An Exploration of the Use of Global Healthcare Supply Data Standards in a Materials Management Information System

A Thesis

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By

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Abstract

The healthcare industry lags behind the rest of the product world in regard to product standards identification. The push for use product standards by labeling products with a GTIN number and GTIN barcode has been a topic in the healthcare industry for years. A global standard for product identification lies with the information systems that are used at each point in an organization’s supply chain. The benefits include greater traceability, and accuracy of documentation in regards to the materials management functions.

A study was undertaken to evaluate the current state of unique identification of supplies in a large university hospital setting by examining the existence of the GTIN number and GTIN barcode on select medical-surgical supplies. Results indicated that just over half of supplies from the study had the GTIN and GTIN barcode at 53% of the sample size of 104 items. In each case where the GTIN was present, the GTIN barcode was also present. The GTIN was confirmed to be associated with the manufacturer, but there was no association found between the unit of measure and the GTIN’s presence on an item.
Dedicated to my wife, Shana, my daughters Carly & Alexis, and Baby #3 for all their love, patience, and just being who they are.
Acknowledgments

Sincere gratitude and appreciation is expressed to my advisor, Dr. Melanie Brodnik for her exceptional guidance and patience during my studies and thesis work. Gratitude is also expressed to Dr. Susan White for her advice and guidance on the statistics portion of my thesis. Thanks are also given to Dr. Laurie Rinehart-Thompson for her help and commitment in my thesis process.
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Major Field: Allied Medicine
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CHAPTER 1

INTRODUCTION

Background of the Problem

A Materials Management Information System (MMIS) is used by healthcare organizations as an electronic means to their purchasing and inventory processes. The MMIS contains information on all supplies that are procured for the purpose of patient care. Supply information is maintained in what is commonly referred to as an item master that is housed within the MMIS. The item master contains information required for procurement and payment for each supply to its vendor.

The item master in a healthcare organization is a module within the MMIS that contains supply information. The individual supplies in the system are uniquely identified with an alphanumeric identifier that serves as the key point of identification for that organization. This identifier is typically one that is system generated using a defined auto-numbering scheme. Each item contains several data attributes that enable it to be procured, received, stored, picked, delivered, and consumed. Additionally, the item master may contain information related to the manufacturer and distributor for each item. For each item, there can be multiples of this data. The accuracy of the data for each supply in the item master is critical, since inaccuracies can result in the wrong product being ordered, delivered, and potentially used on a patient.
Unlike other sectors in the U.S. economy such as retail and grocery, the healthcare sector has not yet implemented a regulated global standard for supply or product identification. Such identification in healthcare would offer several benefits to a healthcare organization. Standardized item identification allows for greater interoperability between information systems across the supply chain from the point of product purchase to the time it is used. It can improve inefficiencies that may exist in other provider-based systems such as the Electronic Medical Record (EMR). Standardized item data may also result in fewer errors, thus less staff time spent analyzing and resolving errors on purchase orders, invoices, and receipts. According to a white paper by the Joint Coalition for Healthcare eStandards and Health Care eBusiness Collaborative PDU Feasibility Committee in April 2003, every day hospital materials management staff spends approximately 30 percent of their time resolving supply errors (Belkoski, 2008).

The Ohio State University Medical Center (OSUMC) is a multi-facility healthcare system comprised of six hospitals and more than a dozen affiliated research centers. It is part of the one of the most comprehensive health sciences campuses in the country. In the fiscal year 2011, the OSUMC had 56,869 patient admissions and nearly 1.1 million outpatient visits. The Material Systems Department of the medical center leverages technology in its supply chain operations on a daily basis. The return on investment has been significant and has allowed its operations to focus on a strategic sourcing method and less on tactical procurement functions. Tactical purchasing involves the routine management of transactional needs for products and services. The strategic sourcing
model is a fact based cost reduction method, which realizes savings by leveraging the
total amount spent by an organization. The greater volumes of spend on supplies and
equipment possible from an organization leads to a greater amount of possible sales to a
supplier. Providers that are in a higher spend tier for commodities realize greater
discounts due to purchasing volume. It focuses on contract management, supplier
selection process, and cost diversion in order to streamline the procurement process to
meet the needs of the organization (Ballard, 2012).

The OSUMC Materiel Systems department is responsible for the procurement,
contract management, distribution and inventory of all goods and services. The
department is tasked with providing the best product to meet patient and provider needs
while keeping costs within budget and reducing costs whenever possible. The
department’s purchasing function is centralized with supply storerooms physically
located at each of the medical center’s hospital based locations. OSUMC has a medical-
surgical supply storeroom at each of its two hospital located in central Ohio. Each of the
storerooms serves primarily as a backup for supply needs for supplies that are purchased
through a just-in-time (JIT) method. In a JIT based ordering environment, supplies are
ordered daily by nursing units and the requested items are delivered to that unit the same
day.

