THE RISING COSTS OF HOSPITAL PHARMACEUTICAL SHORTAGES AND THE

IMPACT ON PATIENT CARE: EXPLORING THE USE OF PREDICTIVE

ANALYTICS IN NEW YORK AREA HOSPITALS

by

LeTicia L. Currin

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Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Business Administration

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Liberty University, School of Business

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Abstract

This qualitative case study examined the rising cost of hospital pharmaceutical shortages and the impact on patient care. This study also explored the use of predictive analytics to reduce costs and improve patient care efficiency. Increased health-care spending is partially due to prescription medication prices. Management of hospital drug procurement affects patient health, quality care, and hospital budgets, while risk management needs to minimize possible medication shortages. For patients to get the drugs that they need, pharmacists need to have resources at their fingertips to obtain a deep insight into the knowledge of drugs through the supply chain. The research questions concentrated on the causes of rising costs, the role of supply and demand, and the possibility of predictive analytics as a tool for inefficiencies relating to rising costs of hospital pharmaceutical shortages. The unexpected factor in this study was the impact of the Coronavirus (COVID-19) pandemic. Not only did COVID-19 alter the data collection method, but the data itself. Hospital pharmaceuticals were and still are greatly affected by the pandemic. The findings from this study was applied to the professional practice of business. Additionally, the researcher discussed the implication of the biblical worldview and the implication of the strategic management field of study. The report finished with suggestions for practice, suggestions for further analysis, reflections, and conclusions. The researcher also recommended that the study be conducted again with a specific pharmaceutical shortage and no global pandemic.

Key words: pharmaceutical shortages, manufacturer, strategic management, efficient patient care, COVID-19

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Dr. Scott A. Quatro, Dissertation Chair

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Dr. Jonathan Wilson, Dissertation Committee Member

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Dr. Edward M. Moore, DBA Program Director

Dedication

This study is dedicated to my husband, Kasheen. Next to God, you are the closest person to me. You are so amazing, and I love you so much. You prayed for me, encouraged me, balanced, and pushed me to the heights I could never have imagined. You're my rock, my strength, and my best friend. I can't thank God enough to have blessed me with you.

I want to also dedicate this study to my squad, family, friends, and my church family for their love and support on this doctoral journey. You kept me going, you understood my absence from events, and I'm very grateful for that. Lastly, I would like to dedicate this study to my three angels in heaven above: my mother, Laura, my adopted mom, Robinette, and my mother-in-love, Carolyn. I have felt your presence in the beginning, the middle, and even now at the end of this journey. I hope I have made you proud. Continue to watch over me, and I love and miss you all dearly. This one is for you.

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Section 1: Foundation of the Study

General supervision of the supply chain is frequently inefficient and wasteful (Hart & McMurtrey, 2018). The increasing amount of healthcare expenditure is partly due to the cost of pharmaceutical drugs. Management of hospital drug procurement impacts patient safety, quality care, and hospital budgets, while risk management needs to mitigate possible drug shortages. Additionally, pharmaceutical shortages can harm patient drug therapies, which result in medication errors and delay in medical procedures (Shaban et al., 2018).

This study examined the rising cost of hospital pharmaceuticals shortages and how they impact patient care. The first section of this study began with a review of the business problem, its purpose, and the nature of which the study was conducted. After the nature of the study, the research questions were discussed, and the conceptual framework was established. The researcher defined terms, assumptions, limitations, and delimitations for the study. Observations of the potential reduction of gaps, Biblical integration, and the relationship to the writer's field of study was discussed. The first section ended with a review of the academic and professional literature related to the business problem. This study addressed prescription shortages due to forecast errors and manufacturing problems.

Background of the Problem

In the healthcare delivery system, pharmaceutical inventory management is complex but vital for patient care and operations. According to Kagashe and Massawe (2012), inadequate and unsystematic monitoring of pharmaceuticals, and inaccurate stock records all lead to poor pharmaceutical inventory management. Moons et al. (2019) argued that the process of performance measurement in any supply chain is essential to address inpatient care inefficiencies and to control rising supply chain inventory costs. Moreover, the ability to use data to predict

pharmaceutical shortages and their effects will be crucial to decrease costs and improve patient care efficiency. Rachmania and Basri (2013) claimed to maintain drugs' availability; it is essential to know the levels of drugs in a pharmaceutical supply chain. Drug shortages may happen for an assortment of reasons, including manufacturing problems, raw material shortages, regulatory problems, natural disasters, and voluntary recalls. Healthcare facility and patient care operations are disrupted by poor inventory management (Vila-Parrish et al., 2012). Moreover, when pharmaceutical inventory management is subjected to poor practices, there can be substantial shortages and inefficiencies that affect healthcare supply delivery (Landis, 2002).

Mustaffa and Potter (2009) emphasized the importance of efficient internal inventory management. For optimizing the medical supply system's efficiency, pharmaceutical inventory management needs to be improved (Almarsdotti & Traulser, 2005; Kelle et al., 2012; Shah, 2004). Castellanos (2019) reported that analysts predict that using data for precise supply-and-demand forecasts could save hundreds of millions of dollars a year through better inventory management for drug makers and hospitals. Moreover, finding a useful data tool that can help specifically with pharmaceutical shortage planning can be valuable to the hospital supply chain's operations. From the background of the problem, it was established that a comprehensive study on the rising costs of hospital pharmaceutical shortages and the impact on patient care in New York.

Problem Statement

The general problem addressed was the rising cost of hospital pharmaceutical shortages and the impact on patient care. Hospitals continue to feel pressure from society to provide affordable, safe, and quality service to patients despite rising medical costs due to un-optimized and wasteful supply chain management (Dobrzykowski et al., 2014). A report by the American

Hospital Association (AHA), the American Society of Health-System Pharmacists (ASHP), and the Federation of American Hospitals (FAH) stated that the strain on hospital budgets, operations, and patient care continues to be impacted by rising costs of hospital pharmaceutical shortages (ASHP, 2019). Pharmaceutical supply chain shortages are caused by many issues such as forecasting errors, plant quality problems, manufacturer consolidation, and a lack of incentives to produce generic brands, increase in demand, and product recalls (Azghandi et al., 2018; Mazer et al., 2014). This study addressed pharmaceutical shortages due to forecast errors and manufacturing problems. Manufacturing is the link between study and patient; there is no medical result without a product.

Heiskanen et al. (2017) argued that manufacturing issues, long or complicated output, was the most common cause of drug shortages. It is more difficult to control the quality of the manufacturing chain as the manufacturing chain becomes more complicated and longer. It was assumed that a long and complicated manufacturing chain and the use of several subcontractors would not only jeopardize the availability of drugs but would also increase the risk of quality problems and increase the cost of manufacturing (Heiskanen et al., 2017). The specific problem addressed was the rising costs of hospital pharmaceutical shortages related to manufacturing issues and the impact on patient care in New York hospitals.

Purpose Statement

The purpose of this qualitative case study was to add to the body of knowledge by expanding on the understanding of factors driving the rising cost of hospital pharmaceutical shortages relating to manufacturing problems and the impact on patient care. The integration and coordination of the hospital pharmaceutical supply chain are essential to support patients' care (Sweeney, 2011a). Hospital supply chain management has many issues, including increased

supplies, manufacturing problems, logistics, and distribution issues. When the supply chain is managed effectively, it can positively affect the hospital's bottom line (de Vries & Huijsman, 2011). Pharmaceutical supply chain management's critical objectives should improve the fulfillment of demand efficiently, drive extraordinary client value, build system resiliency, and promote financial success (Gibson et al., 2005). The more significant problem was explored by studying the rising cost of hospital pharmaceutical shortages, associated with manufacturing problems, the impact on patient care, and exploring the use of predictive analytics in New York area hospitals.

Predictive analytics is a concept describing the use of past data to develop informed assumptions about future results. Many businesses have been using this sophisticated method to assess risk, detect fraud, and the demand for products or services. The study's role in predictive analytics was a method for using data to predict and adapt to changing demands based on historical events and prevailing trends (Brooks, 2018).

Nature of the Study

Research methods in business are utilized by organizations to decide whether a particular business venture merits time and other resources. Likewise, research methods help organizations assess business success viability and select the right marketing approach for goods and services. Before conducting research, organizations usually define the problem and purpose that a research study seeks to explore. After the problem and purpose were established, the most suitable research method was selected. Three research methods are used to support the purpose statement: qualitative, quantitative, and mixed methods. This section discussed the chosen research method and design and the relation to the purpose statement. Additionally, it examined the research methods and design used in the study compared to the alternatives.

Discussion of Method

Pathak et al. (2013) indicated that qualitative research centers on understanding an exploration inquiry as an idealistic or humanistic methodology. To comprehend the interactions, conduct, beliefs, and experiences, a researcher will use a qualitative method. The qualitative research strategy is becoming more popular across disciplines by its assimilation of research into intermediation studies (Sofaer, 1999). Most generally, qualitative research involves methodical gathering, requesting, interpretation, and description of written data produced from perception, talk/interview, or existing records.

Qualitative research designs incorporate questioning, perception, and archival examination (Miles & Huberman, 1994). It will probably investigate the conduct, procedures of cooperation, and the implications, qualities, and encounters of deliberately sampled individual participants and groups in their ordinary setting. Consequently, the qualitative research method best suited the current study exploring the rising costs of hospital pharmaceutical shortage, the impact on patient care, and the use of predictive analytics in New York area hospitals.

The quantitative research method was not chosen because the quantitative method relies on numerical analysis, science, and the cause and effect of relationships. Quantitative research usually includes examining a large group of individuals, using a controlled survey that includes mainly forced-choice, or closed-ended questions. Quantitative analysis is best used when the results need to be conveyed mathematically, allowing organizations to garner statistics upon which predictions and plans can be made. A study that aims to gain insight into the experience with a phenomenon could not be reached with the quantitative method (Creswell, 2014).

The mixed methods research approach was not selected because it is a combination of quantitative and qualitative research methods. It includes philosophical presumptions, the

utilization of quantitative and qualitative methodologies, and the blending of both approaches within a single study to provide a better understanding than a single approach (Creswell & Plano Clark, 2007). Therefore, the mixed methods research method was unsuitable for exploring the current business problem.

Discussion of Design

Qualitative studies can be accomplished with one of the five qualitative designs; narrative, phenomenology, case studies, ethnography, and grounded theory. The focal point of the case study design is to investigate how a group of individuals perceive their experiences with a phenomenon (Creswell, 2016). Case study research has developed in notoriety as a powerful technique to explore and comprehend complicated issues in world settings. The source of case study design exists in the fields of politics, law, psychology, and medicine. Although there are roots of humanities and social science for the cutting-edge sociology contextual investigation (Yin, 2014) when a researcher selects a collective or multiple case study, they can address an issue either by multiple programs with one site, or multiple programs from multiple sites (Creswell & Poth, 2018).

For an examination of rising costs of hospital pharmaceutical shortages and the impact on patient care, exploring the use of predictive analytics in New York area hospitals, a multiple case design will give any insight into the single phenomenon. The qualitative case study design was chosen, following a thorough review of the remaining four designs. Narrative research can be described as a research design that is grounded in different disciplines of social sciences and humanities. Even though narrative research is grounded in social science and humanities, it also has origin related to education, history, and anthropology. Different approaches exist for different fields of study. Narrative design is the lived experiences of an individual(s) through

their stories with an emphasis on what happened in the story and how. The narrative design has several forms and uses an assortment of analytical practices (Creswell & Poth, 2018). The narrative design was not the chosen research design because its focus is on the experiences of an individual or a phenomenon being studied in chronological order by posing story-based questions to the participants sampled from the study population (Creswell & Poth). Hence, the narrative design was not appropriate for this study.

The qualitative grounded theory design reaches beyond the participants' shared experiences. The grounded theory aims to generate or discover a theory for those who experienced the process (Creswell & Poth, 2018). Aldiabat and Le Navenec (2011) described it as an explanation of a theory that is unified. The data collected from participants are what ground the theoretical development. The origin of grounded theory is in social and behavioral sciences. The origin of the grounded theory lies in the social and behavioral sciences. To help predict how people are acting and how events are progressing, a theory is developed as an explanation. Grounded theory can be narrow or broad, and the process is broken into steps as it unfolds (Creswell, 2016). Grounded theory was not appropriate for the qualitative study because the study is not intended to create a new theory.

An ethnographic investigation includes shared examples of conduct, language, and convictions of a whole culture. The procedure of an ethnographic examination begins with inside and out, common submerged perception of the members (Creswell & Poth, 2018). Ethnographic research started in similar social humanities. Ethnography is also used in sociologies and social sciences, and is widely recognized in wellness research (Reeves et al., 2008). Some examples of ethnography logical methodologies include woman's rights, Marxism, primary hypothesis, and postmodernism to give some examples. Because of the absence of universality, pluralistic

methodologies are developed (Creswell & Poth, 2018). Ethnography would not be an appropriate structure, since it is limited to depicting the functions of a cultured group by investigating practices, convictions, and language.

A research study that focuses on an individual(s) that experience a specific phenomenon and what the individuals have in common is the qualitative design of phenomenology. Phenomenology is the investigation of structures of cognizance as experienced from the primary individual perspective. The focal structure of an experience is its purposefulness, and it's being coordinated toward something, as it is an experience of or about some object. An experience is coordinated toward an object by the righteousness of its substance or significance (which speaks to the object) together with proper empowering conditions (Creswell & Poth, 2018).

Phenomenology as an order is unmistakable from however it identifies with other key disciplines in reasoning, for example, logic, ontology, epistemology, and morals. Phenomenological studies structure cognizant experiences from the individual perspective, alongside appropriate states of understanding. The focal structure of an experience is its deliberateness, how it is coordinated through its substance or importance toward a specific object in the world (Moran, 2000). Hence, the phenomenological research design was not chosen because human experiences were the focus and their thoughts over experiences with the phenomenon (Creswell & Poth, 2018).

As stated above, the best research method and design for exploring the rising costs of hospital pharmaceutical shortages, the impact on patient care, and the use of predictive analytics in New York area hospitals, was a qualitative case study. Harrison et al. (2017) stated the case study design is appropriate because it connects with the study's purposes and gives the researcher the tools to obtaining relevant information for solutions for the research problem.

Summary of the Nature of the Study

The qualitative method and case study design was chosen to study the rising cost of hospital pharmaceutical shortages, the impact on patient care and the use of predictive analytics in New York area hospitals. This method was chosen by the researcher because it was the most appropriate way to address the business problem and explore the cases and how the problem could be resolved. The researcher used semi-structured interviews to allow for further detail to be collected on the subject of the rising costs of hospital pharmaceuticals and the impact on patient care. The qualitative study also explored the use of predictive analytics as a possible business problem solution.

Research Questions

In the healthcare field, presenting innovation and management approaches is not as fast as other businesses, mainly since healthcare organizations generally have moderate cultures shaped by employees' special calling, which is sparing the human life (Moons et al., 2019). Scott-Cawiezell et al. (2009) stated that hospital pharmacies anticipate diminishing costs for operations while guaranteeing patient security. For pharmaceutical and healthcare organizations to optimize medication usage, there should be a system in place to be successful. In any case, the logistics of hospital pharmacies are identified with a few issues that affect the expense and nature of the prescription services adversely. Effective patient care that has been influenced by inventory management consists of strategic decisions of predictive analytics and emerging technology. Cohesive hospital management of supply chain strategy enables organizations to increase efficiency.

Moreover, effective execution of a cohesive method results in decreased costs and, in addition to the end of excess exercises, every one of these advantages converts into cash

investment funds inside the hospitals (Hart & McMurtrey, 2018). Designing effective procedures for supply chain management is vital to the success of overall hospital operations. Inventory misplacement, shortages in pharmacy supplies and less than optimal preemptive measures, all play into the truth that hospitals are focal points for inefficiencies without an appropriate system for supply chain management (Kim & Kwon, 2015). This qualitative case study addresses the problem of the rising costs of hospital pharmaceutical shortages related to manufacturing problems in New York hospitals, with the following research questions:

RQ1. How are hospitals challenged by the rising costs of hospital pharmaceutical shortages due to manufacturing problems?

RQ2. What role does supply and demand management play in hospital pharmaceutical shortages?

RQ3. How would predictive analytics improve patient care inefficiencies relating to rising costs of hospital pharmaceutical shortages?

Conceptual Framework

An organizing tool particularly useful in experimental research is the conceptual framework (Shields & Rangarajan, 2013). MacFarlane and O'Reilly-de Brún (2012) explained how a conceptual framework plans out the required activities during a study, given the researcher's prior comprehension of others' perspectives or learning on the researched subject. The conceptual framework for this qualitative case study added to the literature on the rising costs of hospital pharmaceutical shortages and the impact on patient care in New York hospitals.

The importance of hospital pharmaceutical efficiency. According to Manuel and Rossetti et al. (2008), pharmaceutical inventory management has a vital role in a hospital supply chain. Studies have shown the importance of healthcare industry operations and decision support tools

that improve wellbeing, general wellbeing, persistent security, and essential critical leadership in the pharmaceutical supply chain. Medication deficiencies and ill-advised utilization of pharmaceuticals can prompt financial losses as well as significantly affect patients. The Group Purchasing Organization (GPO) /healthcare technology provider, Vizient, estimated that drug shortages would represent an annual additional $360 million to hospital costs, including other labor costs of pharmacy and clerical employees (Pharmaceutical Commerce, 2019). A high level of service for effective inventory policies and medical supplies is essential for all healthcare industries.

Many health systems and emergency clinics experience challenges in accomplishing effective inventory management as they have disregarded how drugs are overseen, provided, and used to spare lives and improve wellbeing (Uthayakumar & Priyan, 2013). Almarsdóttir and Traulsen (2005) noted the various reasons why pharmaceuticals deserve extraordinary thought in inventory control; in the current financial crisis, increasing consideration is being centered on the increasing expenses of health care and explicitly, pharmaceuticals. Uthayakumar and Priyan (2013) stated that pharmaceutical products could be costly to purchase and dispense. Yet, the ill-advised use of prescriptions, deficiencies in basic medicines, and expenditure on superfluous or low-quality meds additionally have a huge cost of wasted assets and preventable disease and death.

Rising costs of hospital pharmaceutical shortages. One of the intentions of the Affordable Care Act is to regulate the cost of pharmaceuticals. Depending upon its unique drug formulary and residing state, medications will be different. In the marketplace of all health plans, prescription drug coverage is mandatory (Edmunds, 2016). Challenges with rising hospital pharmaceutical shortage costs could fundamentally draw down the medicinal business and

become unfavorable to the lives of individuals around the world (Sherwin, 2013). There are more significant challenges in hospital pharmaceutical inventory management because of hospital pharmaceutical shortages relating to manufacturing problems.

According to Bogaert et al. (2015), shortages due to manufacturing problems usually last longer than those due to problems with the supply chain. While when a manufacturing problem occurs, it is sometimes necessary to remove from commission a whole production chain. Current strategy initiatives have had limited success in dealing with drug shortages. Since 2004, pharmaceutical drug shortages have become more frequent and progressively severe. Additionally, shortages have a more significant impact on the care of patients and have become longer in duration. The rise in healthcare costs will motivate hospitals to strategically structure the supply chain that could enable them to control costs, forecast demand shortage, and better serve their patients (Sweeney et al., 2018). According to Gu et al. (2011), holding conversations and probing for practical solutions to drug shortages is critical given the drugs in shortage are essential for treating basic wellbeing conditions and deficiencies.

Pharmaceutical Supply and Demand Management

The components of a hospital pharmaceutical inventory are a large operating expense. Jurado et al. (2016) claimed one of the main tasks of a pharmacy is stock management. "It is a complex problem due to the uncertainty in the drug demand and the variety of constraints to be considered" (Jurado et al., 2016, p. 254). Literature reveals that pharmaceutical inventory can be estimated around 20% of revenues for the healthcare industry (Kelle et al., 2012). Therefore, it is essential to apply measures that may control the pharmaceutical inventory and, in turn, have a positive cost effect on the hospital's overall efficiency. The intricacy of the issue lies in the random nature of the medication demand and the numerous requirements that must be

considered in each decision. The clinical requirement for medications must be satisfied with fewer resources while limiting the utilization of financial assets (Liu et al., 2017).

Business Strategy and Predictive Analytics

The implementation of a business strategy and process improvement would be beneficial for the management of hospital pharmaceutical inventory. The Food and Drug Administration (FDA) acknowledge that the lack of robustness, agility, innovation and flexibility in the pharmaceutical industry poses a potential threat to public health as defects in manufacturing facilities leading to poor product quality could lead to drug shortages (Lee et al., 2015). To improve service levels and lessen cost, some healthcare facilities have evaluated alternative supply chain methods. Data from supply chains of medicines are important to preserve and forecast supply. Iyengar et al. (2016) outlined important steps to minimize drug shortages, and their effects include recognizing the most at-risk drugs, establishing reporting systems for sharing information on current and emerging shortages, and enhancing medication supply chain data. Organizations have enormous data regarding supply chain. So much as organizations are looking to use the value of the data in order to make improved decisions such as establishing risk-based inspection scheduling, predictive of drug shortages.

