

Appendix A

The attached seminar paper, by Cameron Chipponeri, entitled The Inefficient Healthcare Supply Chain, when completed, is to be submitted to the Graduate Faculty of the University of Wisconsin-Platteville in partial fulfillment of the requirements for the Master of Science in Integrated Supply Chain Management degree, for which 3 credits shall be allowed is hereby:

Approved: Wendy A. Bronte Date: 12/19/14
Paper/Project Advisor

Appendix B

THE INEFFICIENT HEALTHCARE SUPPLY CHAIN

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Keywords:

Healthcare, Supply Chain, Standardization, Supply Chain Inefficiency, Healthcare Costs, Bullwhip Effect, EHCR, JIT.

Appendix C

THE INEFFICIENT HEALTHCARE SUPPLY CHAIN

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Presented to:

The Graduate Faculty

University of Wisconsin – Platteville

In Partial Fulfillment

Of the Requirement for the Degree of

Master of Science in Integrated Supply Chain Management

Logistics Area of Emphasis

By

Cameron Chipponeri

Year of Graduation: 2014

Appendix D

AN EXAMINATION INTO THE INEFFICIENCY OF THE HEALTHCARE INDUSTRY SUPPLY CHAIN

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Under the Supervision of Professor Wendy Brooke

Statement of Problem

There is a plethora of available research depicting the importance of an efficient and effective supply chain. There is not one particular factor that serves as a cure-all solution to an inefficient supply chain. Rather, there are a number of factors that comprise an efficient supply chain which include but are not limited to identifying processes that promote continuous improvement efforts, eliminating processes that are wasteful and do not add value so that costs can be reduced, employing steps to foster close-knit relationships with supplier and customers (both internal and external), streamlining processes through standardization to further reduce costs and efficiency, utilizing all available resources and capabilities, and strategically investing in technology to achieve a competitive edge.

Based on research, one particular industry that continues to lag nearly all others in terms of supply chain efficiency is the healthcare industry. Despite the vital importance of an efficient supply chain, and even some experts suggesting that achieving an efficient healthcare supply chain may be even more vital than other industries due to the importance of timely patient care, there seems to be very slow to little improvements to change these industry wide problems. Unfortunately, there is no single piece of evidence to determine how or what can be done to fix the inefficient healthcare industry supply chain. Rather, there are some proposed steps amongst various experts that believe they know how to improve and sustain an efficient healthcare supply chain. In this seminar paper, we identify the numerous problems currently affecting the healthcare industry supply chain, and we also provide relevant information based on expert opinions on how the healthcare industry supply chain can potentially be fixed.

Methods and Procedures

The methods and procedures used in this graduate seminar paper were completed in accordance with the standards, procedures, and guidelines for approved University of Wisconsin-Platteville master's seminar paper. In this paper, we attempted to collect, analyze, and compare various expert information relevant to the healthcare industry supply chain in an effort to demonstrate the ability to survey the field of knowledge and assemble, organize, evaluate, interpret, and present evidence in a logical and intelligent manner.

Summary of Results

The healthcare industry continues to lag other industries such as retail when it comes to supply chain efficiency. The results of this paper also revealed that most healthcare industry workers either do not recognize or do not know steps that can be taken to improve the efficiency of their supply chain. Despite the importance of an efficient healthcare supply chain especially as it relates to immediate and quality patient care, steps are being taken albeit slowly to improve in the areas of standardization, logistics, supply chain collaboration, data quality, and technology. It is clear based on the information provided that this will be an ongoing process to change long standing industry ways of thinking. But, it is with the hopes of this paper and many other subsequent research papers that things will progress in the direction of a more efficient healthcare industry supply chain.

Appendix E

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I. INTRODUCTION

Behind health care service quality, the importance of an efficient supply chain in the health care industry may be the next critical component for sustainable success. Despite this importance, the healthcare industry supply chain is extremely inefficient due to a number of reasons. The purpose of this literature review is to discuss data and research by industry experts depicting why the healthcare supply chain is inefficient and subsequently discuss a comprehensive reasoning framework on how it can be fixed.

II. REVIEW OF LITERATURE

Supply Chain Defined

Mentzer (2001) defines supply chain as "a set of three or more entities (organizations or individuals) directly involved in upstream and downstream flows of products, services, finance and / or information from a source to a final customer".

Ballou (1992) on the other hand, defines a supply chain (SC) as the network that integrates planning design, producing and delivering products and services. The extended supply chain includes processes from the suppliers' suppliers to the customers' customers. While, Supply Chain Management (SCM) is the visualization and the control of the movement of products and services from the point of origin to fulfillment while meeting the organizations market objectives.

A more thorough definition of supply chain is provided by Chandra & Swatantra (2004) as a system of suppliers, manufacturers, distributors, retailers, and customers where material typically flows downstream from suppliers to customers (except for reverse logistics) and information flow in both directions. Likewise, according to Chandra and Swatantra (2004), supply chain

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management involves managing a connected series of activities, which is concerned with planning, coordinating, and controlling movement of material, parts, and finished goods from supplier to customer. For this to occur, material, financial, and information flows are managed as decisions are made at different levels throughout the supply chain, but with this comes the potential for many issues to arise.

There are also a plethora of potential issues with supply chain management that can span a large spectrum of a firm's activities, and/or at multiple levels or categories. Typically, these levels where decisions are made can be classified as strategic, tactical, and operational. At the strategic level, decisions such as investment of plants and capacities, introduction of new products, and creation of a logistics network may occur. At the tactical level, decisions such as inventory policies to use, procurement policies to be implemented, and transportation strategies to be adopted may occur. Lastly, at the operational level, decisions such as scheduling of resources, routing of raw materials and finishing products, and solicitation of bids and quotations may take place (Simchi, Kaminski, & Levi, 2003).

Similarly, Supply Chain Risk Management (SCRM), is the systematic identification, assessment, and quantification of potential supply chain disruptions with the objective to control exposure to risk or reduce its negative impact on supply chain performance (Ilie & Popa, 2013). Potential disruptions can either occur within the supply chain (e.g. insufficient quality, unreliable suppliers, machine break-down, uncertain demand, etc.) or outside the supply chain (e.g. flooding, terrorism, labor strikes, natural disasters, large variability in demand, etc.). Management of risk includes the development of continuous strategies designed to control, mitigate, reduce, or eliminate risk (Ilie & Popa, 2013).

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Resembling a supply chain, value chains are today being perceived as the next logical step for enterprises in order to cut costs and increase Return on Investment (ROI). The Value Chain (VC) is the expansion of the supply chain to include demand planning, defining markets and customers' requirements. The Global Value Chain (GVC) is the future stage to optimize the businesses ability to move its business assets, including product transactions and information from their source of origin to the delivery across the nations in the world. It is envisaged that in a GVC, end-to-end flow of assets is made more efficient and customer responsiveness. According to Looy, Gemmel & Dierdonck (2003), the key factors that are identified to create value in a sector such as healthcare include efficient inventory management, business process management, time management and money management.

Healthcare, as it is defined, is the diagnosis, treatment, and prevention of disease, illness, injury, and other physical and mental impairments in humans. Healthcare is delivered by practitioners in medicine, chiropractic, dentistry, nursing, pharmacy, allied health, and other care providers where work is done in providing primary care, secondary care and tertiary care, as well as in public health (Ilie & Popa, 2013).

Healthcare Dynamics

Continuing on the topic of healthcare, and in particular its supply chain, Ilie & Popa (2013) conclude that the main key members of the healthcare supply chain are divided into five categories which include the following: payers for the service (or rather those who finance this set of activities) which include government, employers and employees, individuals or coalitions; tax authorities which include insurers, healthcare maintenance organizations, pharmacy, beneficiaries or managers; providers which include hospitals, physicians, international distribution, pharmacists; buyers which include wholesalers, orders by postmen, distributors,

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groups of organizations; and producers which include manufacturers of drugs, medical devices and equipment, hospital and healthcare facility medical supplies, and surgical instruments.

Another way to understand the dynamics of the health care supply chain is to understand the different functions within the main categories. Burns (2002) explains the following functions as producers produce products such as pharmaceuticals, medical devices, and implants, and medical/ surgical supplies that are necessary in the delivery of healthcare. Purchasers consist of group purchasing organizations (GPOs) and distributors who facilitate the payment for and shipment of goods from the producers to the providers. Providers may also purchase goods directly from the producers. Providers use the goods produced by producers to administer healthcare services to patients (Smith et al., 2012).