The storeroom is a controlled area with restricted access. Each product is received
on the dock and delivered to the storeroom for personnel to validate and stock the
shelves. The supplies are associated with a default assigned storage location in which
they are stocked in order to be able to identify product location when requested to be
dispensed. The storeroom is organized in a consistent scheme of shelves and rows. The medical-surgical supply storeroom at the OSUMC main campus contains 1,546 unique items. This is small in comparison to the 26,914 items that OSUMC maintains in their item master. In 2011, OSUMC submitted 157,716 purchase orders to over 2,836 different vendors. The item master contained 26,914 unique items that were marked as active for ordering. The customer base continues to grow as well; in past year supplies were ordered and delivered to 1,234 different supply sites including nursing units, administrative offices, and physician-based clinics throughout central Ohio. During the same year OSUMC made 52,510 manual changes to the item master. With each manual change to an item, there is the risk of error resulting in the item containing invalid information.

The OSUMC Materiel Systems department has been actively involved in the global standards movement for healthcare led by GS1. However, the OSUMC is not currently adapting the GTIN in its systems and processes. GS1 is an organization that was formed from the creation of the European Article Numbering (EAN) and - Uniform Code Council (UCC). It has developed standards for over thirty years in multiple industry sectors for the purpose of improving the efficiency of supply chains (Lovis, 2008). The adoption and promotion of GS1 standards for product identification in healthcare has been on the rise for the past 5 years. The Global Trade Item Number (GTIN) is a scheme promoted by GS1 for standardizing product identification. The GTIN represents a unique number for each product and if appropriate its units of measure (UOM). It can be associated with any item that needs to be priced, ordered or invoiced at any point in the
supply chain (Lovis, 2008). In healthcare, the most commonly used identification is the GTIN-14 format (See Figure 1).

![Figure 1: GTIN-14 encoded in a GS1-128 Bar Code](image)

In addition to the 14-digit format, there are two additional barcode and numbering formats that can be found on healthcare products. See Figure 2 and Figure 3, these contain a 12 and 13 digit product identifier.

![Figure 2: GTIN encoded in a GS1-12 Bar Code](image)

![Figure 3: GTIN encoded in a GS1-13 Bar Code](image)

In a recent survey conducted by the Center for Innovation in Healthcare Logistics (CIHL) at the University of Arkansas, twenty-five percent of healthcare manufacturers plan to implement the GTIN, while twenty percent already are actively assigning GTINs.
to their products (Pohl & Nachtmann, 2011). In the same survey, twenty-four percent of respondents indicated they are marking their products with a GTIN barcode. The GTIN provides for identification of a product across any information system within healthcare that has requirements for product information, or how and when the product was used on a patient. The use of GTIN barcode labeling on products enhances the ability to trace of the product. The scanning of a barcode significantly reduces the risk of errors and provides a means for all systems where it’s a standard process to document the item’s flow within the organization. As long as information systems can accept and store the GTIN with all the item attributes, barcode scanning becomes a critical component of overall patient safety and cost containment efforts. The OSUMC Material Systems Department has participated in focus groups and collaborations with GS1 and other healthcare providers that are promoting the GS1 standards. Personnel have delivered presentations at multiple conferences specifically related to GS1 standards. The department continues to value the benefits of using a GTIN and seeks to promote its use and adoption; however, at this time the OSUMC does not currently use GTINs in their MMIS for transactional purposes.

Standardized product identification has existed in other markets outside of healthcare for years. In industries such as retail and grocery, product identification is a key component to their business. In the grocery industry it can assist and enhance the recall management process when products have been deemed un-safe to consumers. In both the retail and grocery industries, a standardized product number allows each product to be labeled in the same manner no matter where the product is sold. The healthcare
industry has been lacking in these standards of product identification. It leads to significant lack of traceability, which in turns leads to difficulties in recall management. In the modern day with the implementation of the Electronic Medical Record (EMR), the documentation of supplies becomes part of the clinician’s responsibility. The supplies that are documented will forever live in the patient’s chart. When documented appropriately, revenue and usage is accurate. In the event of recalls the patient’s chart can be searched for that particular item. In the long term, evidence based research could be done but only if the product was identified identically at each location where it was documented in a patient’s chart.

To better understand the possibility of incorporating the GTIN into the OSUMC MMIS, a study was conducted to determine the presence or absence of GTINs and associated barcodes on supplies currently stored in the medical-surgical storeroom of the OSUMC University Hospital.

**Research Questions**

The research question used to guide this study were as follows:

1. What is the proportion of medical-surgical supplies stored at the OSUMC UH storeroom labeled with a GTIN number for each item and the item’s lowest available unit of measure?

