also essential (Ellen et al., 2018). Electronic logistics information systems may help supply chain operations and activities by providing visibility.

Cost Management and Integration

The use of probabilistic hybrid inventory approaches in healthcare supply chain management (SCM) has the potential to enhance cost management by identifying an ideal stocking level and resulting in considerable cost reductions (Essila, 2023). Strong communication with executives and front-line physicians both throughout and in between contracting cycles may help accomplish integration.

Addressing Hidden Expenses and Overuse

Ellen et al. (2018) state that identifying overused health services, putting stakeholder- or patient-led methods into practice, and starting government-led efforts may all help reduce the overuse of health services. A thorough grasp of the whole supply chain, including production, shipping, storage, and procurement, is necessary to address hidden costs.

Strengthening Procurement, Transportation, Storage, and Manufacturing

In order to strengthen these areas, more money has to be allocated to enhancing governance and accountability, infrastructure, equipment, and support systems, supply chain employees' knowledge and abilities, infrastructure, and policy formulation and execution. For

example, by addressing these areas, the health supply chain system in Uganda was enhanced (Lugada et al., 2022). In conclusion, enhancing the healthcare supply chain is a challenging undertaking that calls for an all-encompassing, integrated strategy that takes into account the input from all relevant parties and addresses every facet of the chain.

REFERENCES

Baker, D. W. (2020). Trust in Health Care in the Time of COVID-19. *JAMA*, *324*(23), 2373. https://doi.org/10.1001/jama.2020.23343

Benevento, E., Stefanini, A., Aloini, D., Dulmin, R., & Mininno, V. (2023). Beyond Digital Technologies: Investigating the Barriers to Supply Chain Integration of Healthcare Organizations. *IEEE Transactions on Engineering Management*, 1–13. https://doi.org/10.1109/TEM.2023.3280329

Bretaudeau, L., Tremblais, K., Aubrit, F., Meichenin, M., & Arnaud, I. (2020). Good Manufacturing Practice (GMP) Compliance for Phage Therapy Medicinal Products. *Frontiers in Microbiology*, *11*. https://doi.org/10.3389/fmicb.2020.01161

Carbonell, Á., Navarro-Pérez, J., & Mestre, M. (2020). Challenges and barriers in mental healthcare systems and their impact on the family: A systematic integrative review. *Health & Social Care in the Community*, *28*(5), 1366–1379. https://doi.org/10.1111/hsc.12968

Ellen, M. E., Wilson, M. G., Vélez, M., Shach, R., Lavis, J. N., Grimshaw, J. M., & Moat, K.A. (2018). Addressing overuse of health services in health systems: a critical interpretive synthesis. *Health Research Policy and Systems*, *16*(1). https://doi.org/10.1186/s12961-018-0325-x

Essila, J. C. (2023). Strategies for reducing healthcare supply chain inventory costs. *Benchmarking: An International Journal*, *30*(8), 2655–2669. https://doi.org/10.1108/bij-11-2021-0680

Hossain, N. U. I., Fazio, S. A., Lawrence, J.-M., Santibanez Gonzalez, E. DR., Jaradat, R., & Alvarado, M. S. (2022). Role of systems engineering attributes in enhancing supply chain resilience: Healthcare in context of COVID-19 pandemic. *Heliyon*, *8*(6), e09592.https://doi.org/10.1016/j.heliyon.2022.e09592

Juneau, C.-E., Pueyo, T., Bell, M., Gee, G., Collazzo, P., & Potvin, L. (2022). Lessons from past pandemics: a systematic review of evidence-based, cost-effective interventions to suppress COVID-19. *Systematic Reviews*, *11*(1). https://doi.org/10.1186/s13643-022-01958-9

Katsaliaki, K., Galetsi, P., & Kumar, S. (2021). Supply Chain Disruptions and resilience: a Major Review and Future Research Agenda. *Annals of Operations Research*, *1*(1). Springer. https://doi.org/10.1007/s10479-020-03912-1