McKesson (2019) suggested predictive ordering (analysis) is a strategy that can improve hospital supply chain of pharmaceuticals by using data to track ordering habits. With the data, the percentage of manual ordering decreases while the focus of ordering standardization increases (McKesson, 2019). The use of predictive analytics may not be able to predict when a manufacturer's supply of a drug is low, but they can be used as a tool for hospital supply chain managers to use in response to a pharmaceutical shortage. It has many strategic advantages as it makes it possible for a company to become the leader when the changes happen. As a part of the

supply chain, predictive analytics has not only focused on savings for pharmaceutical drug costs, but also on helping organizations with their long-term goal plans (Rafati & Poels, 2015). Predictive analytics can have a remarkable positive outcome in the supply chain of any size corporation. To remain competitive and relevant in today's markets, it is essential to use the most useful front-line cutting-edge tools. For supply chain managers, looking to expand the adequacy of the present confounded supply chains, vital predictive analytics is a collection of learning that can help increment effectiveness and lessen costs (Parniangtong, 2016).

Figure 1

Conceptual Framework Model

Understand: The Importance Of Hospital Pharmaceutical Efficiency.	Decrease: The Rising Costs Of Hospital Pharmaceutical Shortages.
Goal: Efficient Patient Care	
Explore: Business Strategy And Predictive Analytics.	Optimize: Hospital Pharmaceutical Demand Management.
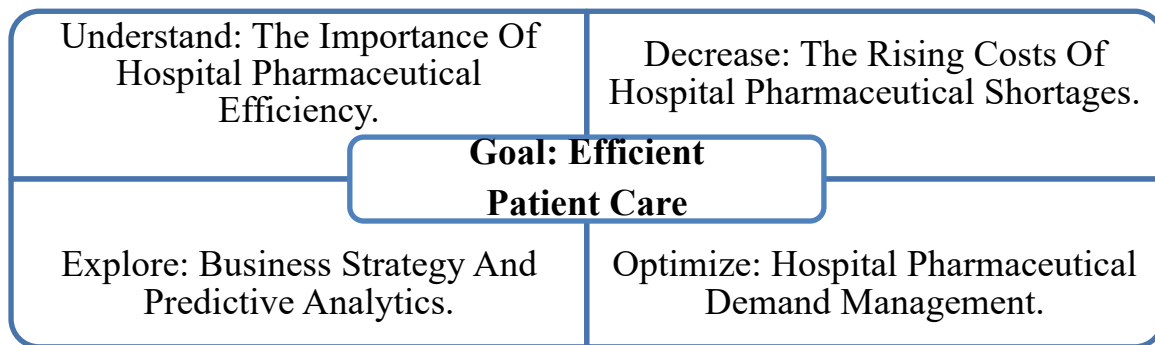
Discussion of Relationships Between Concepts

The conceptual framework for this study builds on the understanding that exploring rising costs of hospital pharmaceutical shortages are essential for efficient patient care. All over the world, patient care profoundly relies on the fundamental components of pharmaceutical supplies. According to the World Health Organization (WHO, 2002), essential medicines are designed as products that serve the vital population health care needs at any time and should be readily available within healthcare organizations at an affordable cost. The following concepts serve as a foundation of this qualitative research study: the importance of hospital pharmaceutical

efficiency, rising costs of hospital pharmaceutical shortages, business strategy and predictive analytics, and hospital pharmaceutical demand management.

Summary of the Conceptual Framework

The components of the conceptual framework drew attention to the importance of hospital pharmaceuticals and the impact on patient care. The structure aligned the business process improvement suggestions and the relation with cost and sustaining quality care.

Definition of Terms

The focus of this study was the rising costs of hospital pharmaceutical shortages, the impact on patient care, and exploring the use of predictive analytics in New York area hospitals. The following terms are offered to explain the use in the research.

Case study: A case study is one of the five qualitative research designs that intend to take a case and identify how the case demonstrates an issue or problem (Creswell, 2016).

Healthcare forecasting: Healthcare forecasting has a vital role in an organization's capability to develop and execute strategies for keeping up with the demands of the healthcare environment that is rapidly changing. The accuracy of data is what drives the decisions of healthcare leadership (Soyiri & Reidpath, 2013). "The use of the right forecasting tools can help leaders combat "future health events or situations such as demands for health services and healthcare needs" and facilitate preventative health strategies" (Soyiri & Reidpath, 2013, p. 6).

Hospital pharmaceutical shortages: The Food and Drug Administration (FDA) defines a shortage in drugs as a certain amount of time (demand) that a drug that is medically necessary in the United States exceeds its supply (FDA, 2019). "They also consider a drug to be in shortage when supply issues affect how a pharmacy prepares or dispenses a drug product, or influence patient care when prescribers must use an alternative therapy" (FDA, 2019). According to the

WHO (2015), "Essential (critical) medicines are those that satisfy the priority health care needs of the population and are intended to be available at all times in adequate amounts in the appropriate dosage forms." The logistics of pharmaceuticals is the errand of attempting to put the correct medications and medicinal supplies, in the exact amounts, in the right conditions, at the correct service delivery points in facilities, at the opportune time, for the correct patients and for the accurate costs (Pinna et al., 2015).

Pharmaceutical inventory management: Pharmacy inventory management is a complicated, however necessary procedure inside the healthcare system framework. Without sufficient practices for pharmacy, inventory management, hospitals risk not having the option to give patients the most proper medicine when it is generally required. Also, pharmacies' apportioning examples and medication determination decisions may directly affect the reasonableness of consideration (Bhakoo et al., 2012).

Predictive analytics: A form of advanced analytics that uses historical and new information to forecast activity and to predict behavior and trend patterns (Coker, 2014). A variety of statistical methods are used in predictive analytics from "predictive modeling to machine learning to data mining, that analyze historical and current data to predict future or other unknown events. Predictive analytics have been widely used in many fields, including actuarial science, marketing, finance, retailing, health-care, and pharmaceutical research" (Hernandez & Zang, 2017).

Qualitative Research Method: Pathak et al. (2013) specified that the focus of qualitative research is on understanding an investigation request as an optimistic or humanistic philosophy. Appreciation of the beliefs, conduct, interactions, and experiences, a qualitative method would be applied. Moreover, qualitative research concerns the description of written data, methodical

gathering, requesting interpretation that derives from the conversation, files, or perception (Miles & Huberman, 1994).

Supply chain management: Supply chain management (SCM) is the effective administration of inventory activities to amplify client esteem and achieve a maintainable competitive advantage. It signifies a conscious effort by the supply chain organizations to create and run supply chains in the best and effective way possible. Supply chain activities include everything from product development, logistics, production, and sourcing, as well as the data systems needed to facilitate these exercises (Pérez-Salazar et al., 2017).

Assumptions, Limitations, Delimitations

To help readers understand the study, assumptions were covered to include thoughts of the researcher, but were not confirmed. Potential weaknesses of the study are covered discussed under limitations. The scope of the study and boundaries are represented in the delimitations.

Assumptions

The qualitative case study had three essential assumptions. The first is that the researcher assumed she would be able to interview multiple pharmaceutical inventory leaders in a few New York hospitals. Interviewing the pharmaceutical leaders would be the ideal scenario, but maybe lower-level staff may have more direct experience. The initial contact may be with the pharmaceutical inventory leadership who may connect the researcher with the more appropriate staff. The second assumption is that there will still be viable information gathered from the study from hospitals that may have already implemented predictive analytics. Moreover, if a hospital already uses predictive analytics, is it beneficial for the rising costs of hospital pharmaceutical shortages. Thirdly, the assumptions included in this qualitative case study were that the research

experiences would be relevant to other rising costs of hospital pharmaceutical shortages in New York hospitals that were not surveyed in this study.

Limitations

The limitations of this qualitative study included the selection of New York Hospitals. The interviewed hospital leaders are a small number and may only have experience in what their respective facilities use in terms of hospital pharmaceutical shortages. Additional limitations of this study are the lack of generalization because of the limited number of participants in the study. Qualitative research and case study design are problematic when identifying the correct number of participants and cases (Creswell & Poth, 2108). There was also the potential to gather data that were not accurate, and limitations can be reduced by the implementation of triangulation of data from more than just the pharmaceutical inventory management leader in a few New York hospitals and the pharmaceutical non-management staff.

Delimitations

The scope of this qualitative case study was the experience with hospital pharmaceutical shortages and the effect on patient care. This study was based upon the experiences of just a few New York hospitals, and the remaining hospitals in New York are outside of this study. Additionally, there are many types of hospital inventory management; however, this study focuses on pharmaceuticals. Any other inventory management areas in the hospitals are outside of the scope of this study. The main research question arose from the problems faced by New York hospitals with the increasing costs of prescription shortages in hospitals and the effect on patient care. The study covers only a few New York-based hospitals, where only senior pharmaceutical leadership will be interviewed. The outer limits would also include if any other supply chain process other than predictive analytics will be explored.

Significance of the Study

The significance of this study provided results for individuals that would like to improve the hospital pharmaceutical shortages that will ultimately improve patient care by exploring the use of predictive analysis. Aptel and Pourjalali (2001) stated that one of the most important healthcare industry management healthcare issues is the management of pharmaceutical inventory. Aptel and Pourjalali (2001) stated that one of the most important healthcare industry management healthcare issues is the management of pharmaceutical inventory. Consequently, careful management of hospital pharmaceuticals is straightforwardly identified with a nation's capacity to address healthcare concerns. The study was also significant because it included biblical integration of inventory, supply chain, pharmaceuticals, and predictive analytics. Additionally, the study was significant because it progresses knowledge in the cognate field of Strategic Management.

Reduction of Gaps

The significance of this qualitative study was that the data would add to the existing body of knowledge and effective practice of business describing the importance of implementing a predictive analytics system, to pharmaceutical inventory management in New York area hospitals. Utilizing systems to improve workflow and lessen wastes has resulted in missing doses reduction, expense savings, and reductions in patient-specific waste, medication mistakes, medication processing times, pharmacist confirmation time, product confirmation time, and the tie associated with the delivery of medication (Shiu & Mysak, 2017).

Implications for Biblical Integration

This study explored the rising costs of hospital pharmaceutical shortages, the impact on patient care, and the use of predictive analytics in New York area hospitals. "The Lord God took

the man and put him in the Garden of Eden to work it and keep it." —Genesis 2:15, God made us work. Not in an aggressive sense to make his offering or face his fury. Yet, to subdue the earth and have domain over each living animal (Gen. 1:28). As it were, all of life, culture, and work is to mirror the magnificence and brilliance of God. This is an accentuation of sacred texts about work all through the Bible. One of the great promised that God gave to us is the promise of supplying our needs. "And my God will supply all your needs according to His riches in glory in Christ Jesus" (Philippians 4:19). The scripture tells us to be content with the provisions of God. God typically works through natural methods in his supply chain with individuals acting steadily, ingeniously, and liberally in doing their part. We ought not exclusively to be an end connected in this chain as beneficiaries; however, we should work as different links also.

In Genesis, Joseph was on an advance track to promotions, due to his logistical planning and forecasting gift. He climbed quickly from the role of superintendent/prisoner in an Egyptian correctional facility to Pharaoh's Chief Logistics Officer with "Prince" in his title. At the pinnacle of his vocation, the man was second just to Pharaoh. Indeed, even there, Joseph's initiative characteristics shone through: "And the attendant of the jail focused on Joseph's hand every one of the detainees" (Genesis 39:22). What is less known, be that as it may, is that during his years in jail, Joseph aced forecasting systems, translating the dreams of Pharaoh's previous Chief Butler and Chief Baker. The two translations were acknowledged, establishing Joseph's notoriety for being an ace forecaster.

Moreover, the change that happens through the Holy Spirit enables people to forfeit oneself for the consideration and sympathy of others. For instance, if a pharmacist is completely versed in God's Word and is being changed into the similarity of Christ regularly, yet has not been keeping up current information and comprehension of new medication treatment or

treatment rules, at that point the consideration of the patient will be lacking. The most minding, sympathetic, Christ-like individual should, in any case, have the vital aptitudes and learning to convey proper drug specialist care. Then again, a drug specialist who is noted in their forte will be unable to give the essential route of moral choices, or even think to forfeit their solace, to think about others without the continuous recharging of their brain through the spirit-coordinated investigation of Scripture (Sweeney, 2011b).

Relationship to Field of Study

Strategic management was the researcher's field of study. A key part of the business strategy is characterizing the minute of opportunity for executing this strategy before competitors do likewise (Meredith & Shafer, 2016). The business strategy of an organization incorporates a collection of plans, policies, and strategies for the organization to compete efficiently in its industries. Fundamentally, the organization's strategy indicates the competitive advantage of an organization will be and how this ideal place will be achieved and supported through the selections the organization's business units make later. Inventory management works at three measurements: strategic, tactical, and operational. At the strategic dimension, an organization settles on a suitable choice within the supply chain that is important to the organization.

In the case of the rising costs of hospital pharmaceutical shortages and the impact on patient care, on a global level, pharmaceutical administrations are confronting difficulties like worldwide quality values, patent expiries, healthcare reform, and increased standard requirements. To address these difficulties, pharmaceutical firms have to improve speed to market, decrease costs, and increase responsiveness. Shah (2004) characterized the key issues that assume a significant job in the structure and advancement of the pharmaceutical supply chain such as development improvement, process improvement, capacity planning, and plant

design. The strategic management decisions will cover the expansiveness of the supply chain. These choices depend on the healthcare customers, wholesalers, logistics, manufacturing, and product development. Furthermore, such critical decisions should embody the organization's corporate strategy that is already in existence (Stanger, 2013).

Summary of the Significance of the Study

The significance of the study revealed how some of the gaps in literature can be reduced. It also presented the integration of biblical implications relating to the rising costs of hospital pharmaceutical shortages and the impact on patient care. Finally, the significance of the study demonstrated the relationship of the study to the researcher's cognate, strategic management.

A Review of the Professional and Academic Literature

For the qualitative study, the following literature review examined the rising cost of hospital pharmaceutical shortages and the impact on patient care: exploring the use of predictive analytics in New York hospitals. The literature review will be a compilation of scholarly peer-reviewed journals published within the last five years, along with books, textbooks, and other source literature that gives insight on the business problem and proposed solution. The literature review started with an introduction to the overall business problem relating to the field of study. The next part of the literature review discuss discusses five main headings:

1. The foundation of the United States healthcare system,

2. The origin of supply chain management,

3. The current state of healthcare industry challenges,

4. Hospital pharmaceutical supply and demand management

5. The history of predictive analytics.

Overall Business Problem

Rising Costs of Hospital Pharmaceutical Shortages. According to the Pharmacy Times, the cost of prescription drugs remains a problem for policymakers, patients, and providers, and pharmacists may play a vital role in ensuring patients have access to the care they need (Marotta, 2019). Kesselheim et al. (2016) stated that in the United States, policymakers, payers, and patients are concerned about the increasing cost of pharmaceutical shortages. Increasing drug costs not only contribute to healthcare spending but can also have implications clinically. Patients have to pay higher co-payments for pharmaceuticals because of cost-containment. If pharmaceutical prices continue to rise, the ability to afford the drugs could lessen, which will result in harmful patient health outcomes. When it comes to drug shortages, there is no warning system; however, the U.S. Food and Drug Administration (FDA) enacted federal legislation, which requires manufacturers to report drug shortage (FDA, 2019). It is not easy to predict drug shortages, mainly because of manufacturing's possessive lack of transparency.

Hospitals can track reports from the FDA, but there is no actionable information available to them. Production-related problems are causes for medical shortages. As with raw material shortages, production concerns were considered a common cause of global shortages. Production issues have far more significant effects on the quality of medicinal products (Heiskanen et al., 2017). Uthayakumar and Priyan (2013) stated in years past, hospitals and health systems viewed the pharmacy as more of a transactional role. However, recent findings demonstrate that hospital pharmaceutical shortages are an essential part of patient results. Pharmaceutical deficiency compromises the safety of patients and surges the liability of the health care system inclusively. Improving the service level for patients in the pharmaceutical business setting is a noteworthy

undertaking towards a socially mindful supply chain. To address these difficulties and enhance the manufacturer capacities, hospitals are confronting the requirement for a solution in inventory management. Inventory management alludes to the procedure of requesting, warehousing, and controlling organizations' inventory of components and raw materials. Furthermore, inventory management enables hospital pharmaceuticals to restock certain things, the measure of procurement, and the costs to pay (Hematologic et al., 2018). High standards for managing pharmaceutical inventories are necessary. According to Volland et al. (2017), pharmaceutical inventory management contrasts from other medical item classes dependent on their particular attributes. Nevertheless, pharmaceutical inventory management has been recognized as one key switch to acknowledge proficiency improvements without adversely influencing the care of patients.

According to Cohen (2019), the impact on human health is excellent when it comes to supply chain management. Patients need accurate and required pharmaceutical supplies to maintain optimal health. Adverse effects, including death, are the result of out-of-stock medicine or medication errors from dispensing to the wrong patient. Kohn et al. (2000) reported that close to $2 billion is the annual cost associated with 7,000 deaths caused by an estimated one million medication errors a year. According to the American Journal of Health-System Pharmacy (2017), pharmaceutical shortages are mostly the outcome of quality issues during the manufacturing process, resulting in a production stop to address the issue. Other businesses cannot absorb this disruption in production in the case of a product with few competitors, and demand outperforms supply, stemming in a shortage. There are no alternatives for output in the case of a sole-source manufacturer, and hospitals must either compound a drug as far as possible, fight to obtain a drug supply, or suggest an alternative therapy if there is one (ASHP, 2017).

In December 2019, the world learned about the Coronavirus disease (COVID-19). An infectious disease caused by a newly discovered coronavirus. This disease was initially in Wuhan City, Hubei Province of China (WHO, 2020). At the time, there were many unknowns about COVID-19. However, the world would soon come to know the seriousness of this disease and the impact it would have on the world, healthcare, and pertinent to this study, healthcare pharmaceutical supply chain.

The United States Healthcare System

Foundation. Healthcare is an interrelationship among those in the United States who receive, provide, and finance healthcare. Health care affects all, including the healthy, the sometimes sick, and those with severe illness. Medicine covers procedures as varied as pregnancy, cosmetic surgery, chronic disease treatment support, and end-of-life hospice care (Moses et al., 2013). In the early days of the colonies, medical care was hard to come by, as few British trained doctors came to North America (Moses et al., 2013).

However, by the mid-eighteenth century, the first significant hospitals had been founded by New Orleans, Philadelphia, and New York, and the primary medical schools had opened. During the United States Civil war, the federal government and individual states began building hospitals for sick and wounded soldiers in each state. Public health initiatives such as clean water, sanitation facilities, and tuberculosis control were also introduced by the state, which began to have a significant effect in the early twentieth century. Health care has since expanded in the U.S. (Moses et al., 2013). Health care services in the United States are largely private. Many of the practices of this system are based on American culture's beliefs and values (Shi & Singh, 2018). Wolinsky (1988) reported that the idea of health and healthcare in the United States have mostly been administered by the biomedical model, which is a part of the medical

model. The medical model describes health as being free from illness or disease. The medical model also draws medical diagnosis and intervention as tools to treat infections.

Healthcare delivery is medically caring for patients that are ill (Wolinsky, 1988, p. 76). The U.S. health care system is not universally accessible. The U.S. health care system is considered a patchwork of broken services that are privately and publicly supported. Insured Americans are insured by both available and private insurance care, which is provided and protected by the place of employment of a person. Federal funds provide Medicare and Medicaid coverage for the poorest people. The government also publicly funds Indian Health Care and the Military (Shi & Singh, 2018). According to Beamesderfer and Ranji (2012), although there is much debate on the leading cause of increasing U.S. health care prices, the expert has identified three causal factors. The first factor is the cost of prescriptions and innovations. Healthcare spending for development costs is fueled by high-level requirement and drugs that intensely generate more demand even when not necessarily cost-effective. The second factor is the rising costs for chronic disease treatment. Treatments for illnesses, such as diabetes, are high because of maintenance while on the medication.

Additionally, health care costs are on the rise for the end of life care. The more persistent a disease, the higher the fees, particularly with many repeated admissions (Dartmouth Atlas of Care, 2013). The last factor reported by Kelin (2009) is the cost associated with administration. The U.S. surpasses all other industrial countries in the prices of insurance administration. The differences between private and public administration are hard to determine because of the broad scope of defining administration.

History of Healthcare Industry Operations. Shi and Singh (2018) stated that one of the fastest growing and most prominent industries in the world is healthcare. Also referred to as the

medical industry, healthcare is the coordination of divisions that gives service and goods to treat patients by rehabilitative, therapeutic, palliative, and preventive care. The healthcare industry in the United States embodies a substantial paradox of low effectiveness and high expenditures. The healthcare situation in the United States is not ideal even for those who may have insurance through their jobs, or savings, or are considered underserved. Because there is no worldwide provider of healthcare and healthcare insurance in the United States, many healthcare organizations use piece work to cover various population subgroups. Social and health services strategies are more incorporated in other nations than they are in the United States. According to Phillips (2012), since medical care systems and public health are incorporated into a consolidated health system, various countries differ from the United States.

The Affordable Care Act (ACA) was signed into law in 2010 by President Barack Obama. The purpose of this act was to regulate the health industry, reduce the costs of healthcare, improve the healthcare service, and healthcare insurance. The ACA established exchanges where people could shop for insurance as a way to steady insurance markets. To lessen cost and improve quality, the ACA energized the production of accountable care associations, whereby professionals in healthcare and healthcare centers would offer composed consideration to Medicare recipients. To pay for changes, the ACA exhausted high-advantage plans and medical devices, while diminishing Medicare spending (Blumenthal et al., 2015).