2. What is the proportion of medical-surgical supplies stored at the OSUMC UH storeroom labeled with a GTIN barcode for each item and the item’s lowest available unit of measure?
Definition of Terms

The following terms are referenced throughout the study:

**GS1:** Organization that promotes the use of standards across supply chains in all sectors.

**Materials Management Information System (MMIS):** Software solution used for purchasing and inventory functions. Often contained within a larger Enterprise Resource Planning (ERP) system.

**Item Master** Module within the MMIS that stores all elements of products that an organization purchases on a regular basis and that are on contract.

**Global Trade Item Number (GTIN):** Fourteen-digit unique item number that GS1 promotes for standardization of supply data. Elements within the number represent the unit of measure and manufacturer. Can also contain secondary information such as lot and expiry date.

**Global Data Synchronization Network (GDSN):** Shared product database solution that organizations can subscribe to in order to receive product information updates.

**Electronic Medical Record (EMR):** Software application that encompasses the entire view of a patient’s care at an organization.

**Electronic Data Interchange (EDI):** Standard interface mapping language used to transact data between vendors and customers.

**Supply Chain:** Term used to reference the flow of products from the manufacturer to the end user or consumer.

**Enterprise Resource Planning System (ERP):** Term used for the complete resource planning system used by an organization. This system includes the financials, human capital, and materials management functions typically.

**Structure Query Language (SQL):** Programming language that can be used to extract and manipulate data from a relational database.
<table>
<thead>
<tr>
<th><strong>Just In Time (JIT):</strong></th>
<th>Ordering method by which supplies are requested and delivered the same day from a distributor.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group Purchasing Organization (GPO):</strong></td>
<td>Organization that leverages the buying power of its member organizations in order to produce savings.</td>
</tr>
<tr>
<td><strong>Unit of Measure (UOM):</strong></td>
<td>Measurement by which a product is ordered, stored, and consumed.</td>
</tr>
</tbody>
</table>
Limitations

The study was conducted in the storeroom of the Ohio State University Medical Center University Hospital’s storeroom. The selection of products was limited to those that the medical-surgical storeroom kept in inventory. Furthermore, the available units of measure for each selected product were limited to whether the storeroom had that particular product on the shelf at the time of evaluation. The impact of this limitation was limited by the used of randomly selected replacement items in the case of an item missing from the shelf.
CHAPTER 2

REVIEW OF LITERATURE

Introduction

A review of literature was performed in order to gain additional knowledge and understanding of healthcare materials management processes and challenges. Information was collected via the use of online academic database publication searches for terms such as: healthcare supply chain, healthcare supply standards, GS1, GTIN, materials management information system and healthcare supply chain issues. Additional information was used from professional organizations web sites that contained case studies, white papers and expert opinions. Finally, knowledge was collected through various periodicals relating directly to healthcare supply chain. The amount of information available on this particular subject is limited as it’s not widely a focus of research. The review begins with a discussion of how healthcare manages the supply life cycle and, from there, proceeds to a conversation about the high cost of supplies in healthcare. The review concludes with the most common theme in regards to the overall lack of data standardization for products in healthcare.


**Literature Findings**

*Healthcare Supply Chain Procurement Life Cycle*

A supply chain consists of all the elements, activities and processes required to deliver a product from raw material to final customer (Callender & Grasman, 2010). In a hospital setting, the final customer is the patient. The main goal of healthcare purchasing is to provide the necessary products to healthcare providers in a timely manner (Callender & Grasman, 2010).

A group purchasing organization (GPO) is one that acts on behalf of its members, negotiate and sign contracts with suppliers in order to aggregate the purchasing power of the healthcare providers and achieve economies of scale (Callender & Grasman, 2010).

Hospitals often rely on the use of a distributor for the majority of their commonly used medical supplies. These distributors act as an off-site warehouse for multiple healthcare systems in a region. The majority of the products sourced from distributors are the less costly and higher quantity used items. The other products, higher cost and more specialized; tend to be purchased directly from the manufacturer (Callender & Grasman, 2010). Often these are products that are implants, consignment, or new to the market. Consignment refers to the procurement method where the provider keeps the product on hand but does not pay the vendor for the item until it is consumed. In this case, the vendor owns the product but the supply is stored at the provider’s location. Each of these above categories requires extra attention. Implants require accurate documentation on the patient’s chart as well as the purchase order. The patient account number and unique
Identifiers from the implant are sent to the manufacturer on the purchase order in order for the manufacturer to have record of the product being consumed. Consignment items are typically implants; they also require a purchase order after the item is used to pay the supplier. In the event the consignment item is an implantable, it will contain unique discrete data elements such as lot, serial, and expiration date. When paying a supplier for the product usage in these cases, the aforementioned data elements are also a requirement on the purchase order so the vendor has record of the consumption.

A single healthcare system can have multiple hospitals within it. Supplies are delivered to respective sites. Each of those hospitals can have numerous locations such as nursing units where items are delivered daily. The same product can go to multiple places from the same delivery.