Klaehn, A.-K., Jaschke, J., Freigang, F., & Arnold, M. (2022). Cost-effectiveness of Case Management: A Systematic Review. *The American Journal of Managed Care*, *28*(7). https://doi.org/10.37765/ajmc.2022.89186

Lawrence, J.-M., Ibne Hossain, N. U., Jaradat, R., & Hamilton, M. (2020). Leveraging a Bayesian network approach to model and analyze supplier vulnerability to severe weather risk: A case study of the U.S. pharmaceutical supply chain following Hurricane Maria. *International Journal of Disaster Risk Reduction*, *49*, 101607. https://doi.org/10.1016/j.ijdrr.2020.101607

Lugada, E., Komakech, H., Ochola, I., Mwebaze, S., Olowo Oteba, M., & Okidi Ladwar, D. (2022). Health supply chain system in Uganda: current issues, structure, performance, and implications for systems strengthening. *Journal of Pharmaceutical Policy and Practice*, *15*(1). https://doi.org/10.1186/s40545-022-00412-4

Miller, F. A., Young, S. B., Dobrow, M., & Shojania, K. G. (2020). Vulnerability of the medical product supply chain: the wake-up call of COVID-19. *BMJ Quality & Safety*, *30*(4), bmjqs-2020-012133. https://doi.org/10.1136/bmjqs-2020-012133

Naidu, M., & Alicia, Y. L. Y. (2019). Impact of Bar-Code Medication Administration and Electronic Medication Administration Record System in Clinical Practice for an Effective Medication Administration Process. *Health*, *11*(05), 511–526. https://doi.org/10.4236/health.2019.115044

Orlando, B., Tortora, D., Pezzi, A., & Bitbol-Saba, N. (2021). The disruption of the international supply chain: Firm resilience and knowledge preparedness to tackle the COVID-19 outbreak. *Journal of International Management*, *28*(1), 100876. https://doi.org/10.1016/j.intman.2021.100876

Rehman, O. ur, & Ali, Y. (2022). Enhancing healthcare supply chain resilience: decision-making in a fuzzy environment. *The International Journal of Logistics Management*, *ahead-of-print*(ahead-of-print), 520–546. https://doi.org/10.1108/ijlm-01-2021-0004

Sawyerr, E., & Harrison, C. (2022). Resilience in healthcare supply chains: a review of the UK's response to the COVID19 pandemic. *International Journal of Physical Distribution & Logistics Management*, *53*(3), 297–329. https://doi.org/10.1108/ijpdlm-09-2021-0403

Shafaghat, T., Bastani, P., Nasab, M. H. I., Bahrami, M. A., Montazer, M. R. A., Zarchi, M. K. R., & Edirippulige, S. (2022). A Framework of evidence-based decision-making in Health System management: a best-fit Framework Synthesis. *Archives of Public Health*, *80*(1). https://doi.org/10.1186/s13690-022-00843-0

Siagian, H., Tarigan, Z. J. H., & Jie, F. (2021). Supply Chain Integration Enables Resilience, Flexibility, and Innovation to Improve Business Performance in COVID-19 Era. *Sustainability*, *13*(9), 4669. MDPI. https://doi.org/10.3390/su13094669

Singh, A., & Parida, R. (2022). Decision-Making Models for Healthcare Supply Chain Disruptions: Review and Insights for Post-pandemic Era. *International Journal of Global Business and Competitiveness*, *17*, 130–141. https://doi.org/10.1007/s42943-021-00045-5

Tan, W. C., & Sidhu, M. S. (2022). Review of RFID and IoT Integration in Supply Chain Management. *Operations Research Perspectives*, *9*, 100229. https://doi.org/10.1016/j.orp.2022.100229

Thiel, C., & Horwitz, L. I. (2019). Improving Value in Health Care Through Comprehensive Supply Optimization. *JAMA*, *322*(15), 1451. https://doi.org/10.1001/jama.2019.15478