In terms of the role of the healthcare supply professional, it is characterized in four distinct functions according to Schneller and Smeltzer (2006) which are customer relationship management (CRM), in which the supply manager must service the needs of patients and clinicians, who exhibit tremendous influence in buying decisions; supplier relationship management (SRM), in which the supply manager must cultivate and maintain good relations with the hospital's vendors and suppliers; internal supply management (ISM), in which the manager must ensure that all necessary supplies are stocked and delivered as needed for clinical use; and finally purchasing partner management (PPM), in which the supply manager must make effective use of the resources available through the hospital's Group Purchasing Organization (GPO).

Although one would think that supply chain management would be of the utmost importance for any industry, the reality of the situation is that supply chain management in other industries, like those of retailers, is considerably more successful than in the healthcare industry, despite its

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importance. Experts say this is because there is a broader acceptance of the need for supply chain excellence. Corporations such as Walmart are more organized and more willing to accept and adopt new technological innovations quickly (Burt, 2006). It is also obvious that healthcare costs are rising at an alarming rate. A significant cost driver is the universal complexity of the healthcare supply chain. It is believed that healthcare logistics is an area in which costs can be reduced and efficiencies gained in order to provide healthcare delivery at a reasonable cost (Nachtmann and Pohl, 2009).

Nachtmann et al. (2009) found in their research that the healthcare supply chain is vast, complex, essential, and purportedly effective but inefficient. Thousands of dedicated individuals interact every day to get the right medical products to the right customer at the right time. Partners within this supply chain such as healthcare manufacturers, distributors, group purchasing organizations, and providers strive for excellence inside and outside of their organizations amidst daily challenges including volatile customer demand, low visibility, diverse processes, and a complex payment structure. Their actions impact the lives of millions of stakeholders including patients, clinicians, and payers.

Within the healthcare industry, despite the lackluster past performance of the industry's overall supply chain, many experts suggest that the importance of an efficient supply chain may be the next critical component outside of health care service quality for sustainable success. As mentioned, a key driver in maintaining an efficient and effective health care supply chain is the logistics process. Smith, Nachtmann, & Pohl (2012) conducted surveys of healthcare supply chain professionals to investigate efficiencies and improvement opportunities within the healthcare supply chain. In particular, their research examined the lack of data standardization across the healthcare industry and its effects on the supply chain.

Lack of Standardization

In a survey by Nachtmann et al. (2009), they analyzed numerous healthcare logistics experts who mentioned data standardization within the healthcare industry as an important issue, both as a challenge (the current lack thereof) and as a solution (future adoption). A data standard is a universally agreed upon and accepted representation, format, and definition for common data. Data standards increase compatibility, reduce redundancy, and improve exchange and collection efficiency. Data standardization is the process by which all data elements related to a data standard conform to achieve common presentation and exchange. For those engaged, this process will be as valuable as the end result of achieving data standardization as processes are defined, tools are developed, and improvement opportunities are identified. According to Nachtmann et al. (2009), at the time of their research, they concluded that there is clear evidence that the healthcare industry is initiating the data standardization process.

Similarly, Smith et al. (2012) found in their research that one of the major differences between the healthcare supply chain vs. other retail supply chains is also the lack of data standardization, in particular, the traceability and identification of products. The Universal Product Code (UPC) barcode, administered by GS1 US (formerly the Uniform Code Council), that is present in nearly all retail product lines has been in use for over 35 years in the retail sector (GS1, 2014). UPC barcodes were developed to improve the efficiency of retail check-out lines; however, many other benefits were realized, allowing retailers to change the way they conducted business by simplifying and improving inventory, rebate, and return processes (Smith et al. 2012).

Unfortunately, the healthcare industry has yet to fully adopt and utilize the capabilities and benefits associated with barcode data standardization.

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Accordingly, Burt's (2006) research indicates that best practices in supply chain management align an organization's internal and external systems with those of its suppliers and customers to improve the flow of products, services, information and monies across the supply chain. But, Burt (2006) also agrees that the healthcare industry issues stem from a lack of standardization, slowness in implementing automation technology and a lack of high-quality data on which to base important strategic decisions. Burt (2006) believes that improvement in these areas can lead to excellent operating room and pharmaceutical management, better inventory management, enhanced vendor relationships, more satisfied patients and more effective work flow for hospital employees.

Burt's (2006) research also concludes that there is no greater illustration of the importance of efficient supply chain management in the healthcare industry than the 2004-2005 flu vaccine shortage. Though the shortage exemplifies problems with supply chain management in the healthcare field on a large scale, examining the reasons behind and the response to the problem can help healthcare executives understand why having an efficient supply chain is paramount. A key step to implementing a successful supply chain management strategy is to make it an organizational strategic initiative, according to David M. Markoski, SVP for VHA. Rethinking supply chain management in healthcare can improve bottom lines and ultimately make healthcare facilities run much more smoothly (Burt, 2006).

Thinking of the impact of a healthcare supply chain professional, Kuehn (2005) suggests that their area of influence has a direct, measurable impact on a healthcare facility operating margin. The supply chain arena is rife with opportunity and from the perspective of a purchasing professional, they are positioned perfectly to mine the supply chain for new efficiencies and

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savings. In fact, Kuehn (2005) also agrees that even small inroads in good "starter" areas such as product or data standardization can make a big difference.

Rowan's (2012) research also suggests enforcing standardization of supplies. Purchasing discipline is the first step toward strategic cost reduction. The average hospital uses 60 to 100 different types of gloves; top performers use half as many. To support compliance, Rowan (2012) suggests that hospitals should use ordering technologies that provide visibility only for products determined to offer the best value with the best outcomes.

According to Perry & Kocakülâh (2010), the healthcare supply chain is idiosyncratic. One can think of few other industries, if any, in which so many actors influence purchases such as patients, physicians and clinicians, Group Purchasing Organizations, materials managers, and where so many different materials and inputs are required. Everything from pacemakers to artificial hips, laboratory reagents, pharmaceuticals, MRI machines, patient monitoring devices, office supplies, and much more can be ordered or received on a single day to make a hospital run and service its patients effectively. What this means is that the healthcare industry is again ripe to implement various forms of standardization to improve the efficiency of products within the system.

Schneller and Smeltzer (2006) also agree that physicians, nurses and other clinical staff members influence the supply chain practices of a hospital in terms of selection, supply management and use (or the provision of care to patients). These clinicians may function as employees of the hospital and thus daily participants in supply chain management practices, or function as temporary suppliers of service within the hospital. Attending physicians and contingent nursing staff for example, may practice in several different facilities and as a result possess little familiarity with the supply chain practices of a particular hospital, but at the same time have

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great reliance and influence on the supply chain (Schneller and Smeltzer, 2006). In this way, these clinicians are customers of the supply chain as they rely on it for material and information in their endeavor to treat patients, and they are also suppliers to it as they add value to the material flowing through the supply chain and also participate in the provision of new information flow. The patient is obviously the ultimate client or beneficiary of the healthcare supply chain and also influences outcomes through his/her medical decisions and compliance with treatment protocols requiring connectivity to other members of the value creation system such as clinicians (Schneller and Smeltzer, 2006). All in all, yet another reason that it is so imperative that the healthcare supply chain focus on streamlining operations and standardizing their products, data, and forms of communication to reduce redundancy and influences from various industry members as well as external sources.

Data Quality and Bullwhip Effect

According to Smith et al. (2012), managers in the healthcare supply chain also face many problems related to the quality of data. For example, hospital item master files are large and constantly changing, which results in product data that is often inaccurate and obsolete.

Compounding this problem is the fact that product identification codes may not be consistent (again, data standardization) between branch hospitals in the same network or even between floors of the same hospital (Belkoski, 2008). The effects of poor data quality are widespread throughout the healthcare supply chain. Incorrect product data leads to increased costs due to pricing errors and thus an inefficient supply chain. Bad data also results in wasted time and rework for managers trying to resolve rebate, return, and credit issues with suppliers. The quality of healthcare can also be adversely impacted. Data problems can result in healthcare procedure delays due to necessary products not being on hand. According to Grossman (2000), a staggering

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fact about the health care industry as it relates to supply chain is that the typical hospital spends 38% of the cost of goods on moving and handling supplies, compared with less than 10% for most industries. As a result, health care costs accounted for 17% of the nation's 2009 gross domestic product (GDP). Subsequently, health care costs are expected to increase at a rate faster than the growth rate of the GDP, reaching almost \$4.6 trillion and accounting for more than 19% of the GDP by 2019 (Centers for Medicare and Medicaid Services, 2010). Nachtmann and Pohl (2009) provide more recent data indicating that supply chain related expenses, including the cost of all activities, assets, information, infrastructure, and labor related to the accurate procurement, delivery, storage, return, and disposal of products and materials necessary to provide healthcare services, account for 31% of the average healthcare providers annual operating expense (Smith et al., 2012).