**Healthcare Supply Chain Cost**

Healthcare providers always want the best products for their patients. In the current economic times, healthcare organizations are always seeking methods to reduce costs but not reduce quality patient care. Supply chain expenses can represent twenty percent or more of a hospital’s operating budget, second only to labor costs (Belkoski, 2008). The budget for supplies alone represents twenty-five to thirty percent of the total operating expense (Callender & Grasman, 2010). Attributing to that expense are errors and inefficiencies that can cost healthcare providers billions of dollars each year (Wylie, 2011).
Healthcare, much like the electronics industry, is consistently evolving and new
products are being introduced to the market every day. (Callender & Grasman, 2010)
The variable amounts of products that are consumed within a single hospital can be well
into the thousands of unique items (Roark, 2005).

In the operating room (OR) supplies usage is one of the most intensive throughout
the organization. The notion of physician preference cards for selected items and the
collection of data within them drive the supply needs for each surgery performed.
Physicians often want what they like and what they are accustomed to. Physicians may
request certain items that are not normally purchased or on contract to be purchased by
the organization, thus driving up costs when the item is requested. The variation of a
product that performs similar functions can be costly. New products are also being
marketed toward physicians. In each of these cases, the cost for the physician preference
items drives up the cost to the healthcare organization (McKone-Sweet, Hamilton, &
Willis, 2005).

In the healthcare market cost savings hinge on standardization of products (Roark,
2005). Reducing the ordering of the number of products that produce the same results on
a patient can lead to cost savings. The healthcare market tends to promote savings and
incentives through volume in purchasing (Roark, 2005). The use of GPO’s provides the
foundation for larger volumes of demand through the use of the aggregation of
purchasers.

A healthcare supply chain is different from other supply chain systems in that
there is no set forecast for products needed at any given time. The difficulty in predicting
frequency and duration for patient visits is a key barrier to effective supply chain strategy (McKone-Sweet, Hamilton, & Willis, 2005). Since patients are not all the same, a surgery schedule has the potential to change at any point in the day. There are numerous factors that could affect the supply needs for any given patient making it nearly impossible to predict accurate and optimal supply levels to keep on hand.

**Lack of Data Standards**

Currently there are no data standards for healthcare supplies. The retail industry has had data standards for product identification for over thirty years (GS1, 2012). Standardized data leads to efficient use of data and the ability to use the same data across multiple mediums. The healthcare industry and its supplies have been lacking in this notion.

Since there are no mandated or universally accepted standards for product identification in the healthcare market, the same supply can be identified differently for each organization that procures and consumes it. This is not limited to healthcare organizations; GPO’s, distributors, and the manufacturer all identify the same product differently. The lack of standardized codes makes it difficult to track and share information throughout the supply chain (McKone-Sweet, Hamilton, & Willis, 2005). The facility recognizes the product at the point of delivery as another unique identifier that is typically produced when the supply is added in their MMIS. The process begins with the manufacturer designating it with a code. The distributor will then assign their number as well to the product. In most cases, any product purchased will have at least
three item numbers see Figure 4. As larger healthcare organizations have well over ten thousand items, the maintenance and margin for error is vastly increased.

![Diagram of product identification in the supply chain]

**Figure 4: Product Identification in the Supply Chain**

A standardized barcode has been cited as essential for product visibility across the supply chain (Callender & Grasman, 2010). From a logistics perspective, traceability can be defined as the capability to trace goods from the suppliers to the retailers (Lovis, 2008). In the healthcare logistics process, the retailer would be replaced with the patient. In other industries such as automotive, the successful traceability of automobiles for recall purposes is attributed to unique identification (Lovis, 2008). The traceability of the product cannot be accurately performed when its identification changes at each stop on the way to the final destination, the patient. The lack of standardization has been cited as a barrier for implementation of supply chain management best practices in the healthcare industry. In a recent survey, approximately fifty-one percent of respondents indicated it was a barrier (Callender & Grasman, 2010). The inability to utilize industry best practices inhibits organizations from growing and ultimately can become costly to both the providers and the consumers.

The lack of a standardized identification can have an effect on data quality in the healthcare organizations MMIS. If the data on the product is entered incorrectly, the effects ripple throughout the life cycle of the item. The item can be incorrectly ordered, delivered, paid for, and even make its way to the bedside. Another aspect of patient care
and supply chain standardization is recall management. As the product tends to have multiple forms of identification between players in the procurement process, the communication of product information can be slow and difficult. The delay in translation can result in the inadvertent use of recalled equipment (Motorola, 2010).