Gostin et al. (2017) reported that in 2014, the ACA law drew criticism because of the website launch failure. More recently, buyers have communicated worry about limited systems, high deductibles, and premium spikes. The individual command has not been adequately viable at getting sound people to select, and some significant safety net providers have pulled back from trades. The ACA has impressively extended access, with more than 20 million people picking up

inclusion—60% through Medicaid. By 2014, the ACA protected people with pre-existing conditions to not face premium increases and access to insurance for those who could not get coverage before the ACA was made possible. The law had some flaws, and there is much pressure to cut costs and improve quality within the healthcare organizations (Blumenthal et al., 2015).

Beamesderfer and Ranji (2012) stated that many of the best research facilities and hospitals in the world are in the United States. The Mayo Clinic, Cleveland Clinic, Johns Hopkins Hospital, UCLA Medical Center, and Massachusetts General Hospital are among their top referral facilities. The U.S. is also considered one of the best cancer treatments, heart care, and orthopedic medicine destinations in the world. There are a wide variety of public and private hospitals, emergency care clinics, surgery centers, and specialty clinics in major cities. Care costs are fueled by high-level requirements and drugs that are more restricted in smaller communities and can include everything from a county hospital, a community care facility run by nurse practitioners, to telehealth facilities.

Current State of Hospital Operations. The current state of hospital operations has thrown various health-related difficulties for individuals over the globe and the residents. The government offices and the healthcare industry are especially worried about the human services related issues and the proactive measures to be taken to improve the health services situation. According to Filser et al. (2017), to stay competitive, businesses must continuously improve their services. In the case of healthcare, it makes even more sense to improve business processes for increased health and well-being. To effectively control the healthcare system, hospital operations concentrate on achieving the following objectives: improving the quality of facilities, improving the reliability of procedures, reducing medication mistakes, using analytical data and business

intelligence, enhancing clinical viability, and improving patient experience. To accomplish these objectives, the administration and medical clinic staff ought to perform different complex errands by keeping pace with the dynamic healthcare condition, including the administrative changes. The multifaceted nature expands given the nature and volumes of patients, growing supply costs, stringent government compliances, quality necessities, various use of benefits, and lastly, the shortage of prepared staff.

Healthcare operations have changed over the years, with a greater emphasis on leading technologies and trends. In 2017, Becker's Hospital Review featured an article of four trends leading advances in today's health care operations (Laing, 2017). The first trend is data and how data drives decisions in any business, especially healthcare operations. Using data can give an organization the tools to make decisions about an organization's financial and performance health. Laing (2017) stated that finding the most cost-effective and efficient data is challenging when capturing and reporting day to day operational data. A data-driven organization management tool may encourage the use of data to control compliance-based inspections, testing and reporting on facility maintenance, rounding to improve the care climate, and patient preparedness and treatment (Laing, 2017). Additionally, efficient data can help manage capital planning and operations budgeting for the healthcare facility or any other organization.

A hospital's preparation in emergency preparedness is the second trend of healthcare operations today. Hospitals are used to minor injuries and mishaps caused by the elements but are they prepared for difficult situations, such as major disasters and mass casualties. The Centers for Medicare and Medicaid Services (CMS) suggests that hospitals should participate in hazard identification, hazard mitigation, response, and recovery safety management programs (CMS, 2019). The third trend is maintaining an efficient environment of care for patients. It is

crucial that patients feel they are empowered and consumers of their health. They are improving the patient experiences and fostering patient engagement. Using innovations such as social media, online reviews, journals, and more can provide patients with quick access to online surveys, price transparency, and care assessments, adds to this shift – from patients to consumers (Laing, 2017).

The fourth trend, which directly relates to this research is the focus on cost reductions not only for pharmaceutical but for healthcare operations as a whole. Hospitals look for ways to trim costs all of the time. Whether it is labor, materials, assets, capital, or pharmaceuticals, a hospital should have a good sense of their expenditures. There should be a sound system in place to record the costs and be a tool for future forecasting and financial planning. Hospitals will reassess what they are spending on hidden-savings materials (Laing, 2017). More patients are now using more drugs designed for a high annual aggregate cost. Rising pharmaceutical expenses, particularly the presentation of excessively high expense drugs, are likewise added to more significant expense structures to U.S. health care.

The latest epidemic, now a pandemic, Coronavirus (COVID-19), has greatly impacted existing operations in hospitals. In China, COVID-19 is considered a respiratory disease outbreak. The disease frequently travels across the globe and is now present both internationally and domestically. Though coronavirus continues to spread in the United States, hospitals are bracing for the inflow of patients who need care for the worst effects of the disease it causes, COVID-19. The World Health Organization's (WHO) International Health Regulations Emergency Committee declared the outbreak a Public Health Emergency of International significance (PHEIC), in January 2020. On January 31, Alex M. Azar II, the Secretary of Health and Human Services, declared a public health emergency (PHE) for the United States to help the

nation respond to COVID-19. On March 11, the WHO publicly described COVID-19 as a pandemic. The US President declared the "COVID-19 outbreak a national emergency" on March 13, 2020 (CDC, 2020). The spread of the coronavirus outbreak is daunting in the health care systems of countries like China and South Korea, which are heavily involved. In those nations, the ongoing increase of infected patients has reportedly overflowed hospital beds and lengthy delays of treatment for other health conditions. The entire clinical future concerning COVID-19 is not entirely understood. Recorded diseases ranged from very mild (including those with no documented symptoms) to severe, including death-induced illness.

Supply Chain Management (SCM)

   Origin of Supply Chain Management. In 1982, in an interview for the Financial Times, Keith Oliver, a Booz Allen Hamilton consultant, introduced the term "supply chain management" to the public domain (Handfield & Nichols, 1999). According to Simchi-Levi et al. (2008), Supply Chain Management (SCM) primarily includes the flow of services and goods. SCM includes all the steps involved in the sourcing of raw materials to the finished goods in a manner that is organized and provides value to the consumer. SCM is a distributor effort to develop and execute supply chains that are as reliable and cost-effective as possible. SCM derives on the idea that the activities of various organizations that make up a supply chain are the consequence of almost any product that comes to market. While supply chains have existed for years, many businesses have paid attention to them as a value-added to their operations only recently. According to Kozlenkova et al. (2015), SCM practice draws heavily from the fields of operations management, logistics, procurement, IT, marketing, industrial engineering, and systems engineering. Moreover, SCM seeks an integrated approach.

As per Beamon (1998), organizations use supply chains to provide them with what is needed to flourish and survive. Each organization has a role to play in one or more of its supply chains. Organizations need to learn to match their supply chains with the needs of the customers they represent to thrive in the competitive markets that make up the economy of today. It was in the 1980s when organizations exposed new business systems to thrive in the competitor markets and reduce costs. Beamon (1998) also stated the present interest sought to expand the conventional supply chain to include reverse logistics, including material recovery for reuse, re-production, and reuse purposes. The supply chain theory originated mainly in industrial science from two-stage multi-echelon storage models, and it is important to note that there has been significant progress in the development and evaluation of two-echelon structures.

If there is a lack of effective supply chain management, there will also be a decrease in market share and profits. The advancement of supply chain management in the last twenty years has been mainly motivated to reduce inventory management. Supply Chain Management represents the organization of a business's functions relating to manufacturing, distribution, and sourcing of service and products and logistics. From a practical point of view, the supply chain theory has arisen from several changes in the manufacturing environment, including increasing manufacturing costs, limited manufacturing bases capital, shortened product life cycles, manufacturing playing field leveling, and business economies globalization (Ellram & Cooper, 2014).

Current State of Supply Chain Management. Varsei (2016) claimed all around the world, supply chains are being transformed. Transportation, warehousing, and metrics that will affect a company would represent the current state of the global supply chain. Technology, external pressure, and the internal transformation of the nature of their future supply chain are

pushing companies to do so. Supply chain management of today leans on service as a strategic discipline, which is progress from logistics operations and procurement. Management of the traditional supply chain focuses on price, time, efficiency, social, and environmental dimensions. This approach is often part of a response to legal requirements or consumer demands. Nonetheless, businesses are gradually moving outside adaptation by considering, as part of a constructive approach, that taking into account social and environmental factors in supply chain management brings a vital strategic benefit to the competitiveness of the business (Bentahar & Benzidia, 2018).

Reefke and Sundaram (2016) noted that in the present trend of growing competition and globalization, the strategic management of stakeholders, both internal and external, from the suppliers of raw products to the end-users, is the essential focus for the supply chain management. Supply chain management is, therefore, very well placed as a convincing management technique for associations' sustainability success. Supply chain management encourages a mix between the client base, the network distribution and, exercises internal to firms and the supply base.

Scholten and Schilder (2015) noted in current and future years, technology and challenges will follow the supply chain. Technologies will give more options for warehouse management, especially in automation. Increasing capacity will continue, and organizations will have to find ways to cut costs to retain customers. Organizations will also have to improve their competitive advantage to keep up with the broader distribution business such as Amazon. Enhancing technology also brings more security risks, and organizations will have to strengthen risk management to protect manufacturers and their customers. According to Scholten and Schilder (2015), in the current complex business environment that requests global but flexible

operations and lean concepts, organizations are even more susceptible to the risks and disruption of supply chain systems. It is a fundamental empowering influence of acquiring ongoing knowledge into generation execution, enabling makers to recognize issues and resolve them with insignificant expense and interruption.

The current state of supply chain management is profoundly affected by the pandemic of the Coronavirus (COVID-19). The spread of the latest coronavirus, COVID-19, is felt across operations worldwide in ways that are difficult to model and measure. The areas affected are central to many global supply chains. There is a lack of hard information; concerns are mounting about depleting (or idling) stock; and businesses worry that they will not meet contractual obligations in due time (PWC, 2020). Businesses need to act on several fronts at once. While trying to secure the health of their employees, they also need to safeguard their operational stability, now increasingly under threat from a historic supply- chain blow (Alicke et al., 2020). While procurement teams are struggling to deal with the global pandemic of COVID-19, most of them have struggled to keep up with the reports of global response initiatives (Choi et al., 2020).

Role of Supply Change Management in Healthcare. Mandal and Jha (2018) stated that healthcare supply chain management involves getting assets, overseeing supplies, and conveying products and enterprises to suppliers and patients. To finish the procedure, physical merchandise and data about medicinal items and administrations, for the most part, experience various autonomous partners, including producers, insurance agencies, hospitals, suppliers, and a few administrative offices. Nevertheless, by endorsing efficiency in the healthcare supply chain, hospitals and doctor practices can make significant cost-diminishing decisions within their organization. The objective of the healthcare supply chain is to find the liabilities among divisions and prescribe measures to decrease them. The upsides of capable healthcare supply

chain are improved systems, gainful use of advantages, employees that are engaged, effective treatment, and fulfilled patients. Numerous clinics of today are encountering an expansion in supply chain inefficiencies, which is bringing about financial losses and wasteful aspects which influence the organizations bottom line (Sweeney et al., 2018).

The supply chain ensures the real connection of the financial cycle, medicinal services activities, and emergency clinic, divisions. One may define the supply chain as running a back-end system, which is imperative to tie together all the various methods. The clinically integrated supply chain is transforming the way human services provide academically developed centers around the world (Jacobs & Subramanian, 2012). Leaders in healthcare are by and by planning to show sound fiscal stewardship by looking much more cautiously at hospital inventory, and how to manage the supply chain to help balance supply and demand. Hospitals need to deal with upstream supplier trades, and downstream patient demands to handle the supply chain process effectively. Moreover, this places a hospital in a position to strike a balance between meeting patients' needs, which are often difficult to calculate with precision or consistency, and ensuring a sufficient supply of materials and supplies. It is essential to set up a policy framework that empowers health care organizations and hospitals to update and benefit from technologies that are being developed for ideal inventory management systems.

While there is bounteous research in the supply chain, only from time to time have the proposed techniques discovered their way into execution in real emergency clinic settings (Rosales et al., 2014). Having the correct items accessible at the purpose of utilization is imperative to the proficient and viable treatment of patients. With the regularly expanding demand for items, it ends up testing to oversee inventory in a dynamic office, for example, at a hospital. Additionally, according to Moons et al. (2019), management of hospital inventory is an

essential area of a supply chain system. In a medical clinic environment, where it is a prime concern to express excellent patient care, inventory management is not a priority. Current strategies used to lead a supply chain execution that is imperfect include bringing about something over the top or too short of inventory in stock, additional time work to oversee supplies, sped up shipments and, conceivably inadequate nature of consideration conveyed to patients.

Healthcare Industry Challenges

Current State of Healthcare Challenges. According to the American Colleges of Healthcare Executives (ACHE), the top challenges for hospital operations in 2018 include financial challenges, government mandates, quality and safety for patients, personnel shortages (ACHE, 2018). The healthcare industry has risen as one of the most significant social and financial issues in the nation. While the prior decade concentrated primarily on the installment and lawful changes that would be required to move the healthcare industry forward, the recent focus has been progressively about how the private segment has reacted and moved to answer new challenges. Some of the pressing challenges in healthcare include the delivery of healthcare relating to planning and scheduling, issues with allocation resources, healthcare logistics, healthcare information, and costs and pricing problems in service delivery (Soares de Mello et al., 2015).

Abelson (2016) reported another significant change is the business move to overseeing wellbeing along a continuum as opposed to treating individuals at the emergency clinic when a medical problem happens. This point of view begins with a preventive drug to keep individuals healthier, so they need fewer hospital services. At the point when they do become ill, this new model consolidates remote patient observing after treatment to enable them to recuperate all the

more rapidly and limit re-admissions. The continuum-wide emphasis on wellbeing and treatment leads healthcare providers to explore value-based care systems that quantify outcomes and step away from the traditional fee-for-service model. The outgrowth of this is population health management, which searches for findings to be feasible for communities rather than people and relies heavily on business intelligence and data analysis.

Healthcare also faces a complex and complicated supply chain management as a client, and in this case, the consumer relies heavily on pharmaceutical inventories as part of their care standard (Moons et al., 2019). A hospital's perspective of success includes operational efficiency. Properly utilizing resources to improve care and lower costs is an increased challenge that many hospitals face. By diminishing bottlenecks and executing strategies that will drive compelling answers for fundamental issues, any business can flourish. Healthcare organizational leadership should expect to encounter challenges, including policy changes, ethical issues, therapeutic and innovative advancements, and regulatory challenges over the next five to ten years (Teel, 2018). Healthcare spending will continue to rise, and leaders must find different tools to battle the rising costs.

Coronavirus (COVID-19) is one of the most serious and widespread of recent global outbreaks. It is also becoming evident that the impact on COVID-19 on health and care systems goes beyond the disease; this is because health systems still have to deal with the current rates of non-communicable diseases (Alessi, 2020). Although China was the epicenter, the effect was global, affecting health care, infecting people, impacting travel, and disrupting supply chains around the world. In the United States, New York has become an epicenter. The Governor of New York states that spatial closeness makes residents vulnerable (Levenson, 2020). There is the need for health care systems to ensure sufficient funding for expenditure in health care services,

the suitable proof equipment in hospitals and emergency departments, the enhancement of accessibility in intensive care units, the rise in the ratio of the number of ICU beds to the total number of hospital beds (Smereka & Szarpak, 2020).

Hospital Inventory Management Challenges. Satisfying a hospital's medical needs requires supplied medications and other supplies to function. Pharmaceuticals required by inpatients; doctors use pads, masks, and equipment while surgery is performed; similarly, hospitals also provide outside patients with unique drugs, like those used to treat diseases such as AIDS and cancer that are not available in retail pharmacies (Maestre et al., 2018). Hospitals are concentrating more on the supply chain because of an increase in reimbursement and pressure from competitors. The use of organizational process improvements is explored to reduce operations costs and sustain quality care. The area with the most significant impact on costs and efficiency is hospital inventory management. The sooner a drug shortage is determined, hospitals will be able to plan accordingly for a patient's safety. However, pharmacies are aware of shortages once they cannot get a requested drug (Rich, 2013). Late notification puts a hospital in a crisis mode, and at that moment, the best decisions are made for a patient's wellbeing. One of the internal supply chain's weaknesses is the lack of space and visibility at the point of use for hospital inventory products (Rosales et al., 2019).

Hospital inventory needs to be tracked, guarded, and accessible at all times. Hospital inventory is not as easy as every patient requires a different product or service. Hospital inventory is also faced with the fluctuation to respond to a specific demand at a particular time. Shelf life becomes an issue when there is no control over temperature. If there is no protection or organized system for complex inventory, hospitals may incur higher costs for expired medicine or stockpiles. Additionally, the challenge of hospital inventory security can cause legal and

safety issues for the organization. There are too many instances where inventory is stolen or tampered with (Zepeda et al., 2015). The recent pandemic of COVID-19 brings hospital inventory challenges (Swerdlow & Finelli, 2020). Hospitals will track the level of equipment to ensure sufficient availability of personal protective equipment for those on the front lines. They will need to engage in hospital protection to prevent theft or hoarding of such equipment. Extended use or restricted reuse of N95 respirators can become essential, and communication is crucial about preservation. Then, supply shortages are likely, where supply may be reduced depending on other countries suffering similar outbreaks. Most N95 respirators are made either in China or in the USA. When COVID-19 begins to spread, the hospitals will find it difficult to get more supplies (Hutchins & Smith, 2020).

Rising Costs of Hospital Pharmaceutical Shortages. Two of the primary issues leading to drug shortages are related to manufacturing quality and forecasting errors. Baumer et al. (2004) claimed pharmacists and physicians have expressed growing concerns about shortages of products since 1999. Threats to the U.S. pharmaceutical supply chain's reputation, like short-term drug usage, will sound an alarm across the medical community. Health care professionals are required to allocate and even restrict limited supplies of certain medications carefully. Pharmacists cannot explain such procedure changes with prescribers and suggest substitute therapies (Baumer et al., 2004). Drug shortages and sudden price increases are the two most challenging issues for hospitals pharmaceutical supply chain (Fox & Tyler, 2017). Over the past ten years, shortages have impacted the rising prices of pharmaceuticals. In a national survey of the impact of drug shortages on U.S. health systems, three-drug shortages, in particular, have been identified as affecting more than 80 percent of responding institutions, namely epinephrine syringes, dextrose 50 percent syringes, and succinylcholine (Kaakeh et al., 2011).

When a drug is not available commercially to meet the patient demand, a shortage occurs. Insufficient quantity and total unavailability of drugs threaten the quality of care for patients. While many shortages can be handled efficiently, there is often a need for substantial staff resources to recognize available substitute products or medically equivalent agents and to ensure that organizational changes are made to accommodate product transition (Kaakeh et al., 2011). Pharmaceuticals' used in hospital critical care unit costs are on the rise for a few reasons. Multidisciplinary labor efforts are required to research the market, discuss and research alternative effective and safe strategies, make operational changes, communicate these findings, and then make appropriate changes again once the shortage has resolved. Hospitals bear a heavy financial burden when the expense of pharmaceuticals increases and must settle on final decisions about allocating limited resources.

Managing these costs requires making difficult choices between providing adequate salaries to staff members, many of whom are highly talented in shortage professions; purchasing new technology to upgrade care facilities; or paying for pharmaceuticals, especially if these increases are not linked to new therapies or improved patient outcomes (AHA, 2019). With little to no warning, rapid price spikes, and medication shortages, all of them are increasing, and patient care would be drastically affected (Fox & Tyler, 2017). According to Flannery et al. (2017), drug shortages, changes in device regulations, generic manufacturer concerns are some of the reasons affecting the costs in critical care. "In a descriptive analysis of pharmacotherapy in the ICU, medications averaged 38% of the hospital's total drug expenses and increased by an average of 12% per year" (p. 54). Pharmacists also spend a great deal of time consulting with suppliers and wholesalers, training facilities workers on substitute drugs, creating or changing policies or medical recommendations, and reviewing digital databases and medication

management systems. Though the pharmacy department often plays a leading role in managing drug shortages, it is essential to collaborate with all healthcare providers affected by the shortage (Kaakeh et al., 2011). LaPointe (2020) argued hospital drug shortages in the United States before COVID-19 (the novel coronavirus) were a persistent, recurrent epidemic with no end in sight. History demonstrates that isolated natural disasters can have drastic, long-term effects on the supply chain of pharmacy products. Now, COVID-19's global effect is likely to exacerbate the situation considerably. Lockdowns in China and Europe have disrupted development. Such countries, where most generic drugs are produced, have been slashing exports recently to maintain sufficient local supply. COVID-19 is spreading through the United States, forcing hospitals to increase their bed capacities. When health-care providers fill these beds with the sickest and most vulnerable patients, we will fully anticipate the demand for life-saving drugs to increase (Yoder, 2020). It is also uncertain how much COVID-19 would cost hospitals. Providers are still at the height of the pandemic, but one thing is sure, because of the high price tag that COVID-19 carries, there will be financial problems for many hospitals for years to come (LaPointe, 2020).