According to Nachtmann et al. (2009), manufacturers, distributors and providers are similar in the most frequently used measures to track their supply chain data quality. Survey participants from these organizations indicate that they are using traditional quality measures such as percentage of items on backorder, order fulfillment cycle time, fill rate and picking accuracy to measure their supply chain performance. Tracking the internal customer satisfaction is more common among healthcare providers, indicating a heavy emphasis on supply chain performance within their own organizations.

In addition, according to Nachtmann et al. (2009), the author's findings indicate that group purchasing organizations are leading the way in successfully attempting supply chain improvement initiatives, particularly when it comes to data quality. More so than the other three organization types, healthcare providers (77 percent) are working to standardize their internal purchasing procedures albeit at a slow process. The majority of healthcare provider respondents

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in their study have also worked to centralize/consolidate supply chain data, improve their service levels and fill rates, and improve their invoice accuracy. The good news is, the findings of Nachtmann et al. (2009) indicate that all four organization types (manufacturer, distributor, GPO, provider) have made inroads to establish strategic partnerships and alliances to improve their supply chain performance.

According to Smith et al. (2012), in order to efficiently plan, organize, and manage the health care supply chain, managers need to be able to properly locate and identify products. Tolk and Aaron (2010) state that managers need to "identify, clarify, define, and standardize the meaning of data." In order for supply chain managers to properly utilize the various decision support and analysis tools available to them to aid in improving process improvement activities, it is imperative that the meaning of the data that is fed into those tools is clearly understood.

According to Behzad, Moraga, & Chen (2009), the majority of research compiled on supply chains has focused on manufacturing. However, with the increased importance of the service industry in the past 10 years, the research of service supply chains has found a significant role. As a result, the research conducted by Behzad, Moraga, & Chen (2009) explored the bullwhip effect in hospital service supply chains. Upstream amplification of inventory and demand in a supply chain has been a well-known phenomenon for supply chain managers for several decades. This phenomenon is called bullwhip effect in which fluctuations in orders increase as one moves up the supply chain from retailers to wholesalers to manufacturers and to suppliers. The evidence of bullwhip effect was first found by Forrester (1961) and has since been researched extensively. According to Zeithaml, Bitner, & Gremler (2009), service supply chains should be managed differently, because they have the following characteristics not found in manufacturing supply

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chains such as intangibility, heterogeneity, simultaneous production and consumption, and perishability.

According to research completed by Ilie & Popa (2013), when it comes to health care supply chain efficiency, perhaps even more than other industries, even small-scale efficiencies can have a potentially large dollar impact. The Efficient Consumer Healthcare Response (EHCR) initiative (discussed in the next section) is a broad-based, industry-wide effort aimed at streamlining the health care products supply chain by making each participant as efficient as possible and eliminating waste between supply partners. The continuity of operations in healthcare supply chain is vital to human welfare and the span and quality-of-life of patients (Ilie & Popa, 2013). A supply chain disruption occurs when supply falls severely short of supply. Such disruptions take place when either the nominal supply capacity of a business process is greatly reduced for some period of time, or a sudden surge of demand manifests itself, or both. The bullwhip effect, or in simpler term disruptions, upset the continuity of providing for patient needs, and can have particularly severe consequences. The resilience of a supply chain entity is defined as the ability to be able to react to disturbances and return to its original state or a more desirable one.

Behzad et al's (2009) research concludes that in today's global markets, competition is ever increasing and companies are widely adopting customer-focused strategies in integrated-system approaches. Changes in technology and globalization of products and services have also resulted in increasingly dynamic markets and greater uncertainty in customer demand. Nowadays, competition is no longer one company against other companies, but one supply chain against other supply chains. Thus, supply chain management is a mechanism that will allow companies to respond to environmental changes. According to Behzad et al. (2009), it has become one of

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the top priorities on the strategic agenda of industrial and service businesses. As a result, it is even more imperative that service oriented businesses typically found in industries such as healthcare, take as many reasonable preventative measures as possible to avoid the bullwhip effect that could severely damage the flow of business.

Inefficiencies persist, despite EHCR

In 1996, a group of healthcare manufacturers, suppliers, and providers met to analyze opportunities for reducing costs in the healthcare supply chain. The study and subsequent report generated from this meeting is called the Efficient Healthcare Consumer Response (EHCR). During the study, the members discovered that the health care supply chain inefficiencies contributed \$11 billion (or 48%) out of the total annual costs of \$23 billion (EHCR, 2000). Their report described that the health care supply chain was centered on distributors, resulting in little contact between manufacturers and hospital material managers. Contract negotiations tended to be adversarial. Providers achieved lower costs, but these costs were not driven out of the system, just pushed lower in the supply chain. They encouraged the health care industry to adopt the concept of “collaborative planning, forecasting and replenishment (CPFR)”, used by other industries such as retail (e.g. Wal-Mart) (Chandra et al., 2004).

The resulting Efficient Healthcare Consumer Response (EHCR) report continues to be the benchmark for assessing the role that supply chain functions play in healthcare expenditures. The EHCR report identifies significant opportunities and formulates strategies for reducing healthcare supply chain costs. Thus, the main idea is to avoid excess inventory through accurate forecasting, utilizing commonly agreed to demand data among various supply chain partners (Chandra et al., 2004). Since 1996, the percentage of orders processed electronically by hospitals has risen dramatically, from 5 to nearly 60 percent, but the concept of EHCR remains essentially

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untapped (GHX, 2011). Despite the effort, a lack of clear and measurable cost and quality improvement is evident within the industry. High quality, both in the form of data and products, is expected by all parties that interact with the healthcare system, yet there remain significant opportunities to improve supply chain quality as well as patient safety (Nachtmann et al., 2009). Acharyulu & Shekbar (2012) research concludes that the pressures on hospital supply chains are changing. In the past, a hospital that managed its purchasing costs well could operate efficiently. Today, the cost of materials management can exceed 45% of a hospital's operating budget, with nearly 30-35% attributable to supply costs alone. The hospital supply chain has insufficient linkages to clinical systems, revenue cycle, IT, and clinical operations. The supply chain often is viewed as a "back dock" support service that provides the products and services required by clinical departments (Acharyulu & Shekbar, 2012). To be fully effective, it must be an integrated link in the chain of clinical and non-clinical operations. Acharyulu & Shekbar's (2012) research suggests that health industry supply and value chain management has only recently been recognized as a fertile area for health services research. Whereas, an effective supply chain has measurable tools in place to manage and promote continuous improvement, cost containment, and increased safety.

According to Ebel et al. (2013), many pharmaceutical and medical-device companies come close to running one-size-fits-all supply chains. However, there can be significant differences in profitability, value per unit of weight, demand, the importance of a drug or device to patients, a customer's cost to serve, and service expectations. Forcing products with such varied characteristics through a single set of supply-chain processes creates multiple inefficiencies, such as high inventories for some products while others are in short supply, the use of expensive air freight when slower surface modes would do, or a need to reschedule production campaigns

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hastily to meet urgent delivery requirements. Ebel et al's (2013) research suggests that leading companies tackle these problems by intelligently segmenting their supply chains according to the characteristics of products and the requirements of customers. They then develop forecasting, production, and distribution strategies for each category.

According to Nachtmann et al. (2009), experts still do not know where the fundamental inefficiencies and associated costs subsist within the complex healthcare supply chain. They also add that researchers do not know where the opportunities for the greatest increases in quality exist within the healthcare supply chain. This lack of knowledge contributes to healthcare supply chain inefficiency. Nachtmann et al's (2009) research foreword asks the question "Can we meet the demand for short-term cost containment yet create a sustainable and efficient healthcare logistics system that enables significant and measurable improvements in the quality of healthcare delivery?" The answer perhaps is yes, but it requires many variables including information and data along with collaboration amongst supply chain partners working towards a common goal in order to develop.

Healthcare Collaboration and Visibility

The research of Nachtmann and Pohl (2009) suggest that one of the keys to success in managing a healthcare supply chain is the ability to collaborate with supply chain partners. In order to enhance collaboration capabilities, engineering managers as well as supply chain managers must ensure that all the necessary data can be obtained by all members of the healthcare supply chain. In order to improve collaboration capabilities, it is necessary for partners to have visibility of data, to be able to understand it, and to trust the creditability of it so they can be responsive to their needs.

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Supply Chain visibility enables someone to see and respond to critical milestones as they occur.

Visibility tools provide an integrated view into the supply chain, from purchase orders to inventory. Reporting and advanced analytics offer visibility into large volumes of data. And the more one can see, the more it can be analyzed and act upon (Kuehn, 2005).