The electronic medical record (EMR) can be defined as an electronic record of health-related information on an individual that can be managed by staff across multiple organizations (National Library of Medicine, 2011). The EMR on a given patient can also contain supply data. The linkage between the item master in the MMIS and the resource data in the EMR provides greatly improved information about supply consumption based on patient diagnosis (Barlow, 2010). The addition of supply documentation adds a burden on the healthcare provider. The presence of a unique identifier by means of a barcode can ease this burden. The scanning of the supply at the bedside can be directly interfaced into the EMR to complete the documentation and to assist in billing purposes (Black & Zimmerman, 2011). Complete and accurate documentation increases transparency and traceability of the products consumed in the hospital setting. The importance of standardized product data increases with the documentation in the EMR. Adding standardized data can assist in comparative effectiveness research and patient safety (Barlow, 2010). The ability to search by a standard unique identification in the EMR and instantly find the patient that the product was used on has a great impact on patient safety and improves the recall management process.
**Materials Management Information System Capabilities**

The healthcare industry utilizes a wide variety of materials management information system applications (MMIS). These systems provide streamlined business processes and promote the use of electronic data interchange (EDI) for transactions between the provider and the supplier. The abilities of the MMIS to accommodate multiple product identification per unit of measure is not a given in the current state. While there is increased awareness of the vendors with GS1 standards, the ability to store the data in the application is only at sixty-four percent (Burks Healthcare Concepts, Inc., 2009). Systems able to support GTIN based barcodes are only fifty-percent (Burks Healthcare Concepts, Inc., 2009). Further, the same survey indicates that most of the vendors will be able to accommodate the unique barcode at all levels of packaging (Burks Healthcare Concepts, Inc., 2009). A key element of product standardization is the identification of products uniquely at each unit of measure. If systems are unable to handle this, there is little value in incorporating the solutions. The majority of healthcare product usage is at the lowest unit of measure (LUM). The procurement of the product is typically done at a higher unit of measure such as a case or box. The MMIS needs to be able to store and transact in each available unit of measure. With regards to eleven different means of EDI, only forty-two percent of MMIS vendors reported that they could transact in some of the eleven transaction sets (Burks Healthcare Concepts, Inc., 2009).
Summary

A review of literature provides a limited amount of information on the healthcare supply chain, as the subject is not a primary focus of research. It does indicate that costs, lack of standards, and barriers to best practices exist. The lack of standardization can be found as a topic or reason for costs and barriers. The efforts to make healthcare supplies standardized will be on-going and increase in their priorities in the industry as measures to contain costs, improve patient safety, and increase traceability in the healthcare supply chain continue to gain momentum.
CHAPTER 3

METHODOLOGY

This chapter discusses the methodology used to identify whether medical-surgical supplies found in the OSUMC UH storeroom are labeled with a GTIN and corresponding barcode.

Research Design

The research design used for this study was an exploratory review of medical-surgical supply packaging in an academic medical center’s supply storeroom for disposable medical-surgical products.

Population and Sample Design

The OSUMC item master contains approximately 26,914 unique items. This is comprised of supplies procured throughout the entire organization. The target population was all medical-surgical products in the OSUMC University Hospitals’ (UH) storeroom. The UH storeroom contains 1,546 unique items of routinely used medical-surgical commodity based supplies. In addition to the medical-surgical storeroom, the OSUMC UH has a storeroom for supplies related to information technology and facilities engineering supplies. The storeroom at OSUMC UH is a controlled environment with
restricted access. Supplies are assigned a location in the storeroom. The shelving is clearly marked with a label containing the product information that is stored at that location. Medical-Surgical supplies were selected by a replenishment class variable. Since the OSUMC UH storeroom can contain supplies that do not apply to medical-surgical use, the items were further filtered by this variable. The classes of “Fax” and “EDI” were chosen since they are the ones used for medical supply replenishment. These classes are associated with supplies in the OSUMC UH storeroom that are used for medical-surgical supplies. The classes indicate the method of ordering supplies for the storeroom. Supplies that are replenished for the storeroom are categorized into one of these two classes for replenishment ordering. Supplies that were active in the Materials Management Information System (MMIS) item master and had been received and put away at least one time in the storeroom in the calendar year 2011 were selected for review. The previous calendar year was selected in order to ensure that product packaging and usage was more current. This prevented having an item selected in the sample that could have been on the shelf for an extended period of time. These criteria yielded a population for the study of 806 items. The sample size was calculated using an a priori value of 0.95 for the proportion of the population of items that would include a GTIN. A sample size of 104 was adequate to detect a 4% deviation from 100% with 80% power at the 0.025 level. Since the study examined two questions relating to GTIN number and GTIN barcode, each question was tested at the 0.025 level to ensure an error rate of 0.05.
Data Collection Procedures

This study was presented to The Ohio State University Institutional Review Board (IRB) prior to conducting the study. Due to the nature of this study it was determined not to be subject to IRB review.

