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**Emerging Trends in Healthcare Supply Chain: An Approach to
Agile Services**



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Emerging Trends in Healthcare Supply Chain: An Approach to Agile Services

¹Emmanuel Ampong Afoakwah, ²Hannah Kemevor, ³Sophia Dauda, ⁴Clara Owusuaa-Konadu Snr.

^{1,2,3,4} Lecturers, Catholic University of Ghana, Department of Management
Faculty of Economics and Business Administration

¹Email: afoakwahemmanuel1@yahoo.com / emmanuel.ampong@cug.edu.gh

ORCID: 0000-0002-9325-9657

²Email: hannah.kemevor@cug.edu.gh

ORCID: 0000-0002-1071-175X

³Email: Sophia.dauda@cug.edu.gh

ORCID: 0000-0003-2849-5781

⁴Email: shenrylina@gmail.com / clara.ok@cug.edu.gh

ORCID: 0000-0003-4433-4099

(Corresponding Author): Emmanuel Ampong Afoakwah

Email: afoakwahemmanuel1@yahoo.com

Abstract

This paper focuses on the emerging trends for optimizing costs in healthcare supply chains, including virtual centralization of supply chains, utility utilization management practices, use of RFID technologies, use of analytics, streamlining of workflows, etc. The application of these Technologies can enable affordable health care solutions in developing countries.

Keywords: *Healthcare Supply Chain, Virtual Centralization, Vendor Managed Inventory*

1.0 Introduction

In an age of competition, no industry can survive without thinking about reducing expenses wherever possible. The same is true for the healthcare industry, which is experiencing sharp price increases in almost all of its products and services. The alarming rate of cost increases is making the products of the industry unattainable for the masses. The supply chain in this industry is a major cost driver and therefore attracts the full attention of industry stakeholders.

This study focuses on discussing the fundamental nature and components of the healthcare industry supply chain with considerable attention to future areas and current trends. The supply chain in this industry is believed to be inherently complex and hence spotting a magic button

that will help eliminate the inefficiencies to reduce costs is quite a difficult task. As part of the research for this paper, we conducted extensive literature reviews and attempted to gain insight into the complexities of healthcare supply chain management (SCM). The current trend shows that the industry is struggling to meet on-time deliveries. The main disadvantage remains the fact that each part of the supply chain operates independently, creating misaligned activities that prevent them from functioning as a system. We also analyzed the healthcare supply chain in Malaysia to better understand the current scenario in developing countries.

The literature review sheds light on issues such as the redesign of inventory management systems in hospitals, the aggregation of suppliers and their products through electronic catalogues, the use of ERP systems to address another bottleneck in the supply chain, namely: inefficient information flow in the system. The paper addresses certain new strategies emerging in the industry that contribute to efficient SCM practices. These are: RFID, Supply Utilization Management, Virtual Centralization of the Supply Chain and Vendor Managed Inventory. RFID helps achieve inventory visibility and accurate counts at every stage of the supply chain, and also helps reduce shrinkage and shipping errors. Supply Utilization Management helps reduce waste, value discrepancy and abuse through standardization and proper specification.

On the other hand, the virtual centralization of the supply chain helps to improve collaboration in hospitals, thereby helping them to control costs and improve services. How the virtual centralization works is explained using an example from CSC: This is a joint property and is managed by several hospitals and health units. CSC brings together geographically dispersed healthcare units and enables them to work together to achieve maximum efficiencies in sourcing, contracting and customer service. Hospitals are currently looking for new sources of competitive advantage and cost reduction measures wherever possible. It is imperative to examine the aspects of supply chain management and identify areas where they can improve service quality for efficient patient care.

Healthcare supply chain management should ensure complete end-to-end visibility of information between suppliers, manufacturers, distributors and customers. The healthcare supply chain involves the flow of many different types of products and the involvement of multiple stakeholders. The primary purpose of the healthcare supply chain is to deliver products in a timely manner to meet the needs of providers. Based on their functions, the actors in the healthcare supply chain can be divided into three broad groups: manufacturers, buyers and providers. (Illustration 1).