Beeny's (n.d.) perspective focuses on establishing visibility within healthcare supply chains. To support today's business model in this high-velocity, complex and distributed logistics environment, real-time visibility has become a key strategic imperative. Visibility to suppliers' production rates and shipment lead times, in house inventory, historical data, and customer sales projections can drive benefits in efficiency, lower inventories and improve fulfillment rates. Overall, visibility is driven by companies' need to become more proactive and systematic in their supply chain operations, track and trace products throughout the supply chain from cradle to grave, proactively alert customers of product availability and status of shipments, improve on-time delivery, reduce lead time and lead time variability, reduce and/or redirect working capital, as well as fixed and variable costs. These are fundamental capabilities for the supply chain today, and given the risk and regulatory oversight, clear visibility is vital in healthcare. Beeny (n.d.) concludes that by not knowing the route by which pharmaceutical products make their way to the consumer can lead to risk in counterfeits. In addition, with FDA regulations, life science companies need to trace drug and product information such as historical locations; time spent at each location, record of ownership, transaction history, packaging configurations, and environmental storage conditions to efficiently and safely manage the full lifecycle of such products in the supply chain. Major drivers for visibility in healthcare include the need to meet pedigree requirements and deal with counterfeits, manage product recalls, deal with offshore manufacturing quality, and identify and mitigate diversion.

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With that said, visibility doesn't exist without collaboration. Nachtmann et al's (2009) research concludes that low to medium collaboration among healthcare supply chain participants is evident in their findings. What this means is that while consumer behavior is a key driver to supply chain performance, healthcare providers are indicated as the second lowest collaboration partner when compared against other sectors of the economy. Nachtmann et al. (2009) did find that healthcare providers do collaborate with GPOs, distributors, and manufacturers to improve their own supply chain performance, however research indicates that a low collaboration with other healthcare providers is evident. Despite the unsurprising low collaboration there is evidence that healthcare organizations are working with outside partners, such as professional associations and academic institutions, to improve their performance.

Similarly, GHX (2011), supports the idea that there are signs that the nature of the relationship between providers and suppliers is continuing to improve. Providers are gradually losing the mindset that the lowest price from a particular supplier is the best choice. Instead, the establishment of long term partnerships is valued more. Many attribute this change to an increased appreciation for the interrelationships between various players and functions in the supply chain. When suppliers serve as partners not adversaries, healthcare providers can gain new insights into opportunities for savings. One of the first observations often made by supply chain professionals entering healthcare is the lack of collaboration between hospitals and their vendors.

According to GHX (2011), by tapping into suppliers' knowledge, healthcare providers can become less expensive customers to serve, which in turn can lower suppliers' SG&A (selling, general and administrative) costs, another area of differentiation between healthcare and other

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industries. Gartner Research has noted that SG&A costs for healthcare suppliers are nearly twice those of companies in other industries recognized for having highly efficient supply chains. GHX (2011) research comments that “world class supply chains benefit in many ways from collaboration, even in times of severe economic stress” with benefits including “lower operational costs” and “new product and process innovations borne from the working relationship between trusting partners.” The challenge is trust is hard to come by in the healthcare supply chain according to experts. In both 2009 and 2010, Gartner Research found that 93 percent of supply chain participants reported a lack of trust among trading partners, up from 74 percent in 2008. Trust and visibility, meanwhile, go hand in hand. When trading partners do not share information, mistrust grows, and when parties do not trust one another, they are less willing to share information, which only perpetuates the problem. The result is increased inefficiencies and missed opportunities. For example, if suppliers do not have visibility into customer demand, they will often overstock inventory at the point of consumption in order to make sure they do not miss a sale. As a result, products often expire or become lost or obsolete before they can be used, a cost that’s ultimately borne by the entire supply chain (GHX, 2011). In contrast, large retailers all have systems in place that use point-of-sales information to trigger upstream supply chain activities. For example, when a product is purchased at Walmart, the product’s barcode is scanned at the register, which sends a series of notices upstream to the warehouse that another product is needed on the shelf; to the supplier that the warehouse needs a new product; and to the supplier’s suppliers that raw materials are needed to manufacture another product. By employing technology and, more importantly, sharing information, all parties are collaborating to serve the customer better and faster, while helping to address inefficiencies that otherwise lead to excessive inventory and higher costs (GHX, 2011).

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While the use of common standards is part of the challenge, supply-chain partners must find ways to collaborate more effectively to reap the full benefit. Ebel et al. (2013) suggest that barriers to improvement are often cultural rather than technical, transactional relationships must be transformed into something more ambitious. Ebel et al.'s (2013) research suggests observing successful collaboration such as considering the six essential steps that can make the difference between a productive collaboration and a frustrating one. These steps start with the fact that companies must collaborate in areas where they have a solid footing; agree on sophisticated benefit-sharing models; select partners for the potential value of the collaboration, as well as their capabilities and willingness to act as a team; dedicate resources to the collaboration and involve senior leadership in it; jointly manage performance, measure cost, quality and impact; and start out with a long-term perspective.

Healthcare Costs

According to Nachtmann et al. (2009), the rising cost of healthcare services is a widespread concern among healthcare professionals, government officials, and the public. Although most stakeholders are quick to acknowledge that costs are too high, determining the contribution of supply chain activities to the cost of healthcare delivery is a more difficult task. Furthermore, understanding how these healthcare supply chain costs are distributed among manufacturers, distributors, GPOs, and providers is challenging. Despite the current cost explosion, there is a lack of clear and measurable quality metrics for healthcare logistics performance. "You can't manage what you don't measure" is a common adage among managers. This highlights the importance of quality performance measures in organizations that are often dubbed "data rich and information poor," a challenge facing many healthcare organizations (Nachtmann, 2009).

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Nachtmann et al's (2009) research indicates that on average, healthcare participants from GPOs and distributor organizations incur the majority of their annual operating expenses to support the healthcare supply chain functions. Interestingly, healthcare providers are using almost a third of their annual operating funds to support the supply chain. Within group purchasing, distribution, and provider organizations, healthcare supply costs are incurred primarily to support inventory and order management. Thus, their research puts into perspective the large variance between healthcare and members from manufacturing organizations who spend their funds more evenly across the supply chain functions.

According to GHX (2011), if you consider the price paid for products, along with the labor and overhead costs to manage them, the supply chain represents 40 to 45 percent of hospital or healthcare system operating expense, second only to labor. Supply chain costs are also increasing faster than labor for many hospitals. Using a calculator developed by the Strategic Marketplace Initiative, a number of leading healthcare organizations project that supply costs will supersede labor costs as early as 2022. With numbers like these, GHX (2011) suggests that it is hard for healthcare providers to ignore the role successful supply chain cost improvement can have on the bottom line. The supply chain is also getting more attention because most hospitals have already focused on staffing levels. GHX (2011) research suggests that when it comes to making a choice between cutting personnel or cutting supply chain costs, healthcare executives will almost always opt for the latter.

On the other hand, when it comes to physician preference items, the stakes are even higher in terms of costs. These items are typically among the most expensive products, are associated with the most profitable service lines, and potentially have the greatest impact on patient care. For example, for some orthopedic and cardiac implants, the cost of the product can account for 50 to

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80 percent of the total cost of the procedure. Under the recent healthcare reform, providers will be reimbursed based on value delivered, which is a function of both cost and quality. Hospitals and physicians, who will likely share bundled reimbursement payments, will need to better understand the role supplies play in creating value (GHX, 2011).

According to Gartner Research (2011), promising news is that many providers can reduce supply chain costs by 5 to 15 percent if they better analyze, plan and control the purchase and use of goods and services. That can translate into a profit increase of 2 to 7 percent. The challenge, Gartner (2011) adds, is that few health care organizations have the level of supply chain talent and leadership necessary to make this possible. Although, as more supply chain professionals from other industries enter the healthcare arena, they bring with them a bevy of best practices. According to GHX (2011), total cost of ownership (TCO) is still a relatively underutilized concept in healthcare. When making sourcing decisions, other industries typically look beyond the price paid for products to consider fully landed costs, which include factors such as freight, rush charges and inventory carrying costs. Total cost of ownership will take on even greater importance in healthcare with the need to report on quality and cost. This need to better understand total cost of ownership is driving hospitals to work more closely with both suppliers and clinicians.