Data were collected from a random sample of 104 unique supplies and 10 spares using RAT-STATS 2007 Version 2 (Office of Inspector General). During the data collection, seven products that were originally selected by the random number tool were out of stock and therefore not available for review. In each instance, the first available product from the spares list was chosen for review in order from top to bottom. Products that were not available for review at the time of the investigation were marked accordingly on the data collection template and a spare product was selected in its place. Spare products or values were to be used in the situation where one of the randomly selected supplies was not available for review. In some instances a supply, could have multiple units of measure available for evaluation. In these instances, the product can be issued to a customer in various units of measure. The product can be ordered in a higher unit of measure, but can be distributed at a lower unit of measure. In these situations, product packaging was available for viewing in multiple units of issue and results were recorded for all available units of issue.

Identification of the supplies that were received and put away within the OSUMC main campus storeroom at least once in the 2011 calendar year was established though the use of structured query language (SQL). A query was developed in SQL that limited the selection of items to the OSUMC UH storeroom. Additional limiters were added to
achieve the items that had a history of stock being put away into inventory in the 2011 calendar year. Additionally, the items with the replenishment class of “Fax” and “EDI” further limited the selection. The query also provided the location of the supplies within the storeroom as well as the associated account code. The primary manufacturer of the supply was also extracted from the database. The results of the query were returned from the production version of the MMIS database. The OSUMC Item ID and storeroom location data results were exported into a comma separated value file and then incorporated in the data collection template (See Table 1). Each value was assigned a sequential row identification number. The RAT-STATS tool was used to generate 104 random numbers and an additional 10 random numbers to be used as spare values only in the event that the product was not available for data collection.
<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Row ID</td>
<td>ID Number of the Row starting at 1</td>
</tr>
<tr>
<td>OSUMC Item Number</td>
<td>Unique Item Number for OSUMC</td>
</tr>
<tr>
<td>OSUMC Manufacturer ID</td>
<td>Unique ID for a Manufacturer at OSUMC</td>
</tr>
<tr>
<td>Manufacturer Name</td>
<td>Name of the Manufacturer for the item</td>
</tr>
<tr>
<td>Manufacturer Item ID</td>
<td>Unique ID assigned by the Manufacturer of the item</td>
</tr>
<tr>
<td>OSUMC Account Code</td>
<td>Accounting expense code for item</td>
</tr>
<tr>
<td>Location Level 01</td>
<td>Location information from where the product is shelved in the storeroom</td>
</tr>
<tr>
<td>Location Level 02</td>
<td></td>
</tr>
<tr>
<td>Location Level 03</td>
<td></td>
</tr>
<tr>
<td>Location Level 04</td>
<td></td>
</tr>
<tr>
<td>Unit of Measure 1</td>
<td>Unit of measure for the product, e.g. EACH, CASE</td>
</tr>
<tr>
<td>GTIN on Package</td>
<td>Indicates if the GTIN was on the product</td>
</tr>
<tr>
<td>GTIN Barcode on Package</td>
<td>Indicates if the GTIN Barcode was on the product</td>
</tr>
<tr>
<td>Unit of Measure 2</td>
<td>If available</td>
</tr>
<tr>
<td>GTIN on Package</td>
<td>If available</td>
</tr>
<tr>
<td>GTIN Barcode on Package</td>
<td>If available</td>
</tr>
<tr>
<td>Unit of Measure 3</td>
<td>If available</td>
</tr>
<tr>
<td>GTIN on Package</td>
<td>If available</td>
</tr>
<tr>
<td>GTIN Barcode on Package</td>
<td>If available</td>
</tr>
<tr>
<td>Product Not Available</td>
<td>Indicates if the product was not available for review</td>
</tr>
</tbody>
</table>

**Table 1: Data Collection Template Elements**
The exploration of supplies was conducted over the days of April 12th & 13th, 2012. The supplies were located and examined for the presence of the GTIN and GTIN related barcode. A “Yes” or “No” was entered into the template to signify the presence or absence of the GTIN and/or barcode. The supplies unit of measure that was being evaluated was also recorded. The column titled “Supply Not Available” was marked with an ‘X’ if the product could not be reviewed at the time of data collection.

**Data Collection Instrument**

The template for data collection was created using Microsoft Excel. The template contained the MMIS unique item identifier (OSUMC Item ID) and the storeroom storage location for purposes of locating the correct supply. The template also included columns for up to three different units of measure for data collection. In most cases, supplies did not have three units of measure to review. Variables for each item are as follows:

- GTIN Present
- GTIN Barcode Present
- Unit of Measure (UOM), e.g., EACH, CASE, BOX
- Account Code
- Manufacturer

An additional input column was added; to indicate if no stock was present at the time of review. A row identification number was included for the purposes of random sampling of items.
Data Analysis

The data collected during the study were analyzed through the use of descriptive statistics. These were limited to percentages and frequencies as well as confidence intervals. The data selected for evaluation were based off of the lowest unit of measure available at the time of the collection. The data were also grouped by the top five manufacturers, in order to analyze if commonalities exist with the presence of the GTIN among product manufacturers.
CHAPTER 4

RESEARCH RESULTS

The purpose of this study was to explore the possibility of incorporating Global Trade Identification Numbers (GTIN) into a Materials Management Information System (MMIS). The results from this exploratory study of medical-surgical items are provided in this chapter.