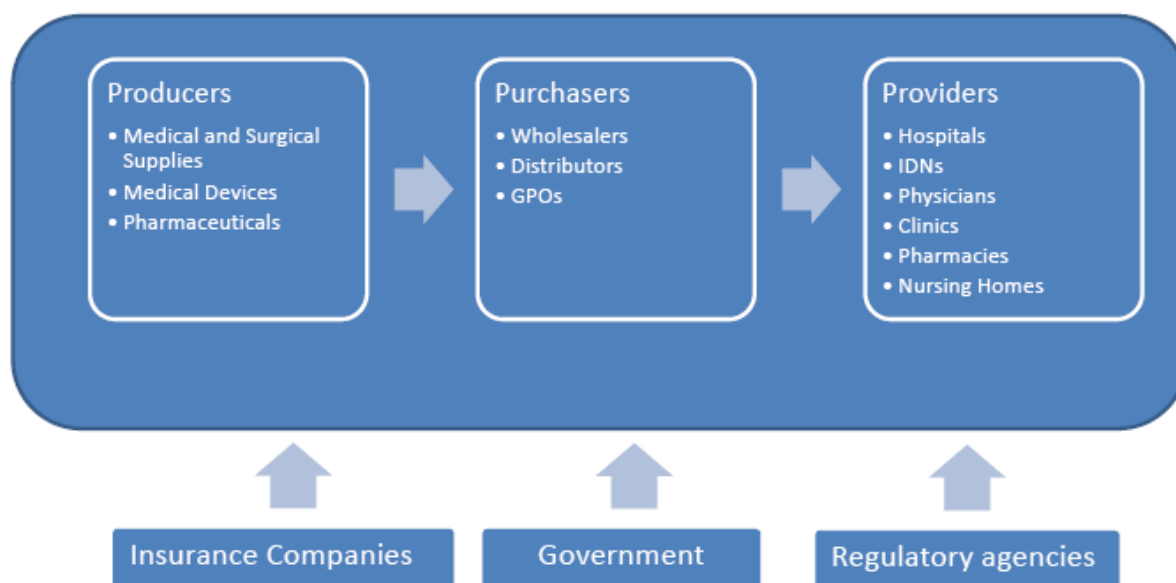


Illustration 1: *Healthcare supply chain configuration (Adapted from Burns 2002)*

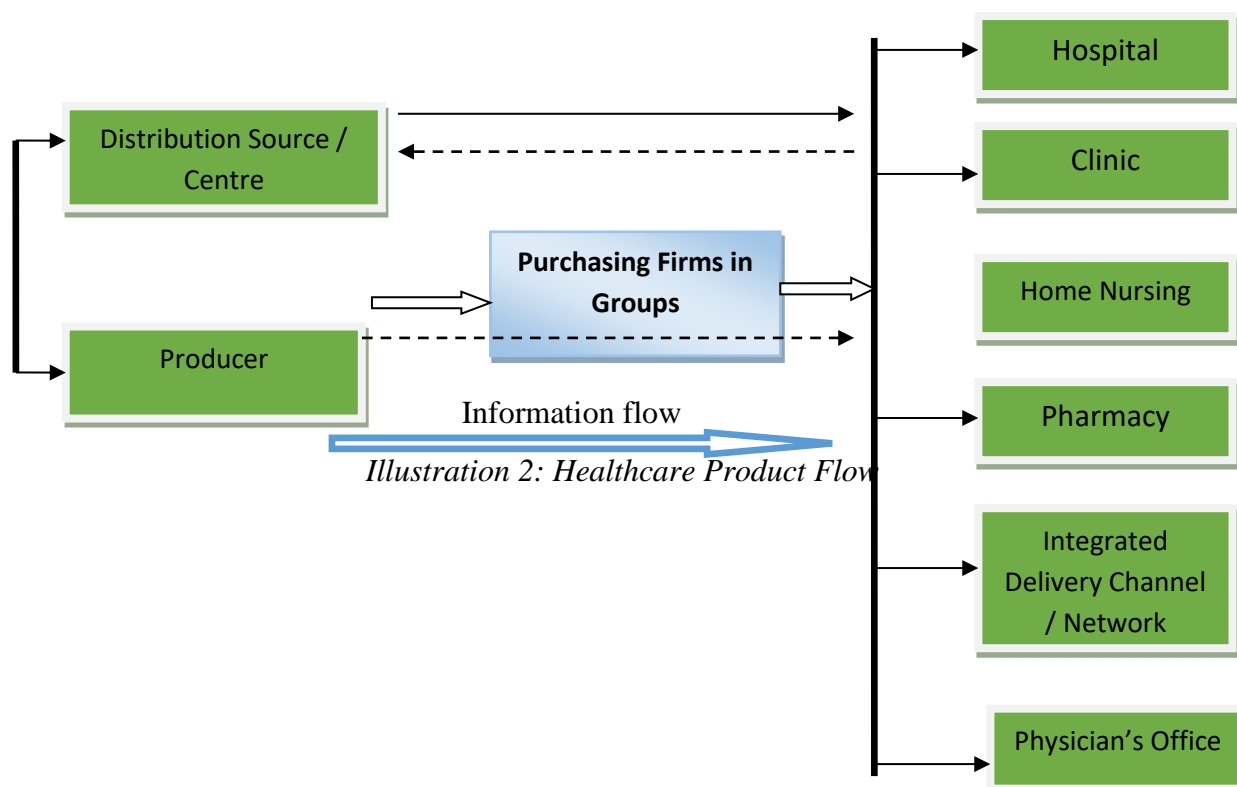
To add to the complexity of the system, there is also the involvement and involvement of government institutions, regulators, and insurance companies (Ryan, 2005). Primary manufacturing involves the manufacture of the active ingredient contained in the drug. Due to the need to avoid contamination between products, there is long downtime in production to allow for cleaning, resulting in batch production (Shah, 2004). In fact, this represents mass production. In secondary production, the active substance is converted into usable products (e.g. tablets, capsules, etc.). This can lead to a significant expansion of the product lines, especially when considering the packaging. Altricher and Caillet (2004) assume a 200-fold product growth in this phase of the supply chain. With increasing globalization in the pharmaceutical industry, the location of manufacturing facilities is often influenced by factors such as tax advantages (Papageorgiou, 2001). In fact, secondary manufacturing may be geographically separate from primary manufacturing, serving local or regional markets (Shah, 2004).