According to the recent research of Ebel et al. (2013), supply chains now account for nearly 25 percent of pharmaceutical costs and more than 40 percent of medical-device costs. The annual spending is so vast about \$230 billion on pharmaceuticals and \$122 billion on medical devices that even minor efficiency gains could free up billions of dollars for investments elsewhere. In fact, Ebel et al. (2013) estimate that if the healthcare sector adopted straightforward advances well established in other industries, the total costs (from the supply chain and external areas,

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such as patient care) could fall by \$130 billion. As a result, Ebel et al's (2013) research concludes that opportunities are available to boost profitability throughout the value chain. They estimate that improvement from better-performing supply chains would range from about 6 percent for retailers to 20 percent for hospitals and producers of devices and medical supplies. To do so, Ebel et al's (2013) research identified five specific capabilities that can have a dramatic impact on healthcare performance and bottom lines such as better segmentation of products, reduction in costs and increased flexibility, measurement and benchmarking, alignment with global standards, and again, collaboration across the healthcare value chain.

According to McKone-Sweet et al's (2005), research by the Center for Studying Health System Change found that hospital spending accounted for 47 percent of the overall 7.2 percent increase in healthcare costs during 2000. With the supply chain costing as much as 40 percent of the typical hospital's operating budget, the strategic importance of hospital supply chain management is evident. Current estimates of the potential benefit of an efficiently managed healthcare supply chain range from 2 percent to 8 percent of hospital operating costs. An efficient, user-friendly supply chain can also impact the hospital's revenues by engendering physician loyalty and staff retention and providing better customer service.

The opportunity cost of product shortages is substantial as well. According to Ebel et al. (2013), since 2005, drug shortages have nearly tripled in the United States and added more than half a billion dollars in costs for hospitals worldwide. Supply issues also create opportunities for counterfeiters and gray-market vendors, threatening patient safety and cutting into the revenues of legitimate companies. Supply-chain security breaches are increasing by an average of more than 33 percent every year, rising not only in emerging markets such as India, China, and Brazil but also in the developed world (Ebel et al. 2013). In addition, according to Ebel et al. (2013),

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medication errors in the developed world occur in roughly 10 to 20 percent of all inpatient hospital admissions. About 1 in 10,000 patients admitted dies from adverse drug events, which potentially adds \$20 billion to \$90 billion in costs to the healthcare system globally. Whether it be domestically or in foreign countries, better supply chain processes are central to increasing patient safety. Ebel et al's (2013) research concludes that adopting a common global data standard and upgrading supply chain processes could slash counterfeiting in half, which may return \$15 billion to \$30 billion in revenue (by 2016) to legitimate companies for reinvestment in further improvements to patient care.

Foreign Healthcare

Viewing healthcare supply chains from a more international perspective, according to Acharyulu & Shekbar (2012), countries such as India spend over 5% of GDP on healthcare. Their healthcare industry is also growing at 15 percent annually. Presently, hospitals are looking for new sources of competitive advantage and cost cutting measures wherever possible. That is why Acharyulu & Shekbar (2012) believe it is imperative to look into the supply chain management aspects and identify areas in which they can improve the quality of service for efficient patient care. As mentioned in our opening section, value chains are today being perceived as the next logical step for enterprises in order to cut costs and increase Return on Investment (ROI). The hospital value chain system has to be reengineered to sustain in the present healthcare environment. In order to analyze this information, Acharyulu & Shekbar (2012), researched the performance of corporate hospitals in India based on well-established criteria of what constitutes a quality supply chain system.

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Acharyulu & Shekbar's (2012) research suggests that today healthcare providers in India and many other emerging countries are under enormous pressure due to increasing competition, government regulations, rising costs, demand for higher quality of service. Undoubtedly, healthcare becomes tremendously complex as a business activity to manage diversified locations, changing organizational structures, mergers, employees, and multiple information systems across the globe. Healthcare organizations must strive for value addition across the entire supply chain by monitoring supply chain performance. In view of the growing trend in business process outsourcing and medical tourism, Indian healthcare facilities along with many other healthcare providers around the globe need to strengthen each activity in the value chain by focusing on continuous improvement in the supply chain operations.

The good news is that constant innovation and changing market forces have transformed the healthcare industry into the most competitive business in the Indian economy and many other global healthcare markets are taking notice. No other industry is challenged by a combination of mass customization, rapidly shrinking product life cycles, rapid inventory depreciation, supply and demand misalignment, complex supply chains, and rising expectations of patients. With relentless pressure to create shareholder value and strengthen market share, quality of healthcare delivery, cost reduction, healthcare companies have to depend on right supply chain strategy to provide the logistical speed, flexibility and superior customer service necessary to remain competitive (Seligman, 2003).

Logistics and Lead Time

Chandra & Swatantra (2004) assert that the health care industry has a long standing record of investing heavily on the development of sophisticated drugs and diagnostic systems instead of allocating some of those dollars towards technologies to manage its day-to-day operations.

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Chandra et al. (2004), contend that in order to achieve improved performance, the healthcare supply chain must be efficient and integrated. The driver for this integration is logistics and supply chain management. According to Chandra et al. (2004), pressures on the health care industry have fostered innovation over the years in terms of design of services and organizations. Most of the innovations have targeted cost reductions in key functions, including logistics. As such, Chandra et al. (2004) conclude that the industry must find a flexible delivery enterprise that has substantial capital and is capable of efficient operations. This means effective management of a broad range of processes with diverse measures, from medical outcomes to the cost of tissue paper. However, like many other global markets, the healthcare sector of the US economy faces several challenges, such as cost containment, outdated information management systems, and mergers and/or acquisitions (Chandra et al., 2004). As a result, the need to cut costs and compete has led to mergers and acquisitions in the healthcare industry. Such consolidations have created new organizations made up of very different entities which are not as integrated as they should be. Due to competition, it has become imperative that enterprises seamlessly and efficiently provide and manage services (including purchase and delivery of supplies to the final user) across entities and continuum of care, both now and in the future (Chandra et al., 2004).

Ebel et al. (2013) suggest that an agile supply chain means building an operating model that can better respond to demand shifts and customer wishes, while potentially at reduced costs. The replenishment lead time from pharmaceutical plants to distribution centers is 75 days, on average. But leading companies in retail sectors such as fast-moving consumer goods take a fraction of that time, often without additional investments. Ebel et al. (2013) suggest that companies must better align the production cycle with the patterns of patient demand and increase the low frequency of their manufacturing processes. The average stock-keeping unit

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(SKU) is packaged every two to three months; only about 10 percent are packaged every two weeks or less. An agile supply chain model also requires stability in production, replenishment, and visibility. Many health-care companies need to make deliveries from third parties and in-house plants more reliable and to upgrade their sales and operations planning capabilities to the standards of the fast moving retail consumer goods industry. The necessary improvements include a more disciplined cross-functional process, a better understanding of demand and supply scenarios and of underlying assumptions, more effective communication, and transparency on potential supply issues and bottlenecks.

Healthcare vs. Retail

Pohl, Rossetti, & Varghese (2013) research via survey indicated that the healthcare industry's supply chain lags behind the retail industry and in particular consumer goods supply chain and could benefit significantly from adopting several of retail's best practices. Pohl et al's (2013) research found that the retail supply chain has done a better job in the critical area of collaborative planning, forecasting and replenishment, which involves suppliers and retailers or healthcare providers, working together to adopt order forecasting and inventory planning to create an integrated supply chain network. Also critical, health care is struggling to catch up with retail in the area of scanning technology, which is used to track materials by means of barcodes and RFID technology. The health-care supply chain also is lagging behind retail in professional training and education, specifically the skills associated with materials-management, purchasing and warehousing.

Pohl et al. (2013) conducted their survey to get a better understanding of the gaps between the two supply chains and to learn how the healthcare supply chain might benefit from adopting some or all of the best practices used by retail. The first step involved identifying best practices.

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Pohl et al. (2013) came up with an initial list of 22 best practices, based on an extensive literature review and guidance from a steering committee made up of industry leaders. The steering committee scored and ranked all 22 best practices according to their potential impact on business and their associated cost and ease of implementation. From this ranking, the top 10 best practices were identified and included in the report. The best practices included collaborative planning, forecasting and replenishment, scanning technology, education and training, centralized purchasing and supply, supply chain services reorganization, regular cycle counting and stock rotation, performance management, actual usage inventory management, e-commerce, data standardization. The survey of healthcare and retail managers revealed that higher-revenue respondents such as large retail stores and hospitals were more likely to have implemented best practices. Across both industries, 80 percent of the respondents thought the identified best practices had a significant or very significant business impact. Forty percent of retail respondents perceived implementation of best practices to be easy or very easy. When compared to the responses from retailers, however, most health-care respondents perceived implementation of best practices to be easy. Healthcare respondents also perceived implementation of best practices to be cheaper and require a lower minimum rate of return for many of the practices. Considering that the healthcare industry lags behind that of retail in terms of implementing best practices, the researchers were surprised by the responses. Pohl et al. (2013) findings suggest that the healthcare industry underestimates the investment necessary to achieve the full benefits from some of the best practices, and overall retailers led in the implementation of best practices, despite their perception that implementation of the practices is difficult and expensive.