Forecasting Errors. The challenge of forecasting variables makes it impossible to produce 100 percent correct forecasts. Pirc et al. (2016) stated there will still be an unpredictable deviation, despite the best efforts. However, ensuring the proper supply of drugs at an appropriate price involves forecasting that has adequate certainty about funding and timing of orders to allow manufacturers to invest in production capacity with confidence. It may also improve the accuracy of periodic forecasts by consistently using the appropriate model and monitoring outcomes to decide whether instances of errors are within specified limits. Several internal and external factors influence forecasting efficiency and order planning, indirectly

increasing market stability and markup safety (Pirc et al., 2016). Demand forecast error adversely affects supply chain performance, low resource usage, obsolete inventory, poor service outcomes, and revenue loss. Subsequently, forecasting is a critical tool in supply chain management (Simchi-Levi et al., 2008). Errors have a significant effect on the ability to make successful business choices. It is essential to use a formula that eliminates all positive and negative averages, ratios, and mean deviations as much as possible.

Hospital Pharmaceutical Supply and Demand Management

History Supply and Demand in any Market. According to Whelan and Msefer (1996), the rate at which a consumer wants to purchase a product is demand. In economics, demand includes being able to purchase and taste. Taste in this context is the wanting for a product or service. The ability to purchase has to do with the price and the affordability of that price. The market price plays a significant part in demand. Demand usually is low when the prices are higher, and demand is high when prices are low. Supply is how much of a service or good is accessible at each cost. It is the seller that determines the ability to supply goods. More supply will be available at higher prices due to maintaining a profit of higher cost manufacturing. According to Marshall (1920), supply and demand are essential topics in economics. Delivery and demand determine the quantities sold in every market and the price creation.

A principle was established by Marshall (1920) on the general law of demand, stating that the quantity demanded increases with a fall in the price. Smith (1863) noted that a decline in a commodity's price allows suppliers to decrease quantities before the cost of that commodity approaches its natural level. An essential part of supply chain management is demand management. Demand management is the process that equalizes the customer's need with the abilities of the supply chain. An adequate system, supply can be matched with the demand to

implement a plan with minor interruptions. Croxton et al. (2002) argued that a sound operating system and good forecasting are insufficient and that "demand management should include finding ways to reduce the adaptability of demand and increase operational flexibility and implement a good contingency management system so that the organization can respond quickly to unintended issues" (p. 64).

Role of Supply and Demand in Hospital Pharmaceuticals Shortages. A drug shortage is a deficiency in delivering a medicinal product, which affects the patient's ability to access the necessary treatment in due time. The origins of drug shortages are complex and varied, and the problem can be both on the supply side and on the demand side (Pauwels et al., 2015). Problems of supply and demand occur when demand for drugs increases beyond expectations or capacity of production. For instance, pharmaceutical prices' awareness does not significantly change because these medically essential pharmaceuticals have few alternatives and are mostly acquired through health insurance by consumers with pre-established rates (Thomas, 2012). Rachmania and Basri (2013) claimed demand forecasting is vastly needed to develop an applicable inventory control. Precise demand for pharmaceuticals can be a tough challenge. One of the issues with this situation is not getting the right documentation for drug usage.

Furthermore, the brand choice of various drugs from doctors allows certain drawbacks for market forecasting. To incorporate this, some analysis of demand should be possible directly from the bat, then the numerical modeling for accuracy should be seen, and these examples re-enacted. In a hospital, the way of supplying pharmaceuticals to patients is through the supply chain of pharmaceuticals. The cost of pharmaceuticals is continually rising. Berdan et al. (2019) remarked that generic drugs are a common reason for drug shortages.

There are not many companies that can manufacture low-margin items. The unpredictable consumer demand cannot survive with such a small supply due to suppliers' lack of generic drugs. Mensah et al. (2015) stated that hospitals worldwide seek ways to reduce costs and improve efficiency without compromising the care and services to patients. "Assessing the supply chain process leads to the identification of problems and opportunities. Having a strategy and measuring key parts are necessary to understand and take control of the supply chain" (Mensah et al., 2015, p. 153). The relationship from consumer to the supplier is a complex supply network. The system is complex because pharmaceutical requirements for healthcare are numerous. "Pharmacies are the final step in the pharmaceutical supply chain before the products hit the customer" (Kaiser, 2005). According to Kaiser (2005) the cycles of hospital pharmaceuticals include:

- Manufacturing sites produce pharmaceuticals.

- Pharmaceuticals transferred to wholesale distributors.

- Pharmaceuticals stocked at retail, mail-order, and other types of pharmacies.

- Pharmaceuticals are subject to price negotiations and processed through quality and utilization management screens by pharmacy benefit management companies (PBMs).

- Pharmaceuticals delivered to and taken by patients.

In logistics and supply change management, demand forecasting is the core of organizational decisions. Demand forecasting is the beginning of planning and executing the supply chain. The notion that pharmaceuticals are a strong industry for the supply chain, there is a lack of supply chain technology that may improve efficiency and the quality of patient care.

The complexity of pharmaceutical products can hinder effectiveness and performance improvement in the supply chain. The complexity comes from a limited and highly regulated

supply and delivery (Merkuryeva et al., 2019). Eventually, supply chain problems affect the supply of drugs based on the decisions made by end-users. Wholesalers or hospitals may have bad purchasing practices, delays in production, restrictive distribution methods, and stock approach focused on increased cash flow contributing to drug shortages (Tyler & Mark, 2002. Because of the current trend in the use of health facilities, demand forecasting predicts how much of the products and services will are required at a specific time. The prediction would suggest the facility balancing product use holds the developer of the baseline with the holding stock's value. Since demand forecasting relates to historical knowledge, there is often some uncertainty about forecasts and inventory rates that require adjustments to enable future uncertainty about demand (Ignaciuk, 2014).

Forecasting and Supply Chain Management

Forecasting. Forecasting acts as decision support tools that allow leaders to plan for the future by undertaking "what - if" analyses to evaluate how input changes affect results. Forecasting is a process that aids inventory decision making to anticipate future demand from archival data is demand planning. A considerable amount of these is subject to volatile demand in a warehouse of hundreds of items (Ellram & Cooper, 2014). Forecasting accuracy is one of the leading performance indicators measuring many organizations' functions focused on improving supply chain efficiency. The main aim of most supply chain-managing operations is to balance supply with demand. Demand forecasting is the point of departure for all attempts to achieve this objective (Ki-Seok, 2015). According to Spithourakis et al. (2011), supply chain management professionals must use a range of up-to-date resources to make educated and effective decisions. An organization will be able to predict future trends that can make the market work in their favor, through reliable historical evidence or expert opinions.

There are many plans in the service industries such as the hospitals that rely on the forecast, from capacity planning to aggregate planning, from layout decisions to the supply chain management (Kasapoglu, 2016). Although it can be challenging to deliver help products to people in need, long-term programs offer an incentive for market modeling supported by forecasting techniques. For all healthcare organizations, forecasting demand for health services is a significant step in strategic decision-making. This job, which financial managers frequently take on, involves first of all the collection and review of historical records (Cote & Tucker, 2001). Health forecasting is a new forecasting field and a powerful resource for anticipating potential health incidents or conditions such as health service demands and healthcare needs. Health forecasting promotes plans for preventive medicine and health care initiatives by pre-informing health service providers to take effective mitigation steps to reduce risks and meet demand. Health forecasting requires accurate data, information, and analytical tools to predict particular conditions or circumstances in health.

Forecasting Methods. Service demand forecasting is the first important step in determining the future course of a healthcare organization. As such, healthcare companies need the best possible demand forecasts for their services.

There are several approaches to demand to forecast. Whatever approach used, the following issues should be satisfied:

1. The necessary data should be readily available. Financial records typically represent the best source of historical data regarding utilization. The forecasting method should be able to use these data.

2. Existing staff members equipped with readily available tools, such as spreadsheet software, should be able to perform the forecasting in-house.

3. The forecasting method and its results should be understandable not only to financial

   management staff but also to those who use the results for decision making. (Murray &

   Tucker, 2001)

A crucial aspect of the forecasting process, in addition to these issues, is understanding

that forecasts based on historical data constitute only the starting point for demand forecasting.

Although historical data provide the best outlook for the short term, healthcare managers know

that demand for healthcare services is complex. Qualitative forecasting is a forecasting approach

based on intuitive or judgmental assessment. For example, expert opinion and knowledge about

specific events of the sort already described, which may or may not take the context into account.

Typically, it is used when data is sparse, inaccessible, or no longer relevant. Quantitative

forecasting is a forecasting approach where historical demand data projects future demand.

Extrinsic methods and intrinsic ones are usually used (Spithourakis et al., 2011). Most of the

traditional demand forecasting focuses on mathematically extrapolating past demand into the

future on the premise that future demand followed the same statistical patterns as in the past

(Lawless, 2015). A few of the most common forecasting approaches are discussed in this study.

Judgment Forecasting. The collection of professional opinion is the Judgement

forecasting method. Judgment forecasting combines expert information with statistical

forecasting, including whether expert expertise will enhance the accuracy of forecasts. Human

judgment can offer a significant advantage to forecasting accuracy, but this may also be subject

to various biases (Lawrence et al., 2006). Judgmental forecasting includes various types of

predictive judgment, including forecasts based on contextual information, information of

intervals, or predictive model judgment (Petropoulos et al., 2018). In practice, it is reasonable to

predict using judgment. In some instances, judgmental forecasting is the only choice, for

example, when a complete lack of historical data, when a new product is launched, or when a new competitor enters the market, or under entirely new and unusual market conditions. Judgment must be applied to forecast such a program's effect because there are no historical precedents (Goodwin & Wright, 2009).

Delphi Method. The pharmaceutical industry plays a significant role in supplying drugs and saving human lives. In this sense, any risk affecting the pharmaceutical supply chain may affect health system efficiency and interrupt the supply of medicines (Tazin, 2016). The Delphi method is a method of forecasting in which a select number of experts merge market orientation and assessments using an iteration function. It is an instrumental technique for evaluating data in which experts express their views, expertise, and experience before mutual consensus is reached (Chuang et al., 2013). With the Delphi method, the most critical threats in pharmaceutical supply chains are finalized. There is no particular restriction to considering data evaluation by experts (Markmann et al., 2013). The outcomes of these iterated variations help to establish the next parallel meeting points for a particular prediction to be sought. This approach has been proved successful and accurate for long-term forecasts (Markmann et al., 2013).

Focus Groups. The focus groups are a popular form of qualitative forecasting (Simchi-Levi et al., 2008). It involves engaging in an open-ended dialogue involving five to ten people from a company's target customers. There is typically a moderator who seeks turn-taking among the participants and often asks questions about their products, brand awareness, and related concepts. Participants are supposed to provide insightful responses that reflect the perspective of a wider audience they are targeting. Discussions in focus groups can involve rewards such as a financial reward or some similar measure in terms of free goods. Current forecasting methods restrict the context of the market available (Blackburn et al., 2015).

Time – Series Methods. A time series is ordered in time by a sequence of data points. Time is always the independent variable in a time sequence, and the goal is generally to predict the future and order series of observations at equally spaced time intervals of a variable or captured object. Time series is measured at regular intervals sequentially over time, such as hourly, daily, weekly, monthly, and quarterly. Time series information is essential when forecasting something that will change over time using past data. In the analysis of time series, the aim is to estimate the future value using past data behaviors. This second concept's significance in terms of health forecasting is the focus it puts on the "uniformly spaced time intervals," which is important in the use of health data for health forecasting.

Time series thus provides a statistical framework for analyzing seemingly random fluctuating health data and the potential prediction of the data series (Chatfield, 2004). The trend is the long-term variability in the data in a time series not influenced by unusual or seasonally-based components. For example, a cumulative record of a gradually increasing occurrence over a given duration of health data will indicate a growing pattern, regardless of any random or systemic fluctuation (Chatfield, 2004). There are several widely used methods, each with varying benefits and drawbacks (Simchi-Levi et al., 2008). Common time-series methods include:

Exponential Smoothing Model. A widespread forecasting method within supply chain models is the exponential smoothing method. The use of a particular forecasting method affects the costs of a supply chain. For hospital drug expenditures, exponential smoothing forecasts a projected value for the preceding time based on the prediction, adjusting the prediction error. New data are weighted more heavily than older data; weights decrease as data get older (D'Sa et al., 1994).

Moving Average. Simply this method says the next observation is the mean of all past observations. The aim here is to pick the number of points on the moving average to minimize the impact of data irregularities (Simchi-Levi et al., 2008).

Casual Method. Causal forecasting is the methodology that assumes a cause-effect relationship between the variable to be forecast and one or more other independent variables. Causal strategies typically take into account all possible variables which can influence the dependent variable. Therefore, the data needed for such forecasting can vary from the internal sales data to external data such as surveys, product features, and social chatter. Causal models are typically continuously updated to ensure the latest information is integrated into the model (Anandhi et al., 2012).

Predictive Analytics and Big Data

Relationship of "Big Data" in Healthcare. In recent years, there has been a growing interest in developing demand forecasting systems for supply chains to help predict, advise orders, allocate resources, and help meet demand (Shafique et al., 2019). The four technological characteristics of big data are veracity, variety, volume, and velocity. These four properties present their information challenges, according to (Rajaraman, 2016). Veracity is the degree to which reliable and precise data is trusted. Volume is datasets that are too large to be controlled by traditional tools and systems. Variety is datasets that are both formatted structured or unstructured. Velocity is datasets that have data to be analyzed quickly because of data that is time sensitive. Hospitals that develop their warehousing system for data can integrate the four properties and all of the other data systems into one database with a common format. The processing and management of massive data sets is a challenging task in and of itself, but one

that is important for the development of descriptive and predictive analytics applications (Alharthi, 2018).

Organizations can obtain data-driven insights in data analytics by finding trends in historical data, such as changes in the sales of various products and preferences for consumer purchases. For example, businesses can use simple techniques such as drawing charts to find patterns in the data, use regression to understand the relationship between different variables, or view data to improve data (Pyne et al., 2016). Such descriptive insight will improve the ability of an organization to develop new products or expand current product lines properly. To order to predict future events and patterns, organizations can also combine massive amounts of data from different sources (Ghasemaghaei & Calic, 2019). This predictive ability allows businesses to forecast their market patterns and overall performance, which can lead to new product production or existing product improvements.

Online retailers, for instance, can use customer online behavior, customer purchasing history, such as page views, time spent on each page to gain predictive insight by predicting consumer behavior while developing new goods. Knowing the best course of action and gaining prescriptive knowledge allows companies to refine their processes of discovery or exploitation. For example, companies can use simulations to analyze various scenarios and find optimal solutions in the processing of current products. As a result, businesses that effectively produce market insights will boost their innovation skills (Pyne et al., 2016).

Another example of an emerging technology designed to handle extensive data with significant implications for healthcare environments is data analytics. Such instruments examine patterns for gaining knowledge and insights in vast and complicated datasets. The use of data is a crucial tool for health organizations to deliver better healthcare services and cut costs. Just like

other industries, healthcare analytics can be predictive, descriptive, or both (Alharthi, 2018). Because of analyzing current and historical data in predictive analytics, the results may identify signatures or detailed patterns of clinical weakening before it becomes apparent, which makes the case of being proactive instead of reactive in medicine (Michard & Teboul, 2019). Using data from healthcare, while focusing on predictive analytics, is developing as a transformative instrument that will allow more treatment options that are preventative and proactive (Alharthi, 2018). A large variety of clinical systems and population delivery interventions can be simulated by predictive analytics to predict outcome measures and forecasts from scenarios of health intervention delivery. Such initiatives are part of major movements that seek to understand how best to balance areas such as accuracy in medicine, accuracy in public health, and community health (Dolley, 2018).

History of Predictive Analytics. Predictive analytics is a general approach used to solve a variety of business needs, problems, and concerns. Predictive analytics is the method of extracting data from current data sets to determine patterns and forecast future trends and outcomes. Predictive analytics is not asking you what is going to happen next. It predicts with an appropriate degree of precision what might happen in the future and provides what-if scenarios and risk assessment (Lawless, 2015). Shmueli and Koppius (2011) stated for assessing predictive power, predictive analytics uses statistics and other empirical methods to generate information predictions. The techniques of predictive analytics also include business intelligence, artificial intelligence, and learning of deep algorithms (Alharthi, 2018). Finlay (2014) stated the center of predictive analysis depends on the capture and exploitation of relationships between explanatory variables and predicted variables from past events to predict the unknown outcome.

It is imperative to note, in any case, that the precision and ease of use of results will depend significantly on the degree of information investigation and the nature of assumptions. The industries that use predictive analytics include finance, marketing, healthcare, and pharmaceutical research. Using predictive analytics could increase the provider's and researcher's access to high-quality patient data. (Fan et al., 2014). What differentiates predictive analytics from forecasting is that predictive analytics is at a level of granularity that is more detailed. Predictive analytics uses probabilities for each separate organizational component. Learning from prior experience to predict a future pattern will aid in better business decisions (Siegel, 2013). Although most organizations generally use big data in warehouse optimization, some organizations are starting to use predictive analytics to make more informed decisions by using insight into the data. In healthcare, searching through large amounts of data and analyzing data to predict outcomes is predictive analytics for individual patients. The data included in predictive analytics can come from published journals, databases, and past treatment outcomes of patients. Big data and predictive analytics have significant potential to support more reliable, more effective treatment, and recent developments have been noteworthy, especially in the field of image analysis (Voets et al., 2019).

Predictive Analytical Models. According to Alharthi (2018), healthcare organizations have started to execute predictive analytics to process and manage big data to discover trends, predictions, and hidden relationships that support improved healthcare services delivery. Kankanhalli et al. (2016) claimed global healthcare systems face increasing pressure from the maturing population and lifestyle changes. Along with the groundbreaking advancements in digitized patient and wellness data, primary and secondary data are growing. While the mass of information offers open doors for enhancing healthcare delivery, policymaking, and

management, new technology frameworks and methodologies will hopefully leverage the vast data. According to Gim et al. (2018), business-related data analysis can be divided into three categories:

1. Descriptive analytics: a collection of technologies and processes for understanding and analyzing business results using data. Descriptive statistics are an integral part of biometric research, and a prerequisite for understanding more statistical assessments, including inferences drawing. When data are well presented, it is generally evident that the author has obtained and interpreted the data accurately and in compliance with agreed field practice (Spriestersbach et al., 2009).

2. Predictive analytics: predicting outcomes using several analytical and computational approaches based on data input. This approach examined many predictive relationships and proposes a framework to optimize business performance. Although relatively new, real-time reporting can deliver timely insights into information and can be used to vigorously adjust the predictive algorithms in line with new ideas and discoveries. Predictive analytics utilizes information from its wellbeing data framework to recognize patterns and examples in drug use in the perioperative setting and create methodologies to repackage mass meds into littler unit dosages at whatever point conceivable. The approach helps the hospital to stock up on supply, decrease squandering, and extend hard accessibility to get medications and shortages (Fan et al., 2014).

3. Prescriptive analytics: A collection of computational methods for evaluating complex business results goals, criteria, and limitations. This approach describes different alternatives and recommendations based on results from descriptive analytics and predictive analytics. Prescriptive analytics seeks to recommend (prescribe) the best

decision choices to take advantage of the predicted future by using vast volumes of data (Pedersen et al., 2018). Prescriptive analytics has two types of human intervention: support for decision making (e.g., offering recommendations, automation of decision making, executing the prescribed action; Lepenioti et al., 2020). The usefulness of the prescriptions varies on how well these models combine a blend of unstructured and structured data, reflect the domain under review and capture the impacts of the analyzed decisions (Pedersen et al., 2018).

Machine Learning. Machine learning refers to algorithms that rely on models and data processing based inferences without using explicit instructions. Machine learning includes basic knowledge, which we see in a graph. Machine learning algorithms create a mathematical model of sample data, known as "training data," such that predictions or decisions can be made without specific programming for the task (Bishop, 2006).

Recommendations for Improving the Costs of Hospital Pharmaceutical Shortages and Improve Efficiency

When executing initiatives that will impact drug expenditures in a hospital system, it is critical to have a method for prioritizing and planning particular pharmaceutical cost management strategies (American Journal of Health-System Pharmacy, 2008). Iyengar et al. (2016) detailed there are single or multiple reasons for drug shortages, extending from "problems at the production level to weak supply chains that prevent medicines from reaching points of care" (p. 1). No matter what the reason, drug shortages increase hospital pharmaceutical costs. According to Pace et al. (2015), pharmacotherapies play a vital role in the treatment of diseases, although expensive. One of the hospital's highest expense centers in the pharmaceutical division.

In recent years, the medical costs per capita for ambulatory and hospital patients have

increased due to variables that decision-makers are not easily manipulating, such as the

increase of life expectancy, the growing population, and the emergence of new diseases,

among others. (Franco, 2020, p. 1)

New standards and quality requirements allow pharmacies to have more services to ensure that

adequate measures are placed in place to improve patient safety and well-being to the highest

level. Simultaneously, the pharmacy speaks to a prime territory of the center for improving cost

efficiencies and benchmarks for reimbursement. Going ahead, hospital pharmacies should

improve operational procedures to make sure employees use their time wisely (Pace et al., 2015).

There is a significant impact on hospital inventory spending due to drug shortages.

According to Gu et al. (2011), there is an increase in government regulations to improve

correspondence on the many factors that lead to drug shortages. Discussing alternative options

can lead to cost savings strategies, quality improvement programs, and opportunities to enhance

clinical practice when a product suddenly becomes unavailable (Clark et al., 2019). McKesson

(2019) stated that because of the negative effect on patient care and financial burdens, drug

shortages may create; an organization should have a prepared response in the event a drug

shortage occurs. Having resolved the shortage situation, the organization should resume standard

operating procurement procedures. There must be a dedicated pharmacy staff member dealing

with drug shortages, given the number of shortages that occur. Some hospitals reported that three

FTE pharmacy staff were primarily involved in drug shortages management. To do that, most

hospitals do not have the money or personnel. Identifying the problem is not the only thing that

is labor-intensive. A drug shortage management system requires time and effort, as well as

measures to assess and execute in response to the shortage (McKesson, 2019).