As far as the distribution of finished products is concerned, there are a number of different channels to the market. The (at least quantitatively) dominant intermediary is the wholesaler. In the UK, about 80 percent of volume flows through this channel (Shah, 2004). Hospitals and retailers with large needs receive supplies directly from the manufacturer's distribution center. Similarly, hospitals can leverage economies of scale by consolidating their purchasing power, for example through group purchasing organizations (Roark, 2005).

Regarding the characteristics of these supply chains, Shah (2004) provides detailed information on typical performance levels. There are long lead times, with products taking anywhere from 1,000 to 8,000 hours to traverse the entire supply chain. Coupled with this, inventories appear to be quite high, with inventory turns taking anywhere from one to eight weeks. This agrees

with the results of Haavik (2000) who reported that in 1994 inventory turns in hospital camps took four to five weeks.

Another issue raised by several authors is demand amplification (Correa 2004, Shah, 2004). Perhaps this is to be expected given the number of intermediaries in the supply chain and the batching nature of primary manufacturing. The product flow (Figure 2) in healthcare begins with the manufacturer and ends with the end customer at the healthcare provider. Depending on the type, a product may be shipped from the manufacturer directly to the healthcare provider or may be routed through a distributor before reaching the healthcare provider. The healthcare supply chain is often described as highly fragmented and relatively inefficient (Schneller and Smeltzer 2006). A major problem with the traditional healthcare supply chain is that each stage of the supply chain operates independently, resulting in misaligned incentives and conflicting goals that prevent the supply chain from functioning as a system. These conflicting goals, along with other obstacles, have hampered the adoption and implementation of SCM practices.



1.2 Literature on Healthcare Supply Chain Management Practices

The following literature reviews present the current state of healthcare in relation to barriers and practices to implementing SCM principles. Heinbuch (1995) described an approach to addressing the challenge of reducing healthcare costs by the hospital material management function. The work underlines the value of a proactive attitude to meet the challenge of technology transfer across industrial sectors.

Alverson (2003) discussed the importance of disciplined inventory management for hospitals and suggested serious consequences of traditional hospital purchasing, including poor

inventory control, missed contract compliance, excessive inventory, frequent out-of-stocks and costly emergency supplies, workflow disruptions and costly rework, and increased labor demands in the healthcare system. The information technology (IT) literature offers some solutions for material management in the healthcare sector. Burns (2002) discussed aggregation of suppliers and their products through electronic catalogues, visibility of purchase orders and materials, and sourcing efficiency.

Schneller and Smeltzer (2006) suggested that e-procurement systems can help reduce purchasing costs significantly by consolidating supplier networks and building supplier partnerships. They also suggested that transaction and administration costs can be reduced through the use of ERP systems, which provide an automated and paperless format for information flow within an organization.

1.3 Current State of SCM in the Healthcare Industry

In the healthcare industry, the supply chain associated with pharmaceutical products is vital to ensure a high standard of care for patients and ensure adequate supply of medicines to pharmacies. In terms of costs, it is estimated that care accounts for 25-30 percent of hospital operating costs (Roark, 2005). It is therefore important that this is managed effectively to ensure that both service and cost targets are met. At the distribution level, especially from the wholesaler to the hospital, various problems exist:

Product life cycle: After patenting the active substance it can take eight years until the product is developed into a marketable product (Papageorgiou 2001).