Profile of the Sample

The population for this study included all items in the Ohio State University Medical Center University Hospital storeroom that had been procured and stocked in a location in the storeroom at least one time within the calendar year 2011. The sample for this study was 104 randomly selected items. All items were placed into a Microsoft Excel spreadsheet for data collection. Each item allowed for up to three different units of measure to be evaluated for both the existence of the Global Trade Identification Number (GTIN) or the corresponding GTIN barcode. A column was also included to indicate if no product was on hand for evaluation. If a product was not available, a spare value was selected starting from the top of the list for available values. The spare values were listed in order from the 105th to the 114th which indicated the sequence in which the random number generator selected the values for review. The values were used in sequential
order when a product was not available for data collection in order to keep the sample size at 104.

All supplies that had either the GTIN or the barcode were encoded as a ‘1’ when they were marked “Yes”. All supplies that did not have the GTIN or barcode were encoded with a ‘0’ when they were marked “No”. Any supply that was part of the original random sample that was not available for evaluation at the time of the study was marked with an ‘X’ in the ‘Product Not Available’ column and was dropped from analysis.

Overall, 104 items were reviewed. Of the 104, 55 had a GTIN and 55 had a GTIN barcode. These were the same 55 items for both the GTIN and the GTIN barcode. Products from 49 different manufacturers were reviewed. Of the products selected randomly for review, seven of the supplies were not available for review and a total of seven spare values from the random number generation were used in sequential order. Each of the seven spare values was present and available for review. A total of five distinct UOM were associated with supplies. Table 2 provides a summary of the supply data captured.

<table>
<thead>
<tr>
<th>Supply Attribute</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Supply Manufacturers</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td>No. of Unit of Measures Found</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>No. of Supplies with GTIN</td>
<td>55</td>
<td>53%</td>
</tr>
<tr>
<td>No. of Supplies with GTIN barcode</td>
<td>55</td>
<td>53%</td>
</tr>
<tr>
<td>No. of Supplies Not Available for Review</td>
<td>7</td>
<td>7%</td>
</tr>
<tr>
<td>No. of Spare Supplies Used</td>
<td>7</td>
<td>7%</td>
</tr>
</tbody>
</table>

Table 2: Summary of Supply Data Collected

From the sample, 16 supplies had varying instances at the UOM level of the presence of the GTIN and/or GTIN barcode. In all but one of these cases, the GTIN was
present at a higher UOM such as a Box, but was not found on the lowest available UOM. These 16 items accounted for all the item instances in which there was variation between units of measure for the same product with regards to the GTIN and/or GTIN barcode. In all other situations, the GTIN and/or GTIN barcode were found in all available units of measure for the product.

Tables 3 and 4 show how the top 4 manufacturers in both cases of having the GTIN or not having it all accounted. In Table 3, the top manufacturers that had the GTIN accounted for 25 of the total sample size. To contrast, the top four manufacturers that had no presence of the GTIN on the supply accounted for 15 of the total sample. Many manufacturers that did not have the GTIN only had one item that was selected for review.

<table>
<thead>
<tr>
<th>OSUMC Manufacturer ID</th>
<th>No. of Supplies</th>
</tr>
</thead>
<tbody>
<tr>
<td>410</td>
<td>9</td>
</tr>
<tr>
<td>32</td>
<td>7</td>
</tr>
<tr>
<td>110</td>
<td>5</td>
</tr>
<tr>
<td>223</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>25 (24%)</strong></td>
</tr>
</tbody>
</table>

*Table 3: Top 4 Manufacturers with GTINs*
For both questions, data for the sample was analyzed using a test of binomial proportions. Additionally, tests were performed for the top five manufacturers of the sample. The top five manufacturers were chosen in order of the highest frequency of supplies noted in the sample.

**Sample Size – Part I**

**Research Questions**

1. What is the proportion of medical-surgical supplies stored at the OSUMC UH storeroom labeled with a GTIN number for each item and the item’s lowest available unit of measure?

   The observed proportion of supply items with a GTIN was 52.9%. A 95% confidence interval was calculated that indicated a variance of +/- 9.6%. The proportion of items with a GTIN was significantly less than 99.9% (p<0.001). Additionally a chi-squared test for independence was performed for the GTIN and Unit of Measure (UOM) combination.
to determine if the lowest UOM available for the study was associated with the availability of the GTIN. Prior to the analysis of the GTIN and UOM, the UOM of ‘Pair’ and ‘Pack’ were encoded to ‘Each’. See Table 5 for a listing of the UOM and occurrences of each. These UOM are synonymous as they are the lowest unit of measure available; however the supply was identified as a pair of gloves for example. In this test, the p value for Fisher’s exact test was 0.134 indicating that the presence of the GTIN is not associated with the UOM. Therefore the varying UOM is not affecting the results.