Healthcare and JIT

One way to potentially implement best practices within the healthcare supply chain perhaps is through continuous improvement or Just-in-Time (JIT) strategies. The goal is to improve the healthcare supply chain return on investment by reducing in-process inventory and their associated costs. Research conducted by Jarrett (1998) investigated the international health care logistical environment to determine if regulatory policies or industry procedures have hindered the implementation of just-in-time systems. Jarrett's (1998) analysis was conducted in a systematic manner and compared the anticipated benefits with those validated in other industries such as retail from the implementation of just-in-time. The study also compared the health care industry environments of the US, UK, and Germany with the manufacturing industry. The paper focused on answering questions such as why has the health care industry not implemented just-in-time? Is it feasible for a healthcare provider to implement a just-in-time logistical system? And what benefits will a health care provider achieve by implementing just-in-time? Controlling health care pricing requires reducing product cost or continues to place limits on product prices, quantities of services, or both. Prices are measurable and more easily controlled than is quantity and, consequently, healthcare cost containment has frequently focused on mechanisms for controlling prices. Regulatory approaches, however, may create market distortions and change access patterns. An alternative approach to controlling prices is to restructure the market for health services to encourage greater price competition among providers. If this method were employed, it would require the market leaders in the healthcare industry to adopt similar cost accounting methods to those used in the manufacturing industry and improve supply management practices through the implementation of JIT Logistical Systems.

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According to research by Jarrett (1998) market-oriented approaches to controlling health care costs offer less certainty about the outcomes that would be achieved, as there is little experience from which to predict the effects on prices and how these effects would differ across patients, regions and providers. Certainly, as Jarrett (1998) suggests, if the industry were deregulated, consumers and providers would be forced to become more price conscious, and the consumers would be provided with more information, and thus downward pressure would be exerted on both insurance premiums and on providers' prices. These recommended changes by Jarrett (1998) and the current market forces should be a strong indication to health care providers that they must evaluate their current supply chain processes and implement JIT systems if they desire to remain competitive in an extremely competitive market. According to Jarrett (1998), the speed with which market forces and change will operate, and the potential reduction in cost that will occur, will not be difficult to assess. If market-oriented approaches to cost control are successful, however, consumers will probably retain a greater ability to choose among alternative treatments, amenities, and quality of care than in the current regulated environment.

Whether the current cost containment regulations remain enforced or a market-oriented approach is initiated, it will be imperative that providers embrace and implement supply management principals and JIT systems in order to be competitive in the current market environment.

Analysis of the total health care system indicates that the supply management system is one of the primary areas where cost reductions are a predictable outcome. One advantage of re-engineering the supply chain is that the cost reductions should not affect the quality of care to patients. This proposed supply-chain re-engineering would affect all components of the medical supply industry, to include manufacturers and their distribution channels (Jarrett, 1998).

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Jarrett's (1998) research suggests that by re-engineering the healthcare supply chain it will require that healthcare providers develop formulary committees to standardize the hundreds of thousands of medical and surgical product options that are being used today. This standardization process should reduce 80 percent of the products by eliminating product duplication. The formulary process should evaluate and select the preferred products by value and costs. Jarrett (1998) adds that even outside the scope of a JIT program, it is useful to know that a particular supplier can produce the quality needed, and in addition, respond flexibly and capably if the provider experiences an emergency or an upsurge in orders. This valuable information reduces manufacturers' error forecasting and improves strategic planning.

Rowan (2012) research suggests simply controlling how much an organization purchases. Owning and handling products drives cost. The goal of top-performing hospital supply chains is to own as little inventory as possible while maintaining optimum service levels. That is why Rowan (2012) suggests that the use of logical-unit-of-measure processes is growing so quickly in healthcare. Under logical unit of measure, inventory is purchased just before it is consumed. Orders are delivered in smaller, ready-to-use quantities. In top-performing supply chains across industries, most product handling happens before the customer buys the product to focus resources in core strategic areas.

Subsequently, Rowan (2012) suggests focusing labor resources on patients. Supply chain processes should require a minimum of staff time for both clinicians and materials management staff. Rowan (2012) believes that it is not uncommon for a product to be touched 10 times before being used by a patient. These touch points waste staff time and increase the risk of errors. A recent PwC study found that hospitals using just-in-time logistics gain significant labor savings. The non-price cost per purchase order line received was just 3 cents for hospitals using just-in-

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time logistics, compared with 15 cents for non-just-in-time orders with a distributor, and 20 cents for manufacturer-direct orders, according to PwC (Rowan, 2012).

Healthcare Supply Chain Technology

Not only can JIT systems potentially positively impact the healthcare supply chain, but also improvements in technology may yield better results and more efficiency. Kumar, Swanson, & Tran's (2009) research concentrated on determining the most efficient and cost effective portions of the healthcare supply chain in which radio frequency identification devices (RFID) can be implemented and how the technology can help the overall effectiveness of the healthcare supply chain. Their motivation in studying RFID and the healthcare industry is to improve the healthcare supply chain by looking at possibilities of exploiting RFID technology. Kumar et al. (2009) believe that with improvements, end customers and patients will receive better service while mistakes in treatment of patients or underutilization of equipment in the hospitals will be minimized through the use of RFID. They also suggest that proper management of RFID technology may enhance healthcare services and products by lowering costs, improving the quality of care, and make patient care more reliable and consistent by properly managing and tracking information and material flows.

According to Kumar et al. (2009), RFIDs, or radio frequency identification tags, are electronic chips embedded within or very near a product or shipment. They serve as a tool of remotely tracking supplies, equipment, and even people as they move through the supply chain from manufacturers to suppliers, wholesalers, hospitals, pharmacies, intermediaries, and end customers as well as their movement within a single firm. Currently, according to Kumar et al. (2009), RFID technology is widely available and relatively easy to integrate into the healthcare supply chain. The training, technology, and necessary collaboration are all within reach of most

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customers and suppliers, however, the costs are still prohibitive for many participants. The cost of the individual RFID tags, the cost of the tag readers, and the cost of creating a singular and unified system that is easily adopted by all players in the supply chain are the reasons Kumar et al. (2009) conclude that RFID is not currently utilized to its full extent.

According to Kumar et al. (2009), in order to improve the healthcare supply chain through RFID technology, there must be collaboration, long-term relationships, and capital investment present. Supply chain collaboration must take place in order for each player to know the downstream as well as upstream uses of their products. Suppliers must be willing to meet the needs of their customers in order to make this technology effective for implementation. Creating long term relationships will make this technology both unified with the wide range of technologies available and justify the equipment purchases and training. In addition, by making the capital expenditures needed for RFID technology in collaboration with supply chain partners, it is much more likely that the costs will pay off in a more expedited manner. Kumar et al. (2009) conclude that with these elements working together, it will improve the opportunity for success that RFID streamlines the healthcare supply chain over time.

Kumar et al. (2009) comment that there are many potential uses for RFID in the hospital and healthcare value chain. RFID applications can be used in the pharmaceuticals, medical device, medical equipment, and patient supply chains. These RFID applications can control product diversion, protect against counterfeit drugs, and track medical devices. In particular, one of the key uses of RFID is asset tracking and scheduling of hospital equipment. According to Kumar et al's (2009) research, they believe that implemented RFID will be capable of scheduling and checking availability of hospital beds and equipment for childbirth delivery. An additional

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assumption is that RFID will assist in information flow of patient data and facilitate electronic medical records.

According to Perry & Kocakülâh (2010), the current state of healthcare supply management is very much a product of its past, though information technology has also changed the way that business gets done. Most of the current generation of hospital enterprise resource planning (ERP) software systems help supply chain professionals manage inventory by automatically calculating economic order quantities and safety stock or by allowing for supplier owned and managed inventory (typically called consignment relationships). ERP software and information technology also provide supply chain professionals the ability to collect, store, manage, and interpret data in many business activities and in many forms. With materials management departments under pressure to stay as asset-light as possible and maximize inventory turns, these tools can be very important.

According to Kumar et al. (2009), the implications of integrating more use of information technology related to supply-chain RFID devices are great. Time, money, effort, and patient deaths can all be greatly reduced with a proper implementation of this technology according to Kumar et al. (2009). Resources could be leveraged more with the implementation. Equipment, materials, and patients can be more effectively managed to lower overall operational costs. Time to locate materials and equipment will be greatly reduced and the contents can be immediately identified once the item is located. A history of the use of a product or piece of equipment can be kept and potential problems can be isolated much more quickly with proper records as a part of RFID technology. Kumar et al. (2009) shed light on the fact that with newer technology comes uncertainty, and with uncertainty comes cost expenditures, but there are also numerous potential benefits available that can aid in the efficiency of the healthcare supply chain.