After the patent expires, alternative products can come onto the market or companies can lower the product price (Lauer 2004). New technologies are shortening life cycles and creating new pressure on sales channels.

Product life cycle: If the active ingredient is patented, it can take eight years for the product to develop into a marketable product (Papageorgiou 2001). After the patent expires, alternative products can come onto the market or companies can lower the product price (Lauer 2004). New technologies are shortening life cycles and putting new pressure on distribution channels.

Profit margins: Despite the high unit value of pharmaceutical products, operating margins are low, especially in the wholesale sector. One reason for this is price control by hospitals, retailers and manufacturers (Lauer 2004).

Forecast: The exact demand for medicines is difficult to predict. One of the problems is the availability of accurate consumption data. However, the lack of a uniform nomenclature for healthcare products and the preferences of clinicians create further uncertainties (Lauer 2004).

Lack of education about supply chains: Awareness of the concept of supply chain management, especially in hospitals, is low (Lauer 2004). As a result, managers are not adequately equipped to control drug supply. With this in mind, a number of initiatives have been taken in recent years to reduce supply chain costs and improve customer service. Initial improvements were based on the implementation of just-in-time (JIT) approaches (Kowalski

1986). Subsequently, this was further developed with the introduction of non-stock inventory systems (Wilson 1992). The JIT and inventoryless approach can reduce inventory carrying costs in the organization while maintaining service levels (Lynch 1991). More recently it has been suggested that the bearingless system should only be used for high volume products, with a more traditional approach for low volume medical items (Rivard-Royer 2002). However, this requires improved information and communication technology (ICT) systems, as well as automated order processing and suppliers (mainly wholesalers) close to the hospital to enable rapid replenishment. Both JIT and stockless approaches represent pull-type inventory management systems.

1.4 Supply Chain Process

The supply chain of healthcare in a developing country is analyzed using data available in the literature. The process below outlines the supply chain management practices in the healthcare industry in Malaysia. We used Malaysia as a reference to examine health care chain practices in a developing country. The main issues are analyzed and we have proposed various supply chain integration methods to improve existing practices. In Malaysia, each clinic is responsible for monitoring and managing its own inventory and placing an order with the wholesaler when necessary. The decision of which products to order, when, and in what quantity depends on the experience and skill of the clinic staff. Clinics order directly via the online ordering system (PO). Orders are usually placed in the first and third week of each month. All orders are processed and delivered within five days. Each order is identified by the order number, which is automatically generated in the system. The first step in order processing at the wholesaler is to check the order data and the availability of the products for delivery. If the product is not in stock, the supply manager will be informed. If an order is pending for the products, the supplier will be contacted to determine their status. Otherwise a new purchase order will be created with the supplier. In this case, the delivery will be delayed until the product is in stock. Sometimes certain products are substituted for others when the alternative product can serve the same purpose. For example, orange lozenges can replace herbal lozenges as the only difference is the taste.

The next process is packing, where the products are packed based on the order. All the products needed for a clinic are packed together for easy delivery. This process should be done three days before the delivery date. All products delivered to each store are listed on the Delivery Order (DO) form, each of which has a unique number. The warehouse keeper must update the inventory status in the record book based on the information in the DO to ensure the inventory status at the wholesaler is up to date.

Deliveries are made according to a schedule that takes into account the availability of the company's transport fleet (a van and a truck) and drivers. As a rule, deliveries are made twice a month, with the vehicles using the milk-run method to deliver to several branches in the area.

When the order arrives at the clinic, they check that the products shipped to them match those on the DO forms. If they are satisfied, the products will be taken to the store or to the refrigerator as soon as possible, depending on whether the medicine needs to be refrigerated.

The DO and delivery form must be signed as proof of delivery with a copy sent back to the wholesaler via the driver. If the delivered product deviates from the DO, the clinic should inform the wholesaler by phone as soon as possible and indicate the errors on the DO. If the product was left behind or delivered to the wrong store, a re-delivery will be scheduled to correct this error.