A case study on challenges hospitals face because of drug shortages suggests that hospital pharmacies should be proactive. Hospitals need to pay attention to the signs that a drug shortage is pending. When organizations such as the ASHP and FDA release information of partial fills and unavailability, contact should be made with the producers of the drugs to see how long the shortage will last and if there are any alternatives (Rich, 2013). Communication is crucial to diverse lists of medication availability as all parties need to be aware of issues, ranging from distributors, pharmacists, nurses, procurement managers, drug safety officers, and pharmacy informatics. A proven drug shortage guideline or policy allows hospitals to respond timely and efficiently to real or probable drug shortages, guaranteeing high-quality clinical care for patients, and reducing the risk of adverse effects and poor results. Written updates, electronic medical record warnings, and correspondence via e-mail are options for transmitting information through health systems (McKesson, 2019).

In the case of COVID-19, there is a shortage of hard information; worries about depleting (or idling) stock are increasing, and companies worry that contractual obligations will not be fulfilled. Understanding how global companies are managing their supply chains through disruptions will help all businesses coordinate their responses (Sanders, 2020). Keegan (2020) impacts in many sectors seem inevitable in many religions. Chinese supply costs will rise sooner than later, stemming from overtime and expedited freight costs, as well as paying premiums for buying up supply and maintaining power (Keegan, 2020). Companies also operate through alternate procurement approaches such as; implementing a program for tracking supply rates, including protection to prevent theft or store limited protective gear, including N95 masks and personal protective equipment. Identifying alternate supply possibilities and deciding what they

mean for operations will be crucial — for instance, when cases of viral transmission occur in various regions (Sanders, 2020).

Benefits of Using Predictive Analytics for Hospital Pharmaceutical Shortages. In recent years, pharmaceutical shortages issues have been growing globally. There are various definitions of drug shortages that include supply issues, how drugs are prepared and dispensed, lack of supply for patient demand, and manufacturing issues. Regardless of what the definition is, the bottom line is that a shortage in hospital pharmaceuticals will negatively affect patient care (Holcombe et al., 2018). Big data predictive analytics is a reliable tool in supply chain management. Big data predictive analytics will help with the relationships between suppliers and buyers to boost the efficiency and performance of the supply chain (Shafique et al., 2019). For the pharmaceutical industry, it is wise to use big data to predict the future. According to Hernandez and Zang (2017), the term big data is viewed in healthcare as large quantities of health records that are electronic, data from clinical trials, administrative claims, phone applications and social media. Hernandez and Zang further claimed that broad data used in predictive analytics may help complicated patients and patients at high-risk drug risks in various areas of prescription management. Shafique et al. (2019) claimed within big data technology, big data predictive analytics can be defined as the systematic method used to collect, store, organize, use, transfer, and visualize data to predict future trends. Hence, through the conception of big data referred to as big data predictive analytics, hospital pharmaceutical shortages can progress the performance of their supply chain (Duan & Xiong, 2015).

According to Admes and Garets (2014), predictive analytics may use a specific set of data to make predictions based on historical events or modeling. There are many and significant clinical applications of predictive analytics, as personalized patient result predictions are

feasible. For this reason, there has been a great deal of interest in predictive analytics in healthcare settings as of late. The knowledge gained by applying predictive analytics to healthcare would change the practice of medicine while enhancing the ability to treat and prevent major diseases and diseases. The role of predictive analytics will expand in drug optimization as better predictive tools, and more patient data becomes available. Establishing a regularly meeting drug shortage committee has allowed an active approach to handling all facets of drug shortage management in planning for future events (Clark et al., 2019). Using predictive analytics can increase the quality of hospital operations. In short, forecasting is a method that looks at numeral data from a time series and forecasts the future value for the information that looks at the patterns. In contrast, a predictive analytical model takes in a variety of variables and forecasts future behavior where numbers may or may not be all of the data points.

Literature-Based Potential Themes and Perceptions

The literature review of this study examined the rising cost of hospital pharmaceutical shortages and the impact on patient care. The researcher identified and explored manufacturing problems as one of the reasons for rising hospital costs of pharmaceutical shortages.

Supply Chain Management and Healthcare. According to Min et al. (2019), supply chain management includes planning and managing all procurement activities, adaptation, and all activities of logistics management. The supply chain also involves cooperation and communication with channel partners, which may include distributors, intermediaries, third-party service providers, and consumers. Supply chain management fundamentally combines the management of supply and demand within and through businesses. Supply chains in hospitals are unique and, in many ways, different from the conventional industrial supply chains. It is a dynamic system that requires the distribution of products and services to meet the needs of

patients (Mathur et al., 2018). Over the past few decades, the healthcare sector has been facing continually rising price challenges. There will be a decrease in profits and market share if there is a lack of supply chain management efficiency (Ellram & Cooper, 2014).

Experts and practitioners have increasingly focused on different supply chain approach for Supply Chain Management (SCM) to cope with ongoing changes in their design, meaning, and requirements (Banomyong & Supatn, 2011). More organizations are incorporating technology into their supply chain management systems to remain globally competitive. Consumers have become increasingly demanding in recent years, setting high expectations in terms of quality and service. Simultaneously, supply chain managers realize that the latest technology can help them to ensure better liability and visibility, permitting them to stay ahead of the pack and keep tight control (Scholten & Schilder, 2015). Problems of supply and demand arise when demand for drugs rises beyond expectations or the ability of production. Supply chain activities allow the healthcare system to efficiently monitor and actively track the desired goals as an invaluable management tool and mechanism to achieve success. Successful SCM may result in a reduction in the overall amount of resources needed to provide the required level of customer service and enhance customer service through increased availability and reduced or decreased product availability (Reefke & Sundaram, 2016).

Hospital Inventory Management Challenges. Yildiz and Khan (2018) reported that the administration of inventory management is a part of the business the board that explicitly centers on arranging and overseeing inventories. While public hospitals are not business units, to improve their customer orientation, inventory management is also essential for public hospitals. The general accounting principle considers inventories as "'capital' or 'asset' that will, in the future, convert into service or product sales" (p. 500). A problem for operating systems was the

design of a reliable inventory management mechanism under volatile conditions of demand (Ignaciuk, 2014). The surplus or deficit of each item shall determine the basis of the effects of the forecasts in the inventory control process. According to Wang et al. (2015), hospital inventory management, however, is more troublesome than modern industrial systems, as the majority of medical and surgical inventory must be of sufficient quantity and quality for the workers to use at all times. Over the past few years, the need to address barriers to efficient supply chain inventory management has become more critical for hospitals and health systems as they face cost-cutting pressures while improving patient outcomes under the Affordable Care Act (Beamesderfer & Ranji, 2012). Automation, analytics, and interfacing will assist health care providers in improving inventory management while reducing costs and encouraging better care. Hospitals can reduce supply chain costs without sacrificing quality by implementing more active inventory management systems (Wang et al., 2015).

Challenge of Pharmaceutical Shortages. Gu et al. (2011) reported that drug shortages were first overserved in the United States, where drug treatment is more customary than anywhere else in the world. Conversing and seeking practical solutions to the problem of drug shortages is vital because scarce drugs are necessary for the treatment of most critical health conditions, and shortages in any of them inevitably disruptions in patient safety and quality of healthcare. Due to the various factors leading to drug shortages, more government regulations are implementing improved communication between the multiple parties involved (Thomas, 2012). Problems with manufacturing are just one of the reasons that cause drug shortages, mainly because of quality, materials, and even factory closures, according to the FDA (Gu et al., 2011). "Some of the unpredictable factors include natural disasters, raw materials, non-compliance with regulatory standards, and voluntary recalls" (Ventola, 2011, p. 748).

Natural disasters, such as earthquakes, fires, and hurricanes, have an impact on the supply of pharmaceutical products in the following ways. For example, finished goods are destroyed, and the loss of sites leads to long-term shortages in cases where there is only one manufacturer. (Tyler & Mark, 2002). Moreover, a product may depend exclusively on one primary raw material, which can only be manufactured by a manufacturer of a sole source. Dill and Ahn (2014) reported that a lack of access to vital medicines should not be a common problem in any country; however, drug shortages have become a primary global concern. Lack of access to critical medication should not be a common problem in any country; however, drug shortages have become a major global concern. Additionally, prompt notice from a supplier of a possible or imminent drug supply disruption is highly related to the ability to alleviate and avoid a drug shortage in any developed country or regulatory agency under any circumstances. This early warning in the US has greatly increased the ability of the FDA to respond more rapidly and more efficiently to emergencies, as it allows for a more accurate and efficient response (Dill & Ahn, 2014).

Impact of Pharmaceutical Shortages. Effective drug shortage management presents significant challenges. Drug shortages affect every health care system stakeholder, and there is a need for concerted efforts to address and reduce shortages. Drug shortages are likely to affect the workload and medical decision-making and have a clinical and financial impact (Pauwels et al., 2015). Health care institutions regularly require quick access to specific medicines to treat patients with acute and emerging conditions. Drug shortages have a clear impact on public health and patient outcomes. Shortages may result in missed doses, prescribing inaccuracies, errors in dispensing and administration, decreased compliance of patients, and increased health care costs (Balkhi et al., 2013). Difficulties in manufacturing, supply and demand, industry and economy,

legislation, supply chain, and health care systems all impact drug shortages. When a company transfers its money from manufacturing to analysis or the development of an alternative product, this contributes to production losses, which can lead to redundancies (Gu et al., 2011).

Furthermore, substitute medical treatments may also have different side effects or maybe less effective than initially prescribed (Balkhi et al., 2013). Prescribing alternative medicines can lead to errors in medication, such as incorrect dosage. Many patients may need medication as a matter of urgency, but drug supply shortages will lead to the rationing of most critical patients. The issue with medication shortages is the regulation of performance. Substitute drugs may not live up to the required quality when there is a shortage of drug supply. Hospitals or hospitals may need to buy drugs from less reliable outlets (Thomas, 2012). It is critical to have a plan in place before shortages arise. To determine the cause of the shortage and the expected time and period, the pharmacy team will contact drug suppliers, the FDA, and the CDC. Prioritization of patients may be appropriate, and organizations such as CDC may provide clinical guidelines. Additionally, the hospital pharmaceutical interdisciplinary group should also develop a patient prioritization plan using an evidence-based approach that provides recommendations for clinical practice and original research (Fox & McLaughlin, 2018).

Data, Analytics, and Healthcare. Fadiya et al. (2014) stated that a considerable amount of data had invaded the planet. Due to digitization, the adoption of information technology as a useful tool, and the Internet becoming a compelling user interface for daily exchanges, all industries, and all their activities are involved. Nevertheless, in terms of volume, variety, and velocity, these generated data are becoming increasingly difficult to manage. A new big data field was born (Gandomi & Haider, 2015). Many analytical programs can improve the future outcomes of models that employ art and science. The data used for such a model are the existing

data from multiple resources. The way researchers and practitioners handle, analyze, and exploit data in any field has changed with Big Data. Voets et al. (2019) said that healthcare is one of the most critical areas for reform. Healthcare analytics may reduce treatment costs, predict contamination episodes, preventable infections, and improve the overall quality of life.

According to Huang et al. (2015), big data analytics application in healthcare has many empowering and life-sparing. Big data information alludes to the considerable measure of data created by digitizing all that is put away and handled by explicit advancements. Applied to healthcare, it will utilize precise wellbeing information from a populace (or individual) and may help prevent epidemics, cure disease, and reduce costs. Huang et al. (2015) also argued that this medical data revolution has the ability at the point of care to change patient decisions. Complicated creative and high price-specific drugs are increasingly entering the health care market. This trending translates from providing care in health facilities that are now implementing new modes of safe delivery and improving data analysis. Physicians will be able to abstract pertinent information for each patient, which will give better choices and results.

Predictive analytics has the ability to boost the company's demand predictions and production plans significantly. It can evolve with changing conditions and consumer needs and behavior. It will help the company better understand what drives both positive and negative demand, thereby giving the company an opportunity for management action and better decision-making (Lawless, 2015). Traditional demand forecasting is somewhat restricted in its approaches and inputs, utilizing a single hierarchy and a single best-fit model to forecast the product at hand. At the same time, predictive analytics uses a variety of models and techniques (including machine learning algorithms) to analyze broader data sets with many additional properties. It may even involve infinite quantities of simple variables. Since predictive analytics can predict

various outcomes, pharmacists can have a greater understanding of the threats that each patient faces from particular medication-related issues (Hernandez & Zhang, 2017). Through employing Predictive Analytics as a decision-making and forecasting method within the organization, the business and all its stakeholders will have a significant economic benefit (Lawless, 2015).

The field of healthcare can benefit from predictive analytics, mainly when large sets of independent and weighty data exist. Providers, along with pharmaceutical and medical device manufacturers, tend to look for ways to improve medical outcomes as health care services progress. Through organizing and directing medical decision-making, predictive analytics can help to reduce and control costs and improve clinical trials that can influence future research (Raghupathi & Raghupathi, 2014).

Summary of the Literature Review

The literature review's goal was to analyze the existing literature to determine the case for the research methodology that the study examined. The analysis of existing literature helps the reader understand the overall business problem of the rising costs of hospital pharmaceuticals and the impact on patient care. The literature review is divided into five sub-sections, a brief history of the United States healthcare system, an overview of supply chain management, healthcare industry issues, supply and demand for hospital pharmaceuticals, and the possibility of predictive analytics and supply chain management as a potential solution to the business problem. The literature concluded with a discussion of the researcher's initial literature-based perceptions and themes.

Transition and Summary of Section 1

The first section of the study consisted of the problem under examination, the purpose of the study, and the research questions to be explored to make a convincing case. The research

study's framework includes analyzing what the study involves and why it is useful. Background information has been provided in this section to help in understanding the need for the study. Then, the statement about the problem and the study intent was clarified. The review's intent was discussed on the nature of the study, describing the research and design method chosen for the study, as well as explaining why the other methods and designs were not selected.

The next part of Section 1 included the research questions and the conceptual structure to be used in the study. The conceptual framework consists of a narrative and sometimes a visual structure that represents the logical connections between key elements of interest in philosophy, structures, and phenomena. The significance of this research relating to the cost of pharmaceutical shortages in hospitals, and the effect on patient care, Biblical Implications, the connection to the strategic management, and key terms were defined. Furthermore, assumptions, limitations, and delimitations were acknowledged as to specify the broad scope of the research. The first section concluded with an exhaustive review of existing literature relating to the focus of this study. The next section of this study will describe the research method and design. The purpose statement will be reintroduced, along with the role of the researcher and the participants. Furthermore, the process and design of the study, population sampling, data collection, and data analysis will be discussed. Finally, the second section will conclude with the technique, reliability, and validity of the study.

Section 2: The Project

This research study explored the rising costs of hospital pharmaceutical shortages and the impact on patient care: exploring the use of predictive analytics in New York area hospitals. According to Berdan et al. (2019), pharmaceutical shortages represent a significant problem for hospitals. One hundred and twenty-one (101) primary lifesaving drugs are in short supply today, and at least 50 shortages a year are recorded by 70 percent of all hospital pharmacists. Providers may have to postpone medically necessary treatment or alternative treatments that may not be as effective without these lifesaving medications at hand (statnews.com, 2019).

The qualitative research method and case study design are determined the best fit for this study to expand on existing research and answer the research questions. The second section begins with the purpose of the study. It then identifies the role of the researcher and the participants. The population consisted of New York hospitals, and the sampling was pharmacists, pharmacy technicians, and other staff that have experience with hospital pharmaceutical shortages. Although a qualitative study, the hypothesis discusses predictive analytics as a possible mitigation method for hospital pharmaceutical shortages and the impact on patient care. The data will come from interviews based on the participant's experience. Finally, data analysis, along with reliability and validity, concludes the second section of the project.

Purpose Statement

The purpose of this qualitative case study was to add to the body of knowledge by expanding on the understanding of factors driving the rising cost of hospital pharmaceutical shortages relating to manufacturing problems and the impact on patient care. The integration and coordination of the hospital pharmaceutical supply chain are essential to support patients' care (Sweeney, 2011a). Hospital supply chain management has many issues, including increased

supplies, manufacturing problems, logistics, and distribution issues. When the supply chain is managed effectively, it can positively affect the hospital's bottom line (de Vries & Huijsman, 2011). Pharmaceutical supply chain management's critical objectives should improve the fulfillment of demand efficiently, drive extraordinary client value, build system resiliency, and promote financial success (Gibson et al., 2005). The more significant problem was explored by studying the rising cost of hospital pharmaceutical shortages, associated with manufacturing problems, the impact on patient care, and exploring the use of predictive analytics in New York area hospitals.

Predictive analytics is a concept describing the use of past data to develop informed assumptions about future results. Many businesses have been using this sophisticated method to assess risk, detect fraud, and the demand for products or services. The study's role in predictive analytics was a method for using data to predict and adapt to changing demands based on historical events and prevailing trends (Brooks, 2018).

Role of the Researcher

The role of a researcher is extensive and detailed. The traits such as ethical, positive, adaptive make a researcher qualified to ask relevant questions and reasonably interpret the answers while conducting the research (Yin, 2014). In this qualitative study, the role of the researcher primarily serves as a facilitator. The researcher will be to identify the best participants for the study, contact the participants for the study, administer surveys, and analyze the data from the surveys. Dezin and Lincoln (1994) defined qualitative research as being focused on multimethod, requiring an analytical, realistic approach to its subject. Sutton and Austin (2015) stated that the researcher's role in qualitative research is to try to access the study participants ' thoughts and feelings. It is not always straightforward as an encounter can be unique, as the

researcher asks the participants to share their experiences. The researcher is primarily responsible for protecting participants and their data. Instruments for such protection must be clearly expressed with the participants and approved by the relevant Research Ethics Review Board before commencing the research (Sutton & Austin, 2015).

Participants

Sargeant (2012) stated that one of the most critical tasks in the design phase of the study is to identify suitable participants. Selection decisions are reliant on the research questions, theoretical viewpoints, and evidence of the study. Since most qualitative data comes from encounters with participants using questionnaires, interviews, focus groups, or surveys, a researcher must identify participants who are willing to speak about their experiences. It is, therefore, at the core of a planned study to consider a prospective participant who has experience with the phenomenon and is willing to share their thoughts (Kuper et al., 2008). In this study, the ideal participants would be individuals that have firsthand experience with hospital pharmaceutical shortages. Therefore, participants will include pharmacists, physicians, supply chain managers, and clinical support staff from New York Hospitals.

Caulder et al. (2015) suggested that to mitigate the clinical outcome of a pharmaceutical shortage, all parties involved must be informed of the impact a shortage will have on the patients. "Pharmacists are uniquely qualified by leading initiatives to minimize the impact of drug shortages on patient care and benefit health-care organizations" (Caulder et al., 2015, p. 284). Next, the researcher obtained approval from the Liberty University International Review Board (IRB) and the IRB of the relevant New York Hospitals. After the approval, a consent form and a narrative of the study was sent via email to the prospective participants. Details that may have identified participants followed the confidential compliance set forth by the IRB. All methods of

collecting data, such as notes, transcripts, and recordings, will also be protected following the study.

Research Method and Design

This study used the qualitative research method and the case study research design. One of the critical decisions in qualitative analysis is identifying who or what to include in the sample. An awareness drives the sampling method that the qualitative study focuses on knowledge building and relevance in line with the specific research question (Kuper et al., 2008). Review of case study as a qualitative approach entails far more nuanced than a conventional case report, and often creatively incorporates multiple data sources. The case study's depth and richness of detail help readers to understand the case and whether results may be relevant beyond that context (Alpi & Evans, 2019).

Discussion of Method

Qualitative research methods include interviewing strategies, analyzing of documents, and observations. The aim is to investigate the attitudes, interaction mechanisms, and the meanings, values, and experiences of intentionally sampled individuals and groups in their "natural" setting. The desired result is the ability to make conceptual generalizations from a qualitative study's local context to other settings (Kitto et al., 2008). Healthcare research, particularly clinical medicine, is a progressively difficult field. Evidence-based clinical researchers have recently become increasingly aware of the importance of looking at qualitative research. Furthermore, a growing interest in exploring the attitudes, values, and experiences of those concerned or influenced by health care delivery has brought qualitative research to the forefront (Green & Britten, 1998). This study examined the rising costs of hospital pharmaceutical shortages and the impact on patient care: exploring the use of predictive analytics

in New York area hospitals. The qualitative research method is best suited because it is a successful model in a natural setting that allows the researcher to establish a level of detail from being heavily involved in the actual experiences (Creswell, 2003).

In this study, the quantitative method of research was not chosen because the quantitative method is based on numerical analysis, science, and the cause and effect of relations (Creswell, 2014). A deductive methodology is used with quantitative studies in which, preferably, the researcher establishes a hypothesis that applies to the subject under study, develops hypotheses based on this theory, and then tests such hypotheses with evidence that either supports the hypotheses or not (Barczak, 2015). Creswell (2014) stated that when the results need to be transmitted mathematically, quantitative analysis is the best research method. Quantitative analysis allows organizations to gather statistics on which predictions and plans can be made. A study aimed at gaining an insight into the experience with a phenomenon could not be achieved using the quantitative method.