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Lastly, Perry & Kocakülâh (2010), suggest that information technology usage in the supply function does not stop at tracing (RFID) or inventory, either. The dot-com boom of the early part of the century vetted numerous online exchanges and trading networks that sought to serve the acute care market. A clear leader eventually emerged in global healthcare exchange (GHX), a trading platform with the support of nearly all of the major suppliers, distributors, Group Purchasing Organizations, and the largest healthcare providers in the country. GHX maintains a common item master/product catalogue and facilitates orders, invoices, and contract management. GHX scrubs and standardizes data across all of the trading network partners to eliminate duplicate data entry, errors, and invoice and purchase order discrepancies. E-commerce transactions like those through GHX have helped coin the term "perfect order," wherein requisitioning, ordering, receiving, invoicing, and payment disbursement all occur electronically, paperless, and automated to a great extent. While the perfect order is far from the standard in most healthcare supply functions, online ordering has become the norm over traditional methods of fax or phone orders, and online requisitions have become more prevalent. According to Perry & Kocakülâh (2010), what we see is information technology enabling significant transactional efficiency.

Efficiency Drivers & Integrating Processes

Increasingly, research continues to show that hospital and healthcare delivery system executives are finally viewing supply chain factors as a strategic advantage that can be leveraged to meet operational, clinical and financial performance imperatives. This has not always been the case. For years, the supply chain was seen as little more than a necessary but ancillary function to buy and deliver products as needed with the primary supply chain improvement strategy focused on buying those products at the lowest price possible.

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The factors that are driving the call for efficiency in health care supply chain are based on common business sense realizing that considering the size of the industry, even small-scale efficiencies can have potentially large dollar impact. Some of the key drivers include fragmented supplier bases which cost significant time and money for the buyer in terms of managing vendor relationships, and thus the goal should be to consolidate purchases so as to buy the majority of products from one source. Another driver is the reduction of government subsidies which have created the necessity to control costs and regulations which have created the urgency for providers to address security and electronic transaction issues, resulting in additional cost of doing business. Next, an efficient supply chain frees up time for health care professionals to focus on their core competency of delivering quality patient care. Internet based purchasing is another driver, this enables supplier consolidation, reducing ordering costs, and a common purchasing platform for hospital networks. In addition, adopting and promoting uniform industry data standards for supply chain transactions over the internet will help streamline and create a more efficient health care supply chain. Another driver is the standardization of hospital supplies for their impact on (a) purchase volume (b) ordering and tracking (c) storage space (d) resource allocation, and (e) economies of scale through group purchasing power (Chandra et al., 2004).

According to Chandra et al. (2004), there is now a greater awareness in the health care industry that there are significant payoffs through efficient management of the health care supply chain, whose processes incur avoidable costs in the following areas such as transportation from a production plant to a regional distribution center, distribution center operations, outbound freight, wholesale distributor's receiving and warehousing operations, wholesaler distributor's

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mark-up for information processing and customer service, transportation to the care provider, and inventory.

According to Brennan (1998), integrated supply chain processes would transform disjointed strings of activities into streamlined, cost effective processes characterized by substantial standardization, integration, and optimal service placement. In order to successfully integrate supply chain processes, supply chain management needs to focus first on demand management. Demand management manages consumption of clinical resources which is key to controlling usage and reducing the number of supplies that move through the supply chain process. In order to do so, three practices need to be implemented in this regard: 1) demand needs to be forecast and a plan implemented to facilitate fulfillment of supplies on a periodic basis, 2) standardization of supplies so as to deliver them as a single unit of inventory, and 3) development of clinical guidelines to define supply requirements for key patient groupings. Next, order management, which includes the initiating of effective order management needs to be met or exceeded. To do so, establishing a standard order management process must take place, e-procurement through Web or electronic data interchange, and implementation of electronic product numbering and tracking process. The next supply chain management area includes supplier management which entails reducing the number of suppliers that provide product to the healthcare system and also establishing and participating in group purchasing contracts to take advantage of discounts and rebates. Integrated logistics management is next which exploits efficiencies offered by consolidation of shipments, utilization of service centers and transportation network, and cross-docking in transportation of goods. Lastly, reducing the storage space, minimizing stock keeping units and their stocking levels, and maximizing inventory turnover rates can achieve integrated

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management savings. One of the key enabler of this policy is reducing variability among common products through yet again standardization initiatives (Chandra et al., 2004).

McKone-Sweet, Hamilton, & Willis's (2005) findings within the healthcare industry supply chain concentrated on the barriers to implementing supply chain management practices.

According to McKone-Sweet et al. (2005), these barriers include: lack of executive support; misaligned or conflicting incentives; need for data collection and performance measurement; limited education on supply chain; and inconsistent relationships with group purchasing organizations and other supply chain partners.

According to McKone-Sweet et al. (2005), despite the recognized importance of managing the hospital supply chain, tremendous variability exists in execution and measurement. There has also been limited academic research that helps to identify barriers to successful implementation or to recommend best practices. With that said, during the last two decades, the scope of supply chain management has greatly expanded. Early supply chain efforts focused on the material and service inputs from suppliers and their impact on an organization's ability to meet customer needs. During those early efforts, much of the attention was placed on cost reduction. Gradually, organizations are continuing to understand the importance of looking at the entire supply chain from raw materials to manufacturing to distribution to retailers and to the final customer and its impact on the customer. The focus has shifted to overall profitability of the supply chain to increasing revenues by having the right product at the right time, and decreasing costs through more efficient material and information flow.

According to Ebel et al. (2013) healthcare companies need to increase the transparency of their costs, including manufacturing, transport, warehousing, inventory holding, staff, and obsolescence; moves that could cut operational costs and optimize route-to-market approaches

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and product portfolios. Improvements are also needed in structural drivers or capabilities such as responsiveness, manufacturing frequency, reliability of supply, and stability are mostly not systematically measured or managed across the network. Consumer-goods companies are clearly more advanced: they watch metrics such as the manufacturing-frequency index to measure the share of SKUs that are produced with high frequency. Finally, Ebel et al. (2013) suggest that companies must standardize metrics across countries and plants. Commercially available benchmarking tools and approaches provide rough guidance for high-level opportunities in services, costs, and inventories, but not fully comparable results or tangible recommendations on how to capture value.

While internal optimization can deliver better service at lower cost, companies have even more to gain from optimizing externally. To do so, they must align processes and improve collaboration. Ebel et al. (2013) findings suggest beginning with alignment. Manufacturers of fast-moving consumer goods use point-of-sale information from retail customers to build production plans. The grocery industry, for example, has created billions of dollars in value by adopting standard barcodes. To build a cost-effective supply chain, the health-care sector could align around a single set of global standards that support data interchange, processes, and capabilities. Doing so may increase efficiency and patient safety by making it harder for counterfeiters to operate, by reducing medication errors, and by improving recall processes.

Looking to the Future

According to GHX (2011), the health care industry needs to do a better job at investing in supply chain technology. Historically, healthcare providers have invested less on information technology than organizations in other industries, and the money they do spend is primarily devoted to clinical systems. That scenario is even truer these days, with the federal government

requiring providers to make substantial investments in electronic medical records. But, as GHX (2011) research points out, industries that invest in supply chain technology are better able to virtually integrate various functions and organizations, which in turn can increase appreciation for the interdependent nature of the supply chain. An e-commerce infrastructure, for example, creates connectivity and linkages that enable supply chain partners to share data with one another, building both trust and visibility to drive supply chain efficient improvement.

According to GHX (2011), successful supply chain transformation encompasses more than just application of best practices and technology. It requires a fundamental shift in how an organization behaves internally and with its business partners. In other words, it is an exercise in change management that must be led from the top of the organization, with effective execution across the enterprise.

GHX's (2011) findings indicate that in most hospitals and healthcare systems, the supply chain is still viewed as a tactical function as opposed to a process that touches nearly every aspect of the organization. As a result, the supply chain rarely holds a seat in the executive suite and is limited in its ability to contribute to overall corporate strategy. Whereas, in most other industries the head of supply chain is considered an executive-level position.

GHX's (2011) findings also indicate that supply chain optimization requires a broader skill set than most healthcare providers currently possess. For example, the vast majority of hospital supply chain departments do not have personnel with formal training in areas such as industrial engineering or logistics, and if a supply chain represents 30 percent of total costs, then the healthcare industry should be investing a proportionate amount in professional development in this area, noting that few healthcare industry associations devote much, if any, attention to supply chain topics (GHX, 2011).