Common problems are urgent orders and unavailability of stock at the wholesaler. Urgent orders can be placed when a product reaches a critical stock level. This is because orders are created manually and are based only on the experience of individuals at the clinics. For normal orders there is a delivery time of five days, which increases the risk of stock failure. Unlike consumer products where the customer can either defer their purchase or purchase an alternative, this can be critical to patient care as there may not be an alternative treatment available to the patient. Therefore, urgent orders must be delivered immediately. Few products are delivered in each urgent shipment and due to the scattered locations of the clinics; Vehicle utilization is lower with increased transport costs. The wholesaler's inventory replenishment is based on the clinics' orders. Due to the nature of decision making in the clinics, it is difficult to predict their needs. In connection with two large order peaks per month, it can become difficult for the wholesaler if many clinics order the same products at the same time. This leads to out-of-stock problems for the wholesaler. Some clinics receive the products ordered while others have to wait for the new stock to arrive.

1.5 Proposed Solution - Supply Chain Integration

In hospitals, the supply chain strategy should be to maximize patient care. The hospital supply chain enables this strategy by:

- ❖ Ensuring product availability
- ❖ Minimizing storage space
- ❖ Maximizing patient care space
- ❖ Reduce material handling time and costs for all medical staff (nurses, pharmacists, doctors).
- ❖ Minimizing non-liquid assets (inventory).

1.6 Emerging Strategies

This white paper looks in detail at the following emerging strategies being practiced in the hospital industry to optimize the supply chain.

Virtual Centralization of the Supply Chain: Collaboration using virtual centralized supply chain management can put hospitals on the path to controlling costs and improving service. Virtual centralization integrates operations from the perspective of the market rather than the healthcare system. The most mature example is a consolidated service center (CSC) that is jointly owned and managed by multiple hospitals and healthcare systems. A CSC brings together geographically based groups of hospitals to form individual entities that work together to centralize contracting, procurement, distribution and logistics operations. The CSC not only

serves as a contact point for sales, but also for central ordering, procurement and customer service.

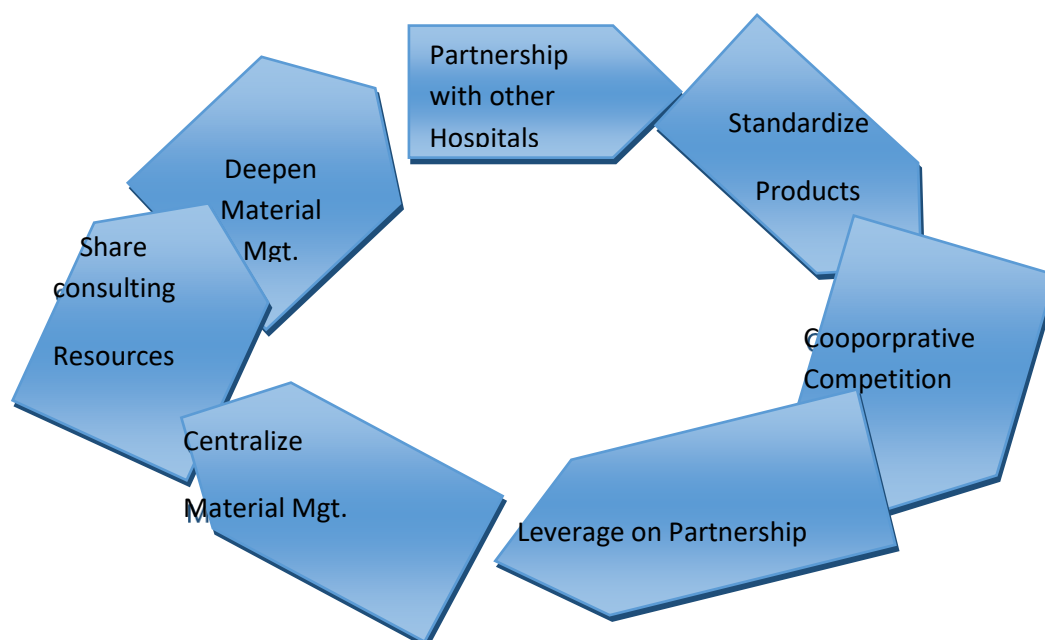


Illustration 3: How to begin a Consolidated Service Center.

This innovative approach helps to solve critical problems related to staff, time and budget constraints. And while saving money is paramount, a CSC also offers attendees networking opportunities. The opportunity to share best practices, conflict resolution and advice helps improve the bottom line. Hospitals would be able to have much more control over product selection and distribution. Consolidation of utility services would result in significantly improved visibility into a hospital's supply chain spend, improved product pricing through standardization and volume aggregation, reduced inventory levels, reduced distribution costs, and reduced inbound freight costs. Other benefits include the elimination of mark-up costs and lower product prices, inventory and inbound freight costs.