Discussion of Design

A qualitative case study provides researchers with the resources to analyze complex phenomena within their context. After the correct application of the methodology, developing theory, reviewing initiatives, and designing strategies become a valuable tool for studies in health science (Baxter & Jack, 2008). Yin (2003) identified a case study design should be considered when:

1. The purpose of the research is to address "how" and "why" questions.

2. The boundaries between the phenomenon and context are not clear.

3. The actions of those involved in the study cannot be manipulated.

4. Contextual conditions should be protected because it is assumed, they are essential to the phenomenon being studied.

According to Stake (1995), case studies are an investigative technique in which the researcher investigates a plan, case, operation, procedure, or one or more individuals in detail. Cases are confined by operation and time, and researchers gather detailed information over a sustained period using a variety of data collection techniques (Stake, 1995).

Summary of Research Method and Design

Research design and methods are separate but closely linked because good research design means that the data you collect can help you respond more effectively to your research questions. This study applied the method of qualitative analysis and a multiple case study design. The qualitative methods of investigation was used to collect and analyze data, identify emergent themes and produce recommendations about the experiences of pharmaceutical staff that has challenged by the rising cost of hospital pharmaceuticals and their impact on patient care.

Population and Sampling

Discussion of Population. Research studies are performed on a population sample, rather than using a whole population. The most challenging part of fieldwork is to draw a random sample from the target population, which would generalize the results of the study (Banerjee & Chaudhury, 2010). Population selection is a prerequisite in the qualitative as well as quantitative studies documentation. However, both designs also apply the principles of accessible, general, and target populations. The accessible population is the participants that are willing and able to participate. The general population is any individual that might fit in with the aim of the research study. The target population is the participants who fit into the selection criteria for the research study (Asiamah et al., 2017).

For qualitative and quantitative research, however, population definition is not motivated by the same principles. Quantitative research requires the involvement of a relatively large number of people who are not needed to describe the experiences and anomalies thoroughly in the review (Creswell, 2003). On the other hand, a qualitative study focuses on relatively few participants who can explain their perceptions and knowledge about specific questions or phenomena in research. Furthermore, participants' explanations of interactions in specific detail form the basis for discussing qualitative research goals (Baškarada, 2014; Creswell, 2003). The population will consist of hospital pharmacists and pharmacist supply chain staff for this study.

Discussion of Sampling. Purposeful sampling is a method commonly used in qualitative research to recognize and pick cases rich in knowledge for the most productive use of limited resources, especially informed about a phenomenon of concern or familiar with it (Creswell & Plano Clark, 2011). Creswell and Poth (2018) theorized that a purposeful sampling approach helps the researcher to select the participants and locations for the case study that can provide an understanding of the study's research issue. Pharmacists are responsible for reducing the effects of pharmaceutical shortages by collecting data and tracking the shortage and maintaining contact with the manufacturer's local representatives (Kaakeh et al., 2011). Hospital pharmacists spend much time managing supply disruptions and drug shortages. Hospital pharmacists in the United States spent about 9 hours a week on drug delivery problems, while hospital technicians spent 8 hours a week (De Weerdt et al., 2015).

This qualitative research used fewer study participants to get a more in-depth investigation per subject. Utilizing the technique of purposeful sampling, the appropriate pharmaceutical and pharmaceutical inventory staff were surveyed until nothing new emerged from the study.

Summary of Population and Sampling

To participate in this research study, participants needed to be 18 years of age and older, possess a Bachelor's degree in pharmacy management, supply chain management or a related field, currently work in the field of hospital pharmaceuticals or pharmacy inventory management in the New York City and Long Island area, and have at least two years of work experience in hospital pharmaceuticals or pharmacy inventory management. The participants' research criterion would limit the population number to a sample that could better fulfill the study's goals.

Data Collection

A feature of many qualitative studies is data collection by interviews with participants. The data collected for a particular research issue is known as primary data. Interviews offer the most apparent and concise approach to gathering detailed and rich data on a specific phenomenon. With the primary methods of data collection, a researcher can gather data from the participants ' direct responses. The type of interview used to collect data can be tailored to the research question, the characteristics of participants, and the preferred approach of the researcher. Interviews are most often carried out face-to-face, though the use of telephone interviews to overcome geographical barriers to participant recruitment is becoming more prevalent (Smith, 2005). An electronic interview is one form of interview which is an alternative to the conventional method. Unlike others, this approach may be used to analyze the behaviors, viewpoints, values and individuals' experiences in the study. These interviews may be conducted concurrently and asynchronously. In the concurrent process, the interviewer interacts simultaneously with the interviewees. Some examples are telephone calls, use of webcams and chatting on social networks. Asynchronous interviews are the ones where interviewer and interviewee engage at various times in an interview. Examples of asynchronous interviews are e-

mails, online forums, online questionnaire or social network sites (Parvaresh-Masoud & Varaei, 2018).

Instruments

The researcher is the main instrument of data collection and interpretation in qualitative research (Stake, 2010). It is through the researcher's facilitative commitment that a conversational space is a domain where respondents feel secure about sharing tales about their experiences (Owens, 2006). In a good case study, interviews, reports, archival records, documentation, and visual materials are excellent sources for data collection and analysis (Creswell, 2016). The researcher used the Interview Guide as set out in Appendix A; a method adapted from Asmussen and Creswell (2016). According to Annum (2014), a standard method of data collection in qualitative research is the semi-structured interview. The thorough creation of a qualitative semi-structured interview guide adds to the studies ' objectivity and legitimacy and makes the findings more probable (Kelly, 2010). For this analysis, the interview guide consisted of a collection of specific questions for each participant. Before the interview, the questions were decided upon and formulated using the interview guide. The participants of the study also had the option of completing the interview in writing and submitting the responses via email.

The interview guide addressed the study's core subjects. It provided a structured framework for conversation during the interviews. The aim was instead to broaden the research area by collecting related kinds of information from each participant, by guiding what to speak about to the participants (Holloway & Wheeler, 2010). The researcher determined it was most fitting to use substantive comprehensive, open-ended knowledge questions. The researcher should have continued with an introduction after the introductory portion of the interview guide was done. The researcher then discussed the purpose of the study and secured signed informed

consent. The next step was to provide the structure for the interview and ask the participants if they had any questions before the interview began.

The first set of questions explored the professional and educational history of the participants. It was essential to know precisely how much experience the pharmacists, technicians, and inventory staff have with pharmaceuticals, more precisely, shortages. The next set of questions were the content questions, focused on research questions and sub-questions. The researcher considered this to be the core of the interview. The questions in this section began with the history of pharmaceutical shortages inside the hospital of participants; the manufacturer's position in hospital shortages; the steps are taken, if any, to mitigate or avoid the shortages. In the interview, the final set of questions discusses the use of data in pharmaceutical shortages and whether predictive analytics is an appropriate predictive strategy.

Data Collection Techniques

Interviews and document reviews are the two forms of data collection techniques used in this study. According to Moser and Korstjens (2018), in qualitative research, interviews are among the most common data collection methods. Before collecting data, the researcher had received the requisite permits from the Internal Review Board (IRB) of Liberty University to work with human participants. After securing permissions, the researcher connected with the IRB department of each hospital. The Hospital's IRB also has guidelines in place to protect the patients and the participants of this study. Once the hospital IRB gives their approval, the research can contact the sample of the population that can best support the study. This study included interviews with Pharmacists, Pharmacy Technicians, and Pharmaceutical Inventory Staff. The goal was to interview 10-15 participants for this study. The researcher used personal contacts as well as LinkedIn to contact potential participants.

The semi-structured interview was conducted by the researcher to get as much raw data from the viewpoint of each participant (Creswell & Poth, 2018). The researcher anticipated numerous amounts of data from the interviews. The best way to keep track of the data was by using a recording device. As a part of the participant's consent, the researcher recorded the interview. Also, many researchers may create a "field notes" folder to accompany audio-taped interviews. Field notes enable the researcher to maintain and track observations, environmental conditions, attitudes, and nonverbal signals, which may not be appropriately captured by audio recording (Moser & Korstjens, 2018).

Data Analysis

Qualitative research data analysis is the process of methodically searching and organizing the transcripts of interviews, field notes, or any other non-textual information collected by the researcher to improve the interpretation of the phenomenon. The method of evaluating qualitative data requires mainly the coding or categorization of data (Patton, 2002). In qualitative studies, coding is the essential phase in the data analysis. It fundamentally includes making sense of enormous amounts of data by reducing the volume of raw information, finding significant patterns, and ultimately drawing meaning from data and creating a logical chain of evidence afterward (Wong, 2008). Codes are tags or marks intended to assign identified themes or topics from the data compiled in the analysis. Patton (2002) coding has historically been done manually, using colored pens to classify data and then cut and sort data. Given the advancement of information technology, qualitative researchers are increasingly using electronic methods of coding data (Roberts & Wilson, 2002). In the end, the researcher must still synthesize the data and decode the meanings extracted from the data. The use of computers in qualitative analysis

has, therefore, merely made data organization, reduction, and storage more proficient and manageable (Wong, 2008).

Reliability and Validity

Reliability

Reliability is the degree to which the findings can be replicated on the same conditions when the work is repeated (Yin, 2014). Bloomberg and Volpe (2019) reported that if qualitative work is accurate, then consistent findings will be made by researchers investigating the same phenomenon. This research would illustrate reliability by continuously using the same methodology and procedures to ensure that each participant has the same opportunities for semi-structured interviews to identify and explain their perspectives. Reliability was achieved for this qualitative study mainly through a detailed and reliable interview process, guided by a semi-structured interview guide, and thorough interview recording transcripts. Lack of reliability in a study may lead outside reviewers to become skeptical of case studies as a form of analysis (Yin, 2014). The goal of reliability is to diminish bias and errors within the study (Yin, 2018). This study used triangulation to test both reliability and to show the reliability of the data and findings obtained. Triangulation refers to the use of several approaches or data sources to establish a detailed understanding of the phenomenon in qualitative research (Patton, 1999). During the analysis, the researcher made specific observations helping to provide data on the phenomenon for testing.

Validity

Validity in qualitative research means that the methods, procedures, and data are correct. Construct validity makes sure the study's operational measures are correct (Yin, 2018). The semi-structured interview was ideal for gathering the data needed to address the research

questions, as the interview guide gave the researcher a template to follow while collecting the data. The first part of the interview guide is the tool used to collect basic data about the participant's education and experience with hospital pharmaceuticals. The second part of the interview guide helps the researcher collect data about the content. The content data evaluate the experience of the participant in their respective New York hospitals is in shortage of pharmaceuticals. This study defines manufacturing as a cause for pharmaceutical shortages, so the participants are asked about the impact of drug shortages because of manufacturing issues. The final part of the interview guide explores the theory of using data, specifically predictive analysis, as a potential solution to decrease the increasing pharmaceutical costs of hospitals. The semi-structured interview guide allowed the researcher to probe the respondents when they needed clarification of their answers and more in-depth insight into a specific viewpoint. The interviews helped the researcher to gather data on each of the themes found.

Fusch and Ness (2015) noted that researchers use saturation to determine when there is sufficient data from a study to create a reliable and accurate understanding of the research phenomenon. With saturation, a researcher can reasonably be confident that further data collection can produce similar results and help to validate emerging trends and conclusions. If researchers may claim to have collected enough data to accomplish their research objective, they should disclose how, where, and to what degree data saturation achieved. Failure to attain data saturation affects the consistency of the research performed and hampers the validity of the content (O'Reilly & Parker, 2012). There is a clear connection between the triangulation of data and saturation of data; one (triangulation of data) guarantees the other (saturation of data). In other words, data triangulation is a way of achieving data saturation (Denzin, 2012).

Transition and Summary of Section 2

This qualitative case study examined the rising costs of hospital pharmaceutical shortages and the impact on patient care: exploring the use of predictive analytics in New York area hospitals. The role of the researcher was to act as a facilitator. The researcher identified participants, conducted an interview, and analyze the data from the interviews. The participants included pharmacists, pharmacy supply chain managers, and clinical support staff that have experience with hospital pharmaceuticals and shortages. This study used the qualitative research method and the qualitative case study research design. The target population included the participants that fit into the research study selection criteria. The data collection method for this study was semi-structured interviews. The instrument was the researcher and the interview guide. The data, collected via transcriptions and field notes, was organized, analyzed, coded, and themed. The main component of all work is validity and reliability. Careful attention to these two things will make the difference between good research and bad research and can help ensure that the results are reliable and trustworthy.

The third section of this study included the overview of the study on the rising costs of hospital pharmaceutical shortages and the impact on patient care: exploring the use of predictive analytics in New York area hospitals. Section 3 continued with the presentation of the findings, applications to professional practice, which includes implications of findings and biblical framework and field of study. The final part of Section 3 consisted of the recommendations for further study, reflections of the researcher's experience, and the summary and study conclusions.

Section 3: Application to Professional Practice and Implications for Change

The last section starts with a study overview. Next, the researcher presents the findings and discusses professional practice applications. The application follows recommendations for action and prospects for future research. The researcher reflects on the experience, including personal prejudices, thought shifts, and the study findings from a biblical worldview. This section will conclude with an analysis of the overall study, including proposals for further studies on pharmaceutical shortages in hospitals.

Overview of the Study

This study examined the rising cost of hospital pharmaceutical shortages and the impact on patient care. It further explored the use of predictive analytics as a tool to forecast and potentially reduce costs. Hospital pharmacists worldwide are challenged with ensuring a growing number of patients receive sufficient medication supplies while preserving the financial balance of pharmacy budgets (Juhász et al., 2016). Various factors can cause shortages of pharmaceuticals, but the fundamental causes that may occur within hospital pharmacies are issues with manufactures, lack of data and communication flow, increased demands, inadequate inventory control, changes in clinical practice, and natural catastrophes (Shrestha et al., 2018). The recent effects of COVID-19 on hospital pharmaceuticals have made the FDA regulate the supply chain of prescription goods strictly in the anticipation that it may be impacted by the COVID-19 outbreak, possibly leading to delays of supply or shortages of drugs products in the United States. FDA recognizes the considerable effect this can have on patient care and is doing everything to help avoid and mitigate shortages in healthcare institutions (FDA, 2020).

This study aimed to understand the factors behind the rising cost of hospital pharmaceutical shortages relating to manufacturing problems and the impact on patient care. The

researcher used the methodology of a qualitative case study to provide the tools to study complex phenomena within their context. Upon proper implementation of the method, developing theory, reviewing projects, and designing strategies is a valuable tool for health science study (Baxter & Jack, 2008). The researcher conducted interviews virtually and in writing to answer the research questions:

RQ1. How are hospitals challenged by the rising costs of hospital pharmaceutical shortages due to manufacturing problems?

RQ2. What role does supply and demand management play in hospital pharmaceuticals?

RQ3. How would predictive analytics improve patient care inefficiencies relating to rising costs of hospital pharmaceutical shortages?

From these questions, the researcher constructed open-ended interview questions for participants to answer (Appendix A). The researcher was able to create a more comprehensive picture of the phenomenon by interviewing multiple people with different experiences.

After receiving the approval from Liberty University's IRB, the researcher reached out to potential participants who would be qualified to participate. Participants needed to be 18 years of age and older possess a Bachelor's degree in pharmacy management, supply chain management or a related field, currently work in the field of hospital pharmaceuticals or pharmacy inventory management in the New York City and Long Island area, and have at least two years of work experience in hospital pharmaceuticals or pharmacy inventory management, and are willing to participate. Participants had to have experienced pharmaceutical shortages at the hospital where they work. The researcher initially planned to conduct interviews in person; however, due to the current COVID-19 pandemic, social distancing, and city lockdowns, interviews had to be done virtually or in writing. The recruitment of potential participants included the use of phone, email,

and LinkedIn messenger. Out of the 28 potential participants contacted, 10 were qualified and agreed to participate. Three of the participants were from hospitals in Long Island, and the remaining seven were from hospitals in the New York City area. A 3-digit and 2-letter identifier was assigned to each participant to protect the privacy of the participant. The presentation of findings addressed research questions along with quotations from study participants.

Anticipated Themes/Perceptions

During the interviews, the researcher had anticipated hearing particular themes before the data collection. Such perceptions and themes resulted from the vast amount of studies and papers read during the literature analysis process. The researcher anticipated the participants would agree that hospital pharmaceutical shortages have adverse effects on patient care, such as insufficient treatment, under-optimal care, delayed or surgery cancellation (Rosoff, 2012). Furthermore, drug shortages can challenge the patient-physician relationship. It was also perceived that pharmacist would say that they are one of the first to face pharmaceutical shortages in hospitals. There was great anticipation that data would play a significant role in pharmaceutical inventory, either not being reliable for the lack thereof. The researcher perceived that there would be similarities in the highest cases of pharmaceuticals.

During this study, the world entered into a global pandemic, Coronavirus, or COVID-19. The researcher anticipated the discussion of the effects of COVID-19 and pharmaceutical shortage would dominate any other shortages that hospital pharmaceuticals face. Moreover, the researcher expected that there would be a theme of health systems banning together to tackle the most difficult of shortages to ensure the entire health system is covered.

Presentation of the Findings

This qualitative research study examined the rising cost of hospital pharmaceutical shortage and the impact on patient care. Furthermore, this study explored the use of predictive analytics as a possible solution to reduce costs. This study's general findings were based upon cases from 10 participants who worked in hospitals in New York City and Long Island. The sample resulted in the following demographics:

Figure 2

Participant Demographics
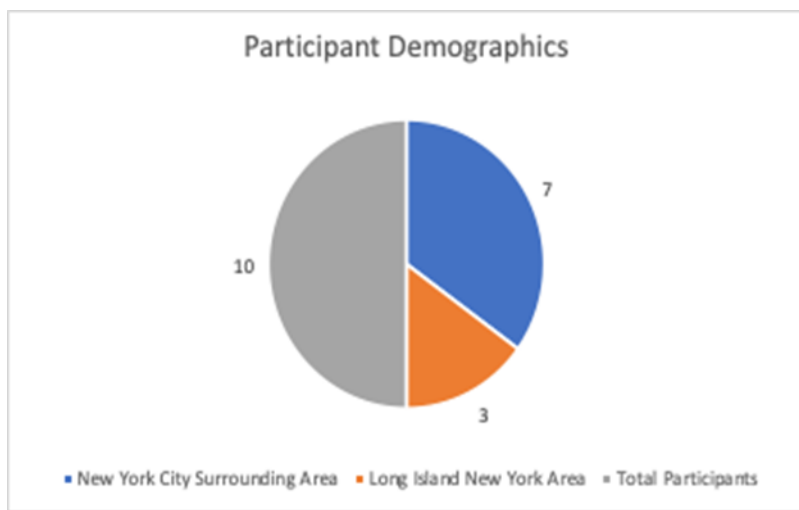
Due to the academic requirement of a bachelor's degree, the researcher could not qualify for potential participants in the population. Each participant had relevant knowledge of hospital pharmaceutical shortages at different levels of the supply chain process. Early in data collection, the researcher learned that a significant pattern occurred, which would change the study's anticipated results. That pattern would be the novel Coronavirus (COVID-19) effects and the havoc it wreaked on hospital pharmaceuticals and patient care. The data were collected and triangulated by interviewing 10 participants from hospitals in New York City and Long Island. The participants had sufficient experience in pharmacy and medication shortages. After the

seventh participant, saturation was reached as it became evident that no further new information would emerge.

Section 3 also described the themes that emerged from the study and how the themes relate to the research questions. This section of writing also includes several quotes from participants. Last, this section of the writing consists of a summary of the findings.

Qualitative Data Analysis

This section will present the data by theme/pattern/relationship. The researcher used interview transcripts and written interview responses to develop emerging themes through the open coding process, based on the main concepts. After the open coding process, axial coding was conducted to create categories from the concepts and connections through the emerging themes (Williams & Moser, 2019). The researcher used Microsoft Excel to organize and examine the data. The themes that emerged from this qualitative multiple case study included manufacturing issues are the main cause of hospital pharmaceutical shortages, supply and demand management is just as challenging as shortages, and there are pros and cons to using predictive analytics. The concepts were essential for the rising cost of hospital pharmaceuticals, and the impact of patient care, exploring the use of predictive analytics. The questions and information gathered in the literature review were also related to the research findings. Furthermore, within the conceptual framework, there was an in-depth exploration of the themes and relationships. Table 1 illustrates the major and minor themes relating to the research questions.

Table 1

Major and Minor Themes

	Research Question	Major/Minor Theme
1	How are hospitals challenged by the rising costs of hospital pharmaceutical shortages due to manufacturing problems?	Manufacturing issues are the primary reasons for hospital pharmaceutical shortages. Alternatives/Replacement Pharmaceutical Raw Material Shortage Natural Disasters
2	What role does supply and demand management play in hospital pharmaceutical shortages?	Supply and demand management is just as challenging as shortages. Greater Transparency Prepared for Shortages COVID-19, the global pandemic
3	How would the use of predictive analytics improve patient care inefficiencies relating to rising costs of hospital pharmaceutical shortages?	There are pros and cons to using predictive analytics. Pros & Cons & COVID-19

Emergent Theme Relation to Research Questions

Research Question 1. How are hospitals challenged by the rising costs of hospital pharmaceutical shortages due to manufacturing problems?