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According to GHX (2011), the bottom line is clear, successful supply chain transformation requires more than well-executed technology, process improvements, and best practices. Supply chain leaders must have executive-level and enterprise-wide responsibility, a fundamental understanding of the interdependencies and interrelationships inherent in the supply chain, and the ability to change how their organizations behave, both internally and externally.

According to GHX (2011), enlightened CEOs should insist that only the best supply chain professionals be hired. The challenge for healthcare system executives is attracting top talent.

Historically, because healthcare has devalued the supply chain role, it has not offered the level of authority, compensation or resources to compete with other industries for skilled supply chain leaders. With a greater appreciation for the role the supply chain can play in optimizing the quality of care and improving efficiencies, the milestones by which healthcare organizations will be measured and reimbursed going forward, GHX (2011) suggests that the time is now for healthcare executives to make the supply chain an integral, not ancillary, part of their organizations.

The growing appreciation for the supply chain is being driven by several factors, with a weak economy and declining reimbursements certainly among them. As the second largest and fastest growing operational expense for most hospitals, supply chain costs are clear targets to yield operational improvements and cost savings. A closer look uncovers even greater opportunities, particularly as it relates to capturing data that can be used to make better purchasing decisions by understanding the role supplies play in delivering quality patient care in a more cost effective and efficient manner, an imperative under healthcare reform (GHX, 2011).

GHX's (2011) findings indicate in terms of communication, one of the challenges with sharing data between trading partners is the lack of adoption of industry standard product identifiers and

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use of auto ID and capture technology such as barcodes and RFID in healthcare. GHX (2011) notes that in other industries, real progress on the supply chain front can be traced back to use of a common language. That's expected to improve with the pending FDA Unique Device Identification (UDI) rule requiring manufacturers to uniquely identify their products, but there are concerns that healthcare providers will not be ready or able to take full advantage of those identifiers. GHX (2011) points out that the FDA rule mandating barcodes on medications went into effect in 2005, and yet today only about a third of U.S. hospitals are actively scanning medications at the bedside. When asked, providers said "a lack of resources" was the biggest barrier to getting ready to use the UDI which is a problem in and of itself.

According to Ebel, Larsen, & Shah (2013), dramatically changing the healthcare sector's inefficient supply chain may eliminate the dangers posed by counterfeiting and medication errors as well. Increasingly, companies are expanding their product portfolios to meet rapidly changing markets and lengthening product life cycles which results in more complex manufacturing, particularly with pharmaceuticals and medical devices. Emerging economies want more affordable products. Quality and compliance issues are rising because products are more complex and regulatory scrutiny is stricter.

Similarly, the number of drug recalls is increasing. Yet the supply chain remains fragmented and incomplete, with weaknesses that put patients at risk, cost billions in value, and lessen the health-care sector's ability to take on the challenges it faces (Ebel et al. 2013). According to the research of Ebel et al. (2013), the good news is that models do exist to strengthen and improve the healthcare supply chain going forward. They conclude that by learning from the experience of industries such as fast-moving retail consumer goods, the health-care sector could cut production lead times and obsolescence, while manufacturers, distributors, hospitals, and

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pharmacies could carry significantly smaller inventories. Improving the health-care supply chain also could give millions of people around the world access to safer and more affordable health care, reduce costs, and provide new revenue sources for manufacturers.

According to Rowan (2012), the new healthcare reform demands that hospitals invest in improving both patient outcomes and patient satisfaction. A high-performing hospital supply chain supports these goals while minimizing the outlay of cash and capital. To do so, Rowan (2012), suggests aligning capital investment with strategic priorities. In a value-based business environment, hospitals integrated delivery systems are driving capital toward their core mission: improving outcomes for patients. Minimizing capital tied up in the supply chain increases hospitals' flexibility to make clinical improvements. Hospitals should steer away from supply chain decisions that do not support the organization's core mission or that require long-term fixed investments (Rowan, 2012).

According to Perry & Kocakülâh (2010), healthcare supply chain management needs leadership and an organizational, strategic focus on accumulating sourcing and contracting capabilities for clinical preference items. An awareness of the problems and best practices in the supply chain is only an initial step toward future success. Healthcare is moving toward one key principle and that is again clinical outcomes. Perry & Kocakülâh (2010) suggest that a cross-disciplinary, inter-organizational leadership is needed in supply chain management to interface clinicians, suppliers, supply chain peers, and group purchasing organizations in a clinical value chain, outcome-based strategy. The abilities to collaborate and access, assimilate, and interpret information from each of these sources will be central to healthcare cost containment and success for all stakeholders.

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Perry & Kocakülâh's (2010) research concludes that healthcare supply chain management needs leadership and an organizational, strategic focus on accumulating sourcing and contracting capabilities for clinical preference items. In the beginning of 2008, the Association for Healthcare Resource & Materials Management (AHRMM) and Arizona State University partnered to offer SCMetrix, a supply chain benchmarking initiative. Hospitals and health systems enter a wealth of supply chain, clinical, and reimbursement data in the SCMetrix system to discover how they compare on key, value-based performance metrics of organizational success. This is an important first step for supply chain management personnel to coalesce around industry-leading practices. As of yet, no such resource has existed in the healthcare supply arena, and the extent to which SCMetrix will be widely adopted is undetermined. Both supply professionals and hospital executives must expect more from supply chain management; having visible feedback on key performance indicators in relation to top industry performers can engender those expectations.

According to Perry & Kocakülâh (2010), an awareness of the problems and best practices in the supply chain is only an initial step toward future success. To meet its vision for transparent, value-driven healthcare, the Center for Medicare and Medicaid Services (CMS) is moving toward outcome-based reimbursement, and clinical performance data for hospitals is becoming more readily accessible to patients. The supply chain needs to close the gap to ensure sustainable success. Supply professionals must look up and down stream to supply's role in the entire healthcare value chain. Perry & Kocakülâh (2010) findings suggest that SCMetrix can help foster that, but what is also necessary is greater collaboration between supply professionals, clinicians, suppliers, and group purchasing organizations. As of now, no information system exists in the hospital that maps supply to clinical outcomes. Most organizations maintain an outcomes

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database, but it is not linked to the management information system. Suppliers can provide the missing link, as many retain patient data for procedures involving their products. Plus, group purchasing organizations can play a key role in providing market and product comparison data to member organizations. A knowledge management application with a social networking component and integrated data could provide the solution, but in any case supply professionals will need the information technology skills to bring these sources of information together in a meaningful way and the people skills to integrate a supply strategy with clinical outcomes.

III. SUMMARY, CONCLUSION, RECOMMENDATIONS

The healthcare industry is at an all-important period of time. The global population is continuing to grow and the median age is increasing. The demand for quality and timely healthcare services has never been greater. Healthcare providers should be moving quickly to make the necessary changes to their supply chain so that they can stay a step ahead of customer needs and capitalize on new opportunities. The problem is, the healthcare industry supply chain is slow to make the necessary changes.

The healthcare industry should be following the lead of the retail industry and implement processes to transform their supply chains in order to meet growing demand. Healthcare providers should be standardizing their data to increase compatibility, reduce redundancy, improve traceability and identification of products, and improve exchange and collection efficiency. Similarly, healthcare providers should standardize their product lines and forms of communication to reduce costs, reduce repetitiveness, and decrease influences from industry members. Another important aspect for the healthcare industry is to improve collaboration capabilities with supply chain partners, as well as increase visibility of data so it can be properly understood and trusted, in order to quickly respond to issues and avoid a potential bullwhip

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effect. Next, with the current cost explosion in terms of healthcare supplies, the industry must implement processes so that clear and measurable quality metrics can be achieved. By doing so, along with better analyzing, planning, and controlling of purchases, this will assist in reducing the increasingly high costs of healthcare goods and services. One idea to improve the healthcare supply chain could be through the implementation of Just-in-Time (JIT) strategies. Although additional research needs to be completed in the future to see whether JIT would be a feasible option for the healthcare industry, the goal would be to improve the healthcare supply chain return on investment by reducing in-process inventory and their associated costs. The healthcare industry should also make a point to continually invest in technology to improve competitiveness and efficiency. Planned technology investments will enable better product protection, visibility, up-to-date logistical tracking, and easier patient access through online ordering. Lastly, organizational changes starting at the executive level in healthcare organizations should begin focusing on the supply chain as an integral, not ancillary, part of the organization's operations. To do so, healthcare organizations should concentrate on attracting, hiring, and appropriately compensating top individuals with supply chain management experience so they can help drive the movement to improve the healthcare supply chain.

Future winners in the healthcare marketplace will be the providers that have created agile, efficient, and flexible supply chains. Now is the time for the healthcare industry to take action, to make the strategic supply chain changes what will allow the industry to capitalize on the future demands of the global population. Not acting could be the greatest risk of all.

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