This type of arrangement would be particularly beneficial for rural, small and medium sized hospitals as they would not need to manage or install complex IT systems and could share the cost of those systems and the staff using them. They may also be able to outsource their sourcing functions to these collaborative fulfillment centers. Not only would this agreement have a major impact on the bottom line, but it would also allow them to focus more on collaborating with clinical quality value analysis teams that help support clinical product selection.

Radio Frequency Identification (RFID): Is a technology that connects objects to the Internet so they can be tracked and businesses can share data about them. Unlike the barcode application, RFID tags are robust and do not require line-of-sight identification, eliminating

the need for human intervention. The tags are programmable and contain information about destination, weight and a time stamp. The tags enable automation throughout the supply chain, including optimization of storage space and efficient tracking of goods to reduce costs and improve customer service. RFID tags provide accurate, real-time information, forcing applications and processes in all organizations to add value to the service.

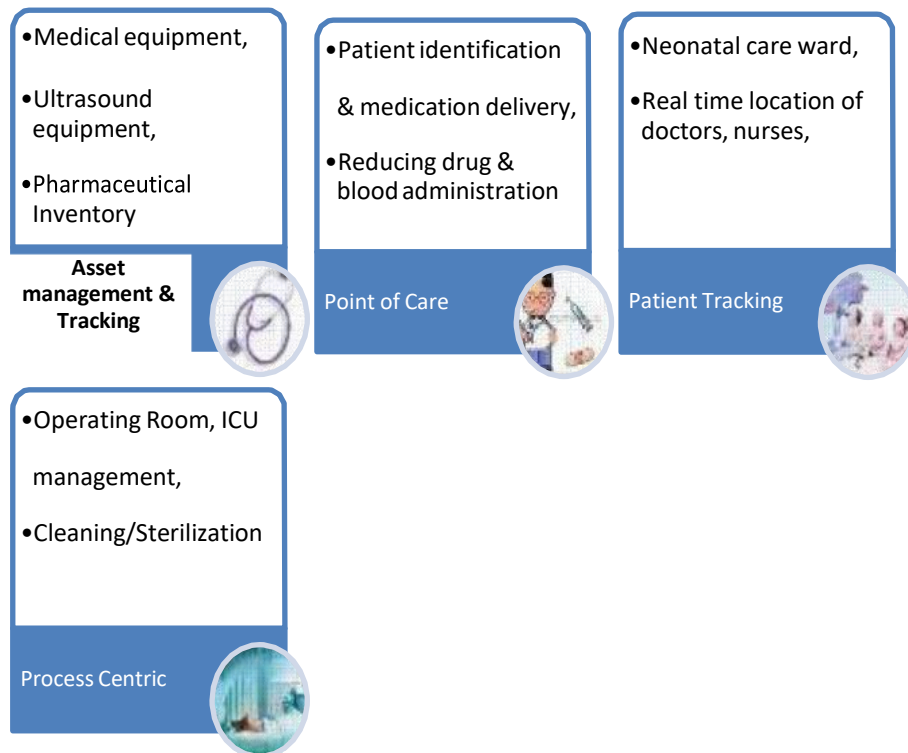


Illustration 4. RFID Applications

Real-time tracking of goods throughout the supply chain provides one of the major opportunities for improving customer service. Real-time information on delivery time supports Just-in-Time (JIT) manufacturing and retailing, enabling organizations to make strategic decisions. With the help of RFID, the following can be achieved:

- Improved tracking of high-value items/assets
- Reduced shrinkage and shipping errors in the supply chain
- Inventory visibility, accuracy, and efficiency at each stage
- Improved production planning and smart recalls for effective scheduling, and
- Technology standards to drive down costs with higher consumption of tags (economies of scale).

However, barriers to using RFID technology in healthcare industry include

- Technical issues - RFID may interfere with the hospital environment e.g., medical devices. Second, RFID systems are not always reliable. RFID read accuracy depends on a variety of factors such as tagged object, tag placement, angle of

rotation, and read distance.

- Cost - RFID costs include initial hardware and software costs, training, as well as the continuously high costs of RFID infrastructure maintenance and upgrade.
- Privacy concerns - The benefits of using RFID in medical settings are achievable only if patients are confident that the data being transmitted will not be misused [The patient information associated with RFID tag is highly mobile and sensitive.
- Other barriers - Other barriers to RFID adoption include the lack of organizational support, trust issues & security concerns.

1.7 Supply Utilization Management

Newly uncovered savings come not from reduced prices, but from eliminating waste, inefficiency, misuse, and value mismatches of the products, services, and technologies healthcare organizations employ. The following types of utilization misalignment are common in healthcare organizations.