MajorTheme 1/Research Question 1

The major theme of the first research question is, "Manufacturing issues are the primary reasons for hospital pharmaceutical shortages." Interview questions 1a, 1b focused on hospital pharmaceutical shortages due to manufacturing problems. Drug shortages may be related to manufacturing problems such as manufacturing or quality issues, API problems, failure to comply with regulations, capacity, or quality issues, to name a few. A problem encountered at a single manufacturing site may well lead to significant disruptions in the global market. All

participants agreed that manufacturing issues were the primary reason for hospital shortages (Bogaert et al., 2015).

Minor Theme 1. Minor theme 1 is alternatives/replacement pharmaceuticals. Drug shortages affect individual services for patients, families, hospitals, and public health. Patients should be notified before receiving alternative pharmaceutical treatment. Alternative drugs are occasionally approved in a hurry, and sometimes patients are the last to know about the necessary changes in treatment. Although such alternatives may produce something the same or better, they often have no impact, or even worse (Scott et al., 2015).

> Participant 004 responded that the physician and pharmacy leadership, along with any related specialists, will meet and assess supplies and any appropriate alternatives. The nature of the shortages and alternative medicines used will be communicated to all providers, nurses, and pharmacists.

> Participant 008 commented that getting substitute drugs during shortages is very challenging.

According to Gray et al. (2005), the provision of alternative medicines by substitution must be made with the patient's consent. It is agreed that pharmaceutical replacement is best performed only in hospital settings. It is vital to formulate a clear strategy for the introduction of pharmaceutical substitution with all concerned.

> Participant 007 remarked, the most significant challenges that occur with pharmaceutical shortages are finding a replacement product and then having to communicate the change and provide any necessary education regarding the replacement product to the end-user. The goal is patient safety, and we never want to introduce a product that can cause confusion on the part of the nursing staff and cause harm to any patient.

The patient is more likely to be satisfied and grateful if the unavailability of the prescribed medicine and its substitute is explained. The hospital makes every effort to obtain and supply the medication that was initially prescribed (Assefa et al., 2011).

> Participant 009 replied that whenever we replace a medicine, we provide something the treating physician didn't intend to do. But if we are unable to provide medicines that make what we do successful, then all our efforts will be for nothing.

> **Minor Theme 2**. Minor theme 2 is the raw material shortage. According to Caldwell et al. (2016) manufacturers should ensure that environmental protection is a crucial criterion when awarding work to their subsidiaries or third-party organizations, regardless of where they might be situated in the world when it comes to APIs. Medicine shortages can lead to higher costs and reduced quality and safety of treatment, as unavailable drugs continue to be replaced by much less effective medicines, which can be much more costly (Horgan & Doeswijk, 2017).

> Participant 007 stated the raw material shortage also referred to as a shortage in Active Pharmaceutical Ingredients (API), can lead to multiple manufacturers unable to produce products, thus creating a lack. API comes from China and India, and any issues that occur that are related to the quality of API coming out of these countries will lead to drug shortages.

> Participant 003 adds that manufacturers have to ensure up their API (active pharmaceutical ingredients) from vendors they may be getting at the same time. Such shortages are especially troublesome when several producers are affected by a primary source supplier of raw material delays or discontinuing production.

Another common explanation behind medication shortages are shortages of raw material for the manufacture of active substances or other ingredients (Heiskanen et al., 2017). Raw material

shortages are a global problem, partially because the consequence is a small number of operating companies with lengthy or complicated supply chains.

Participant 006 stated that the problem arises when many finished goods producers rely on subcontractors, who depend on a specific dealer of raw materials. The raw material is not transferred to the subcontractors and on to the producers when the raw material dealer faces their production quality problems.

Minor Theme 3. Minor theme 3 is natural disasters. Natural disasters can have a significant impact on the supply of pharmaceuticals. Completed pharmaceuticals or suppliers can be affected by floods, hurricanes, fires, and tornadoes. Destruction to manufacturing facilities caused by natural disasters, mainly if the site-produced product is a sole-source product, can cause long-term shortages (Fox et al., 2009). A shortage of many medications occurred in Puerto Rico in 1998 when hurricane George destroyed pharmaceutical facilities. In 2005, hurricanes Katrina and Rita resulted in a spike in demand for and a shortage of such medications.

Participant 008, replied all pharmacies should have contingency plans for shortages and emergency purchases of medicines. Natural disasters can worsen drug shortages as they generate increased demand for the medications needed to treat the victims of disasters. Participant 005 comments there have been many shortages in the last eight years due to materials shortage or natural disasters like hurricanes. After Hurricane Sandy, a lot of pharmacies were closed, and people could not get their medications.

In September 2017, Hurricanes Irma and Maria hit Puerto Rico. The loss of power and water supply, severe flooding, and the deterioration of communications presented Puerto Rican citizens with a big challenge. The pharmacist's functions follow a disaster in such settings that include both clinical services, such as providing direct patient care and logistical services, such as

managing drug delivery. As pharmacists' role expands throughout health care, making use of their skills during a disaster might increase access to care (Jiménez-Mangual et al., 2019).

Participant 009, replied that ensuring that the supply chain for health care works reliably and without interruption during natural disasters requires active cooperation across the healthcare sector.

Research Question 2. What role does supply and demand management play in hospital pharmaceutical shortages?

Major Theme 2/Research Question 2

The major theme for the research question 2 is that supply and demand management is just as challenging as shortages. Interview questions 2.b, 2.c focused on the pharmaceutical shortage challenges and the role of supply and demand. All the participants agreed that problems with the supply and demand for prescription products constitute a significant concern that concerns healthcare organizations. Hospitals can reduce the impact of shortages by creating a robust supply and demand management system before they occur (Fox & Tyler, 2017). Changes in demand were often triggered by daily seasonal market fluctuations and shortages faced by many pharmaceutical firms, which was almost impossible to foresee (Heiskanen et al., 2017). Drug supply problems are an increasing and global problem. Pharmacists at the hospital are trying to manage the drug supply problems to minimize the impact on patient care (De Weerdt et al., 2017).

Participant 004, replied that when a shortage is detected, pharmacy workers will determine the on-going inventory and estimate the period covered by it. Also, having a second drug wholesaler can be beneficial.

Managing inventories is challenging in the face of shortages. Pharmacists at the hospital spend a great deal of time handling supply delays and drug shortages. In the United States, hospital technicians spent about 8 hours a week on drug delivery problems, while hospital pharmacists spent 8 hours a week. Although preparing for any possible shortage is unrealistic, careful preparation will minimize adverse effects on medical care costs and coordinate healthcare and avoid crises from escalating into a crisis. (De Weerdt et al., 2017)

Participant 002 stated that hospital supply chains are incredibly effective at what they do; however, in the middle of a pandemic that requires pharmaceutical drugs of all kinds, you can never be fully prepared.

Participant 010 said a team called procurement and strategic sourcing (PSS) in the supply chain field. This team focuses on the acquisition of supplies/drugs in situations such as back-orders, and this is directly related to drug shortages, which means that with history, natural disasters (Hurricane Katrina), we've been through a lot and come through, this shows preparedness for anything.

The highest case of shortages according to each participant is captured in Figure 3.

Figure 3

Most Common Pharmaceutical Shortages
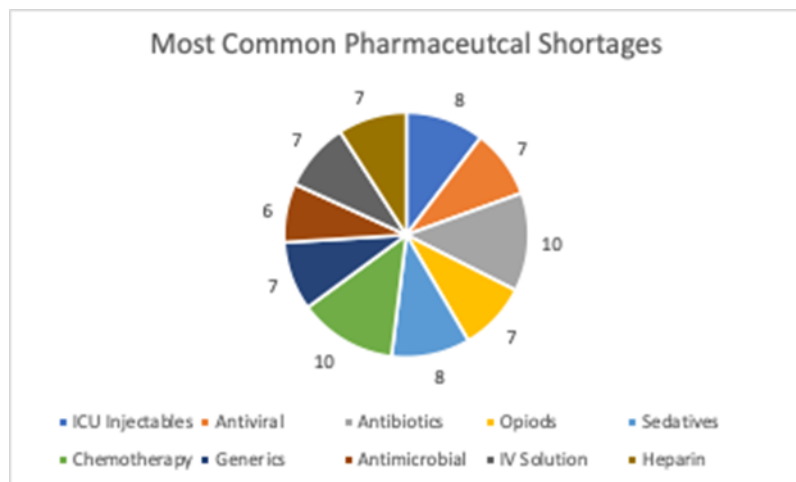
Minor Theme 1. Minor theme 1 is supply chain preparedness. In some hospitals, there is first a supply disruption. A supply disruption can quickly turn into a supply shortage if not resolved correctly. When hospital pharmacists are aware of the possibility of a shortage of medications, they frequently search for alternative products from other sources. When many hospital pharmacists order from the same manufacturer the same alternative drug, the latter manufacturer may not be able to satisfy the unexpectedly increased demand, resulting in a domino effect of supply issues with various suppliers (Caulder et al., 2015).

When asked if the participants felt that their hospitals were prepared for shortages, the answers varied. These responses were based on daily supply chain shortages, and when it came to the novel Coronavirus, their perceptions were different from those addressed in the minor theme 3. Inefficient pharmaceutical supply chain management activities often contribute to significant shortages and inefficiencies in supplying essential healthcare supplies. A shortage happens when a product is not available commercially to meet the demand (Saedi et al., 2016).

Participant 001 replied that their hospital was not prepared for pharmaceutical shortages. The type of distribution system that a hospital has makes a difference. Space is minimal at the hospital; if I wanted to buy bulk pharmaceuticals, there is no space to store them.

Participant 010 replied that their hospital is not as prepared as it should be. Since several of these triggers are unavoidable, they are working to properly manage a hospital inventory to reduce shortages and improve treatment standards.

Given the unpredictable effect and complex existence of drug shortages, organizations must establish a triage plan for threatened on-hand pharmaceutical supplies (Rhodes et al., 2016).

Participant 007 and Participant 005 agreed that supply and demand is the key issue with drug shortages, and that they are prepared for shortages.

Participant 003 stated that they are in better shape than they were ten years ago. In their hospital, it is the norm. Moreover, given the severity of the shortages from a quality of care and cost perspective, the goal is to reduce national hospital shortages.

Minor Theme 2. Minor theme 2 is greater transparency. Drug shortages tend to be complicated by uncertainty about the nature and quality of the information available and the duration of the shortage. Lack of transparency leads to the current shortage of drugs, a crucial health care problem that restricts treatment choices, reduces access to medicines, and may jeopardize patients' well-being in need of substantial therapies (Rhodes et al., 2016).

Participant 001 said that only a handful of primary suppliers in the world could be supplying the raw shortage of goods for most of the generic products. And while they rely heavily on them, there is not much transparency.

Participant 003 replied that it would be helpful if a manufacturing plant needs to shut

down; they can let the competitors know to step in and meet the market demand. It may

not make sense for the competitor to share information like that, but it will help the

hospitals in which they live from an ethical perspective.

Transparency in the data available on the supply chain could help to prevent future drug

shortages. Pharmaceutical manufacturers usually know where the drug raw materials originate.

But these data are kept confidential by every company, and even the F.D.A. has no structured

way of looking at drug development and supply chain efficiency (Bogaert et al., 2015).

Participant 007 agreed that there should be more transparency, such as using the

information obtained from the wholesalers and buyers who work directly with the

manufacturers to see if it is an actual shortage or just delays in shipping products to the

wholesalers. If need be, they should place direct orders with the manufacturers to bring in

the product before it goes to the wholesaler.

Minor Theme 3. COVID-19, the global pandemic. COVID 19 caused a massive shock to

the demand for healthcare systems that are already running close to full capacity. The

coronavirus pandemic directly affects the supply chains of nearly every manufacturer, retailer,

and wholesaler. While the world continues to maneuver through this hard period, most

businesses struggle to continually supply the products and services needed (Sharma et al., 2020).

Every participant has their own experience of how COVID-19 affected hospital pharmaceuticals.

Participant 010 replied that managing the demand requires efficient approaches to control

patient care's resource supply. It is not an easy job when coping with a highly infectious

disease such as COVID-19.

Participant 003 noted that this whole pandemic would change how the inventory is

managed; typically, they want to be lean as much as possible. Still, in the light of what

has happened, it will change the way inventory is managed. Like, for example, instead of

trying to keep a very minimal supply on hand, people feel more comfortable having a lot

more on the side just in case.

COVID-19 has affected the supply chain and its ability to respond to the crisis. Personal

protective equipment, masks, ventilators have been hit hardest by supplies. The scarcity is

attributed to the susceptibility of the supply chain. For instance, China has been producing

approximately half the world's face masks before COVID-19. However, with COVID-19

spreading across China, the country could not export the necessary medical pieces of equipment

(Sharma et al., 2020). The best way to capture the impact is through the eyes of the practitioners

who struggle firsthand.

Participant 008 stated hospitals need to review their supply chain methods, supply chain

structures, and supply chain interactions to prevent behavioral responses to potential

pandemics and train themselves to handle unforeseen disruptions.

Participant 007 replied that they are fortunate to be a part of a health system. As such,

they can move needed product around to hospitals that may have run out of a product.

The shortages occurring during COVID-19 were related to increased demand over and

above a hospital's typical purchase pattern. Hospitals needed more products than they had

previously ordered, and drug wholesalers were not ready. To mitigate shortages, they

went directly to the manufacturer for the product, enabling them to obtain the number of

products needed to treat our patients.

Participant 002 commented that they anticipated a shortage due to COVID-19. They

contacted all of their partners in the pharmaceutical world to see if they can order in bulk.

They received a bulk shipment of drugs, and that has helped them stay afloat. The only

other thing they can do is follow the FDA's guidance as they work closely with

manufacturers.

Research Question 3. How would the use of predictive analytics improve patient care

inefficiencies relating to rising costs of hospital pharmaceutical shortages?

Major Theme 3/Research Question 3

The major theme for the 3rd research question is that there are pros and cons to using

predictive analytics. Interview questions 5, a-d focused on the thoughts of using predictive

analytics as a forecasting tool. Most healthcare systems are struggling to control rising costs and

effectively distribute scarce resources. Predictive analytics can help find an individual choice of

drugs for each patient, which can reduce costs. Predictive analysis involves extracting

information from existing data sets with an appropriate degree of accuracy and reliability to

forecast results and trends. Predictive analytics is a method by which data is analyzed and

modeled using machine learning (Jhajharia et al., 2015). Nine of the ten, the participants were

familiar with predictive analytics, but their views differed about it being a tool that will help with

forecasting and preparing for shortages. However, six of the ten participants related using

predictive analytics with COVID-19 pharmaceutical shortages.

Participant 001 replied that predictive analytics would help to confirm potential

shortages. It would be difficult for a system to know that this is a shortage and that this is

going to be a problem and that this other drug, which is also useful in this situation, is

also going to be in short supply because there are just so many different indications that it

would be too complicated for a system to narrow it down. However, for COVID-19, it may be easier to determine, mostly because they have seen the types of medicines used to treat most of these patients, and they are better able to look at the supply chain and see which ones will be more problematic.

Participant 007 replied that on a typical day, a predictive model might help predict shortages for their most common pharmaceuticals, but for COVID-19, all they can predict is that it maybe ten times worse the second time around.

Participant 009 was not aware of predictive analytics until the researcher gave the definition. After the explanation, they replied that it might have been a great tool to use with the COVID-19 pharmaceutical shortages, but only after the third week into the pandemic, as they had what pharmaceuticals were needed initially.

Participants 002 and Participant 005 felt that predictive analytics was a new science that would need further study.

According to Sohrabi et al. (2019), pharmaceutical marketing and sales managers in hospitals also work with massive marketing and sales data quantities. One of their most significant issues is to consider the effects of drug shortages. Data mining finds and removes useful patterns to identify secret and worthy decision-taking trends from these large data sets.

Participants 004 and 006 commented that pharmaceutical managers want to change and enhance their current marketing contacts and introduce brand building strategies to gain competitive advantage. They thought that predictive analytics should prioritize and define patterns so that marketing and sales managers would plan effectively and optimally to avoid wasting time and resources, better manage their medical representatives and contribute to higher pharmacy sales.

Providers use data from their health information system to identify trends and patterns in drug use in hospital pharmacies and establish strategies wherever possible to repackage bulk drugs into smaller unit dosages (Malik et al., 2018).

Participant 009 later remarked that predictive analytics may be beneficial in the repackaging exercise.

Participant 010 stated that the robustness of the data will depend on this. Often there are shortages due to freak chances such as earthquakes, COVIDs and other impactful events.

Opportunities should be given to the pharmaceutical industry to manufacture medicines for the smaller classes. In other words, if they are found not to help all of those who have been prescribed, previous large bulk medications will certainly be less used. Old drugs should be put back, discarded because the hospital did not use them, as drug manufacturers would find it economically viable to do so (Malik et al., 2018).

Relationship of Themes to Conceptual Framework and Literature Review

The themes and patterns presented in the findings align with the focus of the conceptual framework and the literature review in the first section of the study. Table 2 illustrates the relationship of the themes to the conceptual framework and literature review.

Table 2

Theme Relation to Conceptual Framework and Literature Review

Research Question 1 – Theme - Manufacturing issues are the primary reasons for hospital pharmaceutical shortages. How are hospitals challenged by the rising costs of hospital pharmaceutical shortages due to manufacturing problems?
The importance of hospital pharmaceutical efficiency. Deficiencies in the prescription and excessive use of pharmaceuticals can cause financial losses and affect patients in a significant way. According to Bogaert et al. (2015), shortages due to manufacturing problems typically

last longer than those due to supply chain problems. Thus, when a manufacturing problem arises, a whole supply chain is often needed to be withdrawn from commission.

Rising costs of hospital pharmaceuticals shortages. Pharmaceutical shortages of drugs have become more frequent and progressively severe since 2004. Also, shortages have a greater impact on patient care and have become longer in duration. The increase in healthcare costs would empower hospitals to strategically plan the supply chain so that they can manage prices, predict demand shortages, and better meet their healthcare needs (Edmunds, 2016).

Research Question 2 – Theme – Supply and demand management is just as challenging as shortages. What role does supply and demand management play in hospital pharmaceutical shortages?

Pharmaceutical supply and demand management. The components of a hospital pharmaceutical inventory are a sizeable operating expense. Most health facilities and emergency departments face difficulties in achieving successful inventory control as they have neglected how pharmaceuticals are regulated, distributed, and used to save lives and improve well-being (Uthayakumar & Priyan, 2013).

Research Question 3 – Theme –There are pros and cons to using predictive analytics. How would the use of predictive analytics improve patient care inefficiencies relating to rising costs of hospital pharmaceutical shortages?

Business strategy and predictive analytics. Implementing a business plan and developing procedures would help handle the pharmaceutical inventory in hospitals. Usage of the most innovative cutting-edge front-line technologies is critical to stay competitive and essential in today's markets. For supply chain executives, aiming to improve today's fragmented supply chains' adequacy, critical predictive analytics is a learning gathering that can help increase productivity and reduce costs (Parniangtong, 2016). McKesson (2019) suggested predictive ordering (analysis) is a strategy that can improve the hospital supply chain of pharmaceuticals by using data to track ordering habits. With the data, the percentage of manual ordering decreases while the focus of ordering standardization increases.

The researcher concluded that data saturation was reached after completing seven out of the ten interviews, as participants were giving no new input. According to Creswell and Poth

(2018), data saturation is the stage where sufficient knowledge was collected to establish an analysis in full. Additionally, the data collected were triangulated by comparing the cases and identifying commonalities and differences among participant responses. According to Stake (2010), triangulation uses multiple data sources to facilitate interpretation from different perspectives. Also, to ensure accuracy, the researcher compared participants' opinions and suggestions with existing research on pharmaceutical shortages.

The findings showed multiple viewpoints. The themes were derived from the analysis of findings from interviews in a qualitative, multiple case study. The major and minor themes that emerged for each research question were:

RQ1: Manufacturing issues are the primary reasons for hospital pharmaceutical shortages. The minor themes: alternatives/replacement pharmaceutical, raw material shortage, and natural disasters.

RQ2: Supply and demand management is just as challenging as shortages. The minor themes: greater transparency, prepared for shortages, and COVID-19, the global pandemic.

RQ3: There are pros and cons to using predictive analytics. The minor theme: pros and cons and COVID-19.

A common form of analysis within qualitative research is searching for meaning patterns in the data to identify central themes. One discounted analytical strategy in qualitative data analysis is how researchers respond to and potentially use exceptional data. Data that tell us something about a central theme deviates significantly from its defining plot and characteristics (Phoenix & Orr, 2017). For this study, the researcher learned early in the data collection that the Coronavirus (COVID-19) would be an exceptional outlier. In examining the rising costs of hospital pharmaceutical shortages and the impact on patient care, the researcher did not expect

that there would be a global pandemic that would deviate the study from day to day pharmaceutical shortages to the shortages caused by COVID-19. The current shortage of vitally needed drugs is a dangerous situation that is exacerbated by the COVID-19 pandemic.

Lack of tests, masks, other personal protective equipment, and ventilators threatens to worsen our state. Unfortunately, however, we are already in the midst of another devastating problem: the scarcity of medicines essential for COVID-19 management. Medication shortages anticipated to worsen with time, directly affect COVID-19 patients, and pose a threat to the health and safety of non-COVID-19 patients with other illnesses (Choo & Rajkumar, 2020).