- **Standardization.** Customizing products to customers' exact requirements can reduce an organization's supply chain expenses. Otherwise, the healthcare organization's money is wasted on unnecessary functions and features. Hence customization is preferred over standardization.
- **Over-specification.** Hospitals often purchase products with components or features that are not medically, legally, or functionally required.
- **Under-specification.** Too few components, wrong components, or missing critical features in products, services, and technologies are another common cause of utilization misalignment.
- **Value mismatches.** Many healthcare organizations bloat their supply budgets with costly products, services, and technologies that are not functionally required. These organizations often fail to look for available lower cost functional alternatives that can meet or exceed the customer's requirements.
- **New technology.** All new technology needs to be closely monitored for at least three months to ensure that it is meeting or exceeding the manufacturer's performance specifications.
- **Old technology:** All technology-whether elevators, IV pumps, anesthesia machines, or imaging systems-has a useful life of a certain number of years, and is not cost effective for the hospital to continue to maintain it beyond its useful life.

1.8 Vendor Managed Inventory

Under Vendor Managed Inventory (VMI), the supplier assumes responsibility for the management of inventory at the customer, and takes decisions regarding replenishment (Waller et al. 1999). To some extent, this builds on the information requirements of stockless inventory systems. The main difference is moving responsibility for stock control to the

supplier, as the ordering process remains automated. For VMI to work successfully there is a need for accurate information on current stock levels and consumption. However, providing such information within hospitals can be difficult (Haavik, 2000 and McKone-Sweet, 2005). In Kim (2005), VMI has brought a number of benefits including less administration at the hospital, fewer errors, improved information reliability and a 30 per cent reduction in inventory. By contrast, Altricher and Caillet (2004) found that, because of a lack of trust in the supply chain, the hospital kept over-ruling the VMI system, holding more stock and eliminating any benefits that accrued.

Today's healthcare providers are under tremendous pressure from increased competition, government regulations, rising costs and demands for higher quality of service. Undoubtedly, healthcare as a business activity is becoming enormously complex to manage diversified locations, changing organizational structures, mergers, employees and multiple information systems around the world. Healthcare organizations must strive to add value across the supply chain by monitoring supply chain performance. The latest innovations in RFID technology, supply utilization management and virtually centralized supply chain management are key to the future. Looking ahead, Supply Usage Management is an emerging best practice that will enable healthcare organizations to delve deeper and more fully into their supply chain costs for new and even better savings in supplies. Unleashing the power of RFID technology isn't just about replacing barcodes with tags.

The specific advantages that RFID tags offer over barcodes represent a whole new way of working in the competitive business environment. In summary, the healthcare industry is highly interdependent and only some can achieve efficiency and leave others behind. Because of this, strategies like virtual centralization are proving popular and successful. That's not the end of the road, the industry needs to look forward to every little development in the supply chain of related industries to take advantage of being vigilant and adapting quickly.

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1.9 Findings and Recommendations

There are two opportunities in this work where reengineering is applied: a) centralized supply system, and b) material management. In the redesigned system, several benefits have been Achieved, in terms of:

- 1. *cost and inventory reduction***, due to more frequent deliveries, and the minimization of hospital central stores;
- 2. *staff reduction*** in terms of amount of work of both hospital pharmacies and patient care

staff, previously occupied in the point-of-use replenishment;

3. *higher level of service;*

4. *exploitation of economies of scale*, due to large orders and the absorption of uncertainty on the estimates due to the large numbers.

The transformation of the SCM model requires three main conditions: *collaborative governance structures, efficient processes and integrated information system*. The right governance structure for SCM allows hospitals to maintain the balance between reducing costs and providing high-Emerging Trends in Healthcare Supply Chain Management, an Italian experience quality care. It requires that the SCM governance evolves to a collaborative approach involving all stakeholders, without which all other efforts to move to the transformation model simply will fail. This collaboration requires the appropriate governance structure and processes.

Indeed, when processes are fragmented or incomplete, they cause errors in terms of ordering the wrong item or wrong quantities of an item. At last, automating and integrating IT systems will allow hospitals to seamlessly link their logistics processes. The centralized management requires that hospitals in the network dialogue continuously with the warehouse, together with a flow of information that travels in both directions (from the hospital to the Central Warehouse and vice versa).

10.0 Conclusion

Today, healthcare providers 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 organisations must strive for value addition across entire supply chain by monitoring supply chain performance. The latest innovations in RFID technology, Supply Utilization management & virtually centralized Supply chain management hold the key to the future. Looking to the future, supply utilization management is an emerging recommended practice that will enable healthcare organizations to dig deeper and more broadly into their supply chain expenses to harvest new and even better supply savings. Exploiting the power of RFID technology is not simply about replacing bar codes with tags. The specific benefits that RFID tags offer over bar codes present an entirely new way of working in the competitive business environment.

11.0 Summary

The health care industry is highly interdependent and only one part can't attain efficiency leaving behind others. That is the reason why strategy such as Virtual Centralization is proving to be popular and successful. That is not the end of the road, the industry has to look forward to each and every minute development in the supply chain of related industries to reap the benefit of being alert and quick to adapt to.

References

- Acharyulu, G. (2007). *RFID in the Healthcare Supply Chain: Improving Performance Through Greater Visibility*. Journal of Management, **VI**(11): 32-46.
- Altricher, F., T. Caillet. (2004). SCM in a pharmaceutical company. Stadtler, H., C. Kilger, eds. *Supply Chain Management and Advanced Planning: Concepts, Models, Software and Case Studies*. Springer- Verlag, NY, 355-70.
- Alverson, C. (2003). *Beyond Purchasing Managing Hospital Inventory*. Managed Healthcare Executive. Burns, R. Lawton. 2002. *The Healthcare Value Chain: Producers, Purchasers, and Providers*. Jossey-Bass.
- Corrêa, H.L. (2004). Supply chain management in Latin America: the Brazilian pharmaceutical industry case. *CELog Working Paper*. Available at: http://celog.fgvsp.br/.../fig/artigos/supply_chain.pdf (accessed date Jan 15, 2013).
- Grasman, S. E., S. Missouri (2010). *Barriers and Best Practices for Material Management in the Healthcare Sector*. Purchasing. **22**(4): 11-20.
- Haavik, S. (2000). *Building a demand-driven, vendor-managed supply chain*. Healthcare Financial Management. 56-61.
- Heinbuch, E. Susan. (1995). *A Case Study of Successful Technology Transfer to Health Care: Total Quality Materials Management and Just-In-Time*. Journal of Management in Medicine. **9**(2):48-56.
- Kim, D. (2005). *An integrated supply chain management system: a case study in healthcare sector*. Lecture Notes in Computer Science. **3590**:218-27.
- Lauer, C. (2004). *Excellence in supply chain management*. Modern Healthcare. **34**(50): 29-32.
- Waller, M., M.E. Johnson, T. Davis. (1999). *Vendor-managed inventory in the retail supply chain*. Journal of Business Logistics. **20**(1):183-203.
- Lo, W. (2009). *A practical framework of industry-university for supply chain management of health care industry with using distance health-care ICT platform*. International Journal of Electronic Business. **7**(4). 241-247.
- McKone-Sweet, K.E., P. Hamilton, S.B. Willis. (2005). *The ailing healthcare supply chain: a prescription for change*. Journal of Supply Chain Management. 4-17.
- Mustaffa, N. H., A. Potter.(2009). *Healthcare supply chain management in Malaysia: a case study*. Supply Chain Management: An International Journal. **14**(3): 234–243.
- Papageorgiou, L.G., G.E. Rotstein, N. Shah. (2001). *Strategic supply chain optimization for the pharmaceutical industries*. Industrial and Engineering Chemistry Research. **40**:275-8
- Roark, D.C. (2005). *Managing the healthcare supply chain*. Nursing Management. 36-40.

- Ryan, K. Jennifer. (2005). *Systems Engineering: Opportunities for Health Care, Building a Better Delivery System: A New Engineering/ Health Care Partnership*. National Academy Press.
- Schneller, S. Eugene S., Larry R. Smeltzer. (2006). *Strategic Management of the Healthcare Supply Chain*.
- Shah, N. (2004). *Pharmaceutical supply chains: key issues and strategies for optimisation*. Computers and Chemical Engineering. **28**:929-41.
- Shekhar, B Raja, G. Acharyulu. (2012). *Role of Value Chain Strategy in Healthcare Supply Chain Management : An Empirical Study in India*. International Journal of Management. **29**(1): 91-98.
- Parker, J., D. DeLay. (2008). *The future of the healthcare supply chain. Healthcare financial management*. Journal of the Healthcare Financial Management Association. **62**(4):66-
- Rahman, B., N. Wilson. (2010). *An HSRC-ASU White Paper Repositioning Supply Chain in Health Care Systems*.
- Raviprakash, A. V., B. Prabu, N. Alagumurthi, V. Soundararajan. (2009). *RFID : Rx to Healthcare Industry*.
- Yokl, R. T. (2011). *The future of supply chain expense management. Healthcare financial management*. Journal of the Healthcare Financial Management Association