Like other at-risk services in this crisis, shortages of drugs have been invisible but endanger our ability to resolve this pandemic and patients' health with other diseases. Shortages include medications known as effective COVID-19 treatments, such as chloroquine and hydroxychloroquine. In reality, hydroxychloroquine is now difficult to access because of off-label prescriptions and hoarding for patients without COVID-19 who need this medication to treat rheumatoid arthritis and other autoimmune disorders. The fragility of the complex supply chain of medicinal products has not been generated overnight, and yet we must overcome its limitations quickly and effectively (Lee, 2020).

Applications to Professional Practice

This sub-section analyzed the applicability of findings to the professional practice of business. Moreover, this section also addressed the biblical context and the strategic management field of study. This research will benefit hospital pharmacies, hospital pharmaceutical supply chains, and aide in the planning for the effects of pharmaceutical shortages during a global pandemic. Only half of the ten participants in this study felt their hospital is prepared for

shortages. However, none of the hospitals represented by the participants had a one-size-fits-all plan on how to manage during a pharmaceutical shortage strategically.

Improved Business Practice

Hospitals recognized the need to improve their pharmaceutical operations by strengthening their overall supply chains by combining processes such as sourcing, inventory management, and demand forecasting to plan and meet the expected product demand (AlAzmi & AlRashidi, 2019). Although drug shortages are a chronic problem, an increasing number of hospitals and healthcare facilities are putting in place teams and strategies to address the logistical and ethical challenges of shortages to better anticipate and cope with them. As stated by Participant 003, establishing a strategy and procedures will help a hospital respond rapidly when there is a shortage and alleviate some of the effects (personal communication, July 5, 2020).

Identifying supply chain shortfalls and mitigation strategies. The findings show that hospitals identify shortfalls in supply chain management systems and discover areas for prevention and cost reduction of future shortages. Hospital pharmaceutical leadership should consider creating a strategy to address drug shortages. The strategy should include three stages, according to the American Society of Health-System Pharmacists (ASHP) evaluation, planning, and contingency (Hoffman et al., 2008). Participant 001 backs this concept by commenting that strategy should include a unique process because every single drug requires a unique solution and guidance (personal communication, June 30, 2020). More significantly, the right drug management approach for the system and organization will strengthen patient safety by encouraging more efficient response to urgent needs. In reality, pharmacies are best able to reduce shortages entirely by recognizing trends for enterprise drug use and channeling necessary

drugs to the right places. Real-time inventory visibility makes it easy to identify the drug's quantities and locations when there is a shortage (Mokgatlha & Kadama, 2017).

Learning from COVID-19 and planning for the future. Participants 002, 007, and 010 identified several approaches to reduce the effect on patient health and treatment from drug shortages in the second wave of COVID-19. According to the same participants, addressing drug shortages due to the pandemic cannot be addressed using institutional-level approaches. Instead, it requires the intervention of international health and regulatory bodies at national and occasionally. The value of preventing drug shortages and finding solutions has become more prevalent in the COVID-19 pandemic context. Because of COVID-19, the rapidly increasing demand for pharmaceutical products puts added pressure on hospitals and health systems to better maintain the inventory of medicines to sustain patient care. There is a shortage of effective drugs used to ease breathing issues, relieve discomfort, and sedate patients with coronavirus.

Hence, hospital pharmacies also need inventory- and shortage-management strategies to survive the surge (Sharma et al., 2020). Since much of the world has outperformed COVID-19's first wave, pharmacies can be pushed through infrastructure and technology to improve inventory management processes that increase visibility and help managers make better choices. Where health providers can adjust and monitor expenditure to the entire network's needs, there are significant positive effects on the bottom line and on the bottom line (personal communication, July 3, 2020).

Use of Strategic Management. Since the birth of "business planning" and "business policy" in the 1960s, the strategic management field has grown considerably. Pioneering experiments were essentially conventional, customary, and mostly focused on profound case studies. The development of strategic management into a recognized academic research area has

resulted from the introduction of commonly used analysis methods in economics (Dagnino & Cinci, 2015). The study revealed a need for continued research on communication between manufacturers amid a shortage. Every manufacturer has systems in place to track, manage orders, and monitor supplier performance. However, manufactures are sometimes not forthcoming with their information. The manufacturing sector needs to generate, share, and disseminate up-to-date information to survive and compete in today's global economy. The real value of information exchange within the supply chain can be determined by the fact that the benefits received outweigh the costs involved. Coordination and alignment of supply chain management (SCM) have long been the concerns of both the academic and business community (Nunes et al., 2006).

There is a Need for Pharmaceutical Inventory Automation. The study also revealed that there is a need for further exploration of the use of inventory automation. According to Acosta et al. (2019), it is crucial to create a consensus to construct or adopt definitions of shortage and scarcity, and to define all local definitions, to produce a glossary relating to inventory automation and the availability of medicines to encourage the collection of data from various sources and to manage potential situations better. It is also important to remember that if there is a shortage due to logistical and availability constraints, and it is not feasible to deliver prescription products on time, alternative paths must be approved and communicated effectively. Automating analytics functions allows for fast par-level changes, which, in effect, helps ensure that essential drugs are not stored in a hospital (Bogaert et al., 2015).

Participant 008 stated that the drug inventory level should be monitored, but acquisition speed is also relevant. Partnerships with suppliers to optimize process parts may affect

how easily alternative products can be inserted into a shorted product (personal

communication, June 25, 2020).

Hospitals, regulatory bodies, and academia need to tackle the shared problem of lengthy

and expensive medical product development programs with high attrition rates and lack of

automation in the face of these challenges. This involves well-structured translational sciences

and pre-competitive research and the curriculum's requisite background for which planning and

building skills are essential. For the success of pharmacology as a discipline, standards,

automation, knowledge sharing, and applied focus training are important (Woodcock, 2010).

Often, an automated device may be used to inform inventory management if the drug demand is

down. Pharmacies should be informed whether there is a newer medication with improved

clinical results available. Automation can alert the pharmacy to the shift in traditional

prescription habits, and whether the PAR levels need to be adjusted, which is the number of

drugs they need to have on-site at any time in safety. To be more effective purchasers,

pharmacies need time and skill to collect data from their automated systems. As more successful

consumers, they save money and cut waste (Bogaert et al., 2015).

Invest in Systems and Human Capital. In addition to the recommendation for

automation, strengthening an organization's commitment to providing efficient patient care, an

investment should be made for both systems and human capital. A few participants in the study

expressed their frustration with the lack of human capital resources to manage drug shortages.

Full-time workers are needed to handle medication shortages and felt that the duties associated

with this phase had been limited to the time usually dedicated to patient care and medication

protection, risk-taking, and error contributing (personal communication, June 25, 2020).

Moreover, dedicated human capital can minimize the time between the expiry date of the drug

and its withdrawal from inventory and creating a crucial prescription list that enables less comprehensive control over inventory changes.

Biblical Framework

God has perfect strategic foresight. God is omnipresent omniscient and eternal; thus, He knows everything about everybody in the past, present, and future. In this study, the biblical insights align with the need for supply to the care of patients. God is aware of the requirements for his people and promises to supply what they need. "But my God shall supply all your need according to his riches in glory by Christ Jesus" (Philippians 4:19, KJV).

The Christian worldview of stewardship for an efficient pharmaceutical hospital supply chain. We learn from the Bible that the world's ill health, sickness, and death are the product of sin. Most of the earthly work of Jesus included battling the curse; He healed people wherever he went (see Matthew 15:31). Jesus is the exact image of the being of God (Hebrews 1:3), and by curing people, Jesus showed us God's love and His role as the Great Physician by healing people who will one day restore all life to health. The principle of stewardship is based on the assumption that the earth and its abundant resources belong to God and are made for all our good (Psalm 24:1). Pharmaceutical supply chain managers focus on creating resources for the benefit of the organization, particularly its patients and shareholders. Stewards calculate both product quality and the amount of revenue required to drive results. Stewardship requires accountability. As Christians, both what is normal (our person) and what we have gained must be responsible for what we have been given. A steward understands that resources are finite and must be managed well if all creation is to benefit.

Stewards must consider the expected effect of supply chains for public health not only on drug delivery but also on improving health outcomes and broader development goals, such as

improved efficiency and elimination of poverty. Moreover, consider these broader "bottom line" principles, the cost-benefit analysis of the alternative supply chain models will be expanded. Serving others is an important Old and New Testament concept. Leviticus points out how important it is to take responsibility for our neighbor and hired employees (Leviticus 19:13).

Christian world view at COVID-19 on vigilance. Drug shortages were a fact of life before the health crisis. Vigilance on the worlds to prevent the spread of COVID-19 should also increase accordingly. It translates directly into saved lives and shows that drug shortages require ongoing diligence on clinicians who are up to date to ensure that prescription drugs are safe and effective for patients who rely on them. Respect for those who are more vulnerable to illness (including the elderly and immune deficiency) will lead us to practice prudence and humility while forming the personal power and hope of those who follow Christ (Prov. 24:10). Therefore, followers of Christ should model compassion for those who want to respond differently or react to situations and events more aggressively (Prov. 18:2). Be compassionate for others. Recognize that there is a particular subjectivity in reacting to this crisis, even among those who listen and follow God's guidance.

COVID-19 has taught the world to completely and entirely dependent upon the living God. "Jesus Christ, the Son of God, realized he was solely and completely dependent upon his Father. Amid the COVID-19 Pandemic, pharmaceutical shortages were high; for the physician, patients, and families, the best thing they could do is rely on God's promises. Matthew 11:28-30 states, "Come to me, all who labor and are heavy laden, and I will give you rest. Take my yoke upon you, and learn from me, for I am gentle and lowly in heart, and you will find rest for your souls. For my yoke is easy, and my burden is light." In Philippians 4:6, the Bible tells us, "Do not be anxious about anything, but in everything by prayer and supplication with thanksgiving let

your requests be made known to God." As the nation thinks about how to act during this tough

period, Job's words should be remembered. "The Lord gave, and the Lord took away; blessed be

the Lord's name" (Job 1:21). Just when it appears the world is falling apart, God is still in

control.

Recommendations for Action

The researcher recognized a few recommendations which could apply to hospital

pharmacies and their supply chains.

Increase Manufacturer Transparency and Communication

The first recommendation should be for hospitals to collaborate with the FDA to allow

manufacturers not only to report when there is a manufacturing issue but to provide more

information about how long the problem will cause the disruption. Manufacturers must convey

the advantages and risks of pharmaceutical products to a wide audience in an open way (clear

and understandable) to inform treatment decisions and clarify the factors and rationales that play

a part in decisions. Further clarity on a specific prescription shortage will help hospitals prepare

for shortages further efficiently (Headquarters & Trusts, 2018). If the hospital can appoint

anyone to focus exclusively on information exchange with the supplier and the FDA, they will be

able to minimize the shortage by handling the disruption's notification as soon as it occurs.

Collaboration between academic physicians and industry is essential for advancing scientific

knowledge and improving patient care.

Implementation of Inventory Management Automation System

The second recommendation would be to implement automated inventory tracking. A

few study participants stated that their hospitals are using manual systems to track

pharmaceutical supplies. Participant 004 said that having a manual for inventory tracking is not

efficient. "To make the right decision for the patients, you need to know what you have got on hand at any given time" (personal communication, June 17, 2020). Manual processes take much longer, and the margin for error is higher. With drug and distribution errors being a significant risk factor for hospitals, implementing an automated dispensing system can reduce the inherent human risk factor by creating an auditable trail. While hospitals continue to seek approaches to healthcare challenges, advances in technology can bring significant benefits. Hospitals can achieve the highest return on these investments by integrating solutions to automation and managing workflows, operational improvements, and wise financial decisions (Uy et al., 2015).

Perform Organization Reviews During and After a Crisis

The third recommendation is to perform an organizational review during an unexpected occurrence. Given the adverse effects on patient care and the possible financial burdens of drug shortages, an organization should have a prepared response in the event of a drug shortage arising from a global pandemic. Pharmacists and policymakers should work proactively to mitigate this threat to patient care and outcomes (Ebrahim et al., 2020). The American Society of Health-System Pharmacists has created an assessment method that will help prepare COVID-19 pandemics in pharmacy departments and encourage pharmacists' involvement in institutional and community preparedness. This tool can help find weaknesses in the COVID-19 pandemic preparedness of a hospital pharmacy department (ASHP & Coronavirus, 2020). Also, hospital pharmacies and supply chains should analyze their activities using a network approach. Frontline physicians may help mitigate these medication shortages by recognizing short-term medications, evaluating alternatives, and determining risks while using such alternatives (Siow et al., 2020). Participant 009 shared that there was no way hospital pharmacies could have been prepared for

COVID-19 when it first surged. After a few weeks, hospitals began to assess what would be needed in the event of a second wave (personal communication, July 8, 2020).

Recommendations for Further Study

This study had some limitations, which leaves room for further research.

Participants

The participants in this study were expected to have a bachelor's degree. While they had many years of experience, many prospective participants did not qualify for the study because they did not have a degree or an associate degree. The sample size should be expanded to individuals that had a lower degree or no degree.

Geographic Location

This study was also limited geographically to only New York City hospitals and hospitals on Long Island New York. The study should be expanded to the whole state of New York and the tri-state area.

Specific Pharmaceuticals

The study focused on all hospital pharmaceutical shortages. The study should be narrowed down to specific pharmaceuticals that encounter shortages, identifying more specific recommendations for action.

Timing of Study

The study had an unexpected event occur during the timeframe of the study. The world has entered a global pandemic, the novel Coronavirus or COVID-19. At the time of field study and data collection, the researcher did not think about how much COVID-19 would have an impact. This study focused on the rising cost of hospital pharmaceutical shortages and the impact on patient care. One of the most significant factors of COVID-19 would be pharmaceutical and

equipment shortages. If the study were conducted pre-pandemic, the findings would be different. COVID-19 dominated the findings for pharmaceutical shortages related to the pandemic. This study should be conducted once the pandemic has lifted, and the supply chain returns to what they may consider typical operational supply chain issues.

Different Analytical Approaches

This study used a qualitative approach to research designed to capture the perceptions and perspectives of the participants. Mixed research approaches would have provided experience, expertise, and data on pharmaceutical shortages that could improve the reliability and understanding of pharmaceutical shortages in hospitals.

Internal Factors and Risks of Pharmaceutical Shortages

The researcher believes that there should be a further examination of the internal factors and risks of hospital pharmaceutical shortages related to internal communication. The importance of constant communication and good collaboration between hospital leadership, hospital pharmacies, health providers, and patients is demonstrated by analyzing a hospital drug shortage. The role of communication internally should be explored as it can affect the ability to order supplies and to pay for the supplies ordered, stockpiling and pharmaceutical delivery disruptions. Additionally, what measures can be taken to mitigate risk when it comes to a breakdown with internal communications between the hospital supply chain and providers. Standardizing our drug shortages management process and effectively communicating these shortages plans throughout the hospital has brought about several meaningful results.

External Risks in the Supply Chain

This study also allows further research on external risks in the supply chain and the relation to communication. The supply chain's external risks can be caused by supply and

demand risks, natural disasters, and business risks. When these risks occur externally in the supply chain, there is not always a path forward that is communicated clearly. A breakdown in communication needs to be explored with recommendations on how to decrease the impact in the supply chain. Unfortunately, there are a number of suppliers who are not as transparent to their customers as they should be. This breakdown in supplier contact will bring multiple risk factors into your supply chain. Better communication contributes to more efficient business practices. Suppliers that interact well will also understand your criticality of the shortage and what is needed to minimize the risks. When a supplier has these characteristics, errors related to communication problems are much less likely. For the safe management of drug shortages, planning, standardization, communication and monitoring are critical. Although planning for any potential shortage of medicines may be difficult, diligent planning may minimize the adverse effects on both patients and providers.

Reflections

This section includes a reflection of the researcher's experience with the research process. Reflections concentrate on the effect that personal values, preconceived ideas, and previous knowledge may have had on the topic of study. The researcher has fifteen years of healthcare administration experience, so effective and efficient patient care is a significant personal value. However, the researcher is aware that there are many challenges in different aspects of patient care, hence the reason for this study. Any fears of personal bias were diminished as the participants were so passionate about sharing their experiences with the business problem. The researchers had a change of attitude when COVID-19's surprising influence pushed the study in a different direction. There was not a single interview that did not discuss the effect of COVID-19 on hospital pharmaceutical shortages. COVID-19 dominated the results and changed the data

collection process. The researcher planned on conducting in-person interviews, but the interviews were conducted virtually or completed in writing because of the restrictions and social distancing rules. Scheduling was the most challenging, as the participants were heavily involved with COVID-19 patient care efforts.

The biblical principles relating to the rising cost of hospital pharmaceutical shortages and the impact on patient care included faith in God through challenges, Proverbs 3:5 declares, "Trust in the LORD with all thine heart, and lean not unto thine own understanding." There will always be challenges in business, but God gives us direction on how to respond. It's from the Bible, James 1:2-4, NIV. "Consider it with pure joy, my brothers, as you face many kinds of trials, for you know that the testing of your faith produces perseverance. Perseverance must finish its work so that you may be mature and complete, not lacking in anything."

Summary and Study Conclusions

The objective of this case study was to explore the problem of the rising cost of hospital pharmaceutical shortages and the impact on patient care. Additionally, the study examined the use of predictive analytics as a possible solution. The study applied a qualitative research method and a case study design. Three research questions were developed in response to the problem and purpose of the study. RQ1. How are hospitals challenged by the rising costs of hospital pharmaceutical shortages due to manufacturing problems? RQ2. What role does supply and demand management play in hospital pharmaceutical shortages? RQ3. How would predictive analytics improve patient care inefficiencies relating to rising costs of hospital pharmaceutical shortages?

The researcher conducted qualitative semi-structured questions based on the interview guide in appendix A. The themes that emerged from this qualitative multiple case study include

1) manufacturing issues are the main cause of hospital pharmaceutical shortages, 2) supply and demand management are just as challenging as shortages, and 3) there are pros and cons to using predictive analytics. After the researcher presented the findings and themes that emerged, there were recommendations made for action and further study. Finally, biblical principles relating to the study were presented. The literature confirmed the findings; however, there is more to be learned regarding hospital prescription shortages and, in particular, the effects of shortages during a global pandemic.

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Appendix A: Interview Guide

Time of Interview:

Date:

Place:

Interviewer: LeTicia L. Currin

Interviewee:

Position of interviewee:

Introduction: Thank you for being willing to contribute to the study to examine the rising costs of hospital pharmaceutical shortages and the impact on patient care: exploring the use of predictive analytics in New York area hospitals. I appreciate your participation. This interview will consist of semi-structured question. Interviews are documented and then transcribed. Recordings are kept for three years on a password-locked computer and then deleted. Such recordings will only be available to the researcher.

Are there any questions before we begin?

Opening Questions: (Icebreaker)

Engage the interviewee so they will be at ease. Ask them how their day has been before starting the questions.

1. How long have you been here at hospital A and what is your position?

2. Did you get a degree in pharmacy or any other related field?

3. Why did you decide on a career in pharmacy?

4. Do you work directly with hospital pharmaceuticals?

5. What is your role when there are pharmaceutical shortages?

6. Before we begin the content questions, is there anything else about your background you would like to share?

Researcher note: After the opening questions, remember, you are trying to obtain all the information you can relating to rising costs of hospital pharmaceutical shortages and the impact on patient care in New York area hospitals. Inform the interviewee that the next set of questions will be based on this business problem.

Use Probes: Ask for more information, ask for examples, ask for explanations.

Content Questions: Based on the research questions and sub-questions.

1. What is the history of pharmaceutical shortages over the last few years in your hospital?

   a. What are the causes of pharmaceutical shortages in your hospital?

   b. Do you know how much the costs of pharmaceutical increased due to the shortages? If not, can you direct me to the person that may have the answer?

   c. What are the most significant challenges with pharmaceutical shortages?

   d. How often does your hospital encounter drug shortages?

   e. How are patients affected by pharmaceutical shortages?

   f. How are your hospitals handling any shortages due to the Coronavirus?

2. What role does the manufacturer play in pharmaceutical shortages?

   a. What type of pharmaceuticals have the highest case of shortages?

   b. Does your hospital have a standard process for drug shortages? If so, what is the process? Can I obtain a copy of the process document?

   c. How does supply and demand factor in? Would you say that the hospital supply chain is prepared for shortages?

d. What specific measures does the hospital take to minimize or avoid the shortages of pharmaceuticals? Do you think that there are any more steps that could be taken?

3. Do you think that data is useful when it comes to pharmaceutical shortages?

4. Does your hospital rely on data when it comes to forecasting pharmaceutical shortages?

   a. If so, what type of forecasting system does the hospital use?

   b. If not, what other methods does your hospital use to track shortages?

5. Are you familiar with the term predictive analytics? (If not, the researcher will explain).

   a. Do you think a predictive analysis forecast will confirm continual care by assuring there is an alternative pharmaceutical when a shortage occurs?

   b. What do you think of predictive analytics that classify commonly correlated consumer variables with product shortages?

   c. Do you think predictive analytics can identify trends and patterns in hospital pharmaceuticals, and develop strategies for repackaging bulk drugs in smaller unit doses whenever possible?

   d. Could predictive analytics help in the shortage of pharmaceuticals with the Coronavirus?

Is there anything else you would like to add?

Closing Statement: Thank you for participating in the study. Please be assured that your comments will remain confidential and that you will receive a copy of your interview transcript.