<table>
<thead>
<tr>
<th>Unit Of Measure</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Each</td>
<td>83 (80%)</td>
</tr>
<tr>
<td>Box</td>
<td>11 (11%)</td>
</tr>
<tr>
<td>Case</td>
<td>10 (9%)</td>
</tr>
</tbody>
</table>

Table 5: Units of Measure

2. What is the proportion of medical-surgical supplies stored at the OSUMC UH storeroom labeled with a GTIN barcode for each item and the item’s lowest available unit of measure?

The results from the data analysis for the GTIN barcode yielded the exact same numbers as the results for the GTIN itself. Therefore the proportion of items with a GTIN barcode was also significantly less than 99.9% (p<0.001).
Top Five Manufacturers – Part II

The data was analyzed using the basis of the same two research questions but for the top five manufacturers from the randomly selected sample. For the sample, there were 49 unique manufacturers of supplies. From this, the manufacturers that only had one item were removed leaving the 19 remaining manufacturers as seen in Figure 5. Of the manufacturers from the study, the top five manufacturers by frequency of items accounted for 53% of the total 19 selected for review. See Table 3 for a listing of the top 5 manufacturers’ frequencies.

![Figure 5: Manufacturer Frequency & Cumulative Percent Pareto Chart](image-url)
<table>
<thead>
<tr>
<th>OSUMC Manufacturer ID</th>
<th>Items with GTIN/GTIN Barcode</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>410</td>
<td>9 (90%)</td>
<td>10</td>
</tr>
<tr>
<td>32</td>
<td>7 (88%)</td>
<td>8</td>
</tr>
<tr>
<td>110</td>
<td>5 (63%)</td>
<td>8</td>
</tr>
<tr>
<td>223</td>
<td>4 (57%)</td>
<td>7</td>
</tr>
<tr>
<td>24</td>
<td>0 (0%)</td>
<td>6</td>
</tr>
</tbody>
</table>

**Table 6: Top Five Manufacturer Frequencies**

The observed proportion of supply items with a GTIN and a GTIN barcode was 64.1%. A 95% confidence interval was calculated indicating a variation of +/- 9.2%. The proportion of items with GTIN or a GTIN barcode was significantly less than 99.9% (p<0.001). A chi-squared test for independence was performed for the manufacturer and GTIN as well as the GTIN barcode; there was an observed p value for the Fisher’s exact test of 0.002 indicating that the presence of the GTIN is dependant on the manufacturer. Results were identical for the GTIN barcode and manufacturer.
CHAPTER 5

SUMMARY, CONCLUSIONS & RECOMMENDATIONS

The purpose of this study was to evaluate the existence of the Global Trade Identification Number (GTIN) and its associated barcode on medical-surgical supply packaging. The purpose of this chapter is to discuss the results of the study.

Summary of Findings

The existence of the GTIN and GTIN barcode on medical-surgical supplies was analyzed using a test of binomial proportions and a chi-squared test for independence. The results yielded the same information for both research questions. In part I, the chi-squared test result provided that there was no association with the unit of measure of the supply and the GTIN or the GTIN barcode. The results of the binomial test returned an observed proportion of 52.9%. A 95% confidence interval was calculated which stated that the normal proportion is between 43.3% and 62.5% in the whole population the likelihood to have a GTIN or GTIN barcode.

Further analysis of the association of the GTIN and GTIN barcode to the manufacturer was conducted. The top five manufacturers were analyzed; for both the GTIN and GTIN barcode using a test of binomial proportions that yielded the proportion was significantly less than 99.9%. The results of the binomial test returned an observed proportion of 64.1%. A 95% confidence interval was calculated which stated that the
normal proportion is between 54.9% and 73.3% of the population to have the GTIN or GTIN barcode. A chi-squared analysis for independence was also calculated that indicated the GTIN and GTIN barcode were associated with the manufacturer.

**Conclusions**

The existence of the GTIN and the GTIN barcode on medical-surgical supplies is still a developing effort. Little research has been conducted to explore the use of the GTIN and GTIN barcode on supplies. The results of this study suggest that additional research be conducted to determine if systems should be accommodated to handle the GTIN as the unique identifier across the supply chain. Additionally, since the study included the presence of the GTIN barcode, further research should be conducted to determine if systems are able to support the use of barcode scanning directly into the documentation.

Global data identification standards for healthcare supplies are a goal that should be achieved. There are potential benefits waiting to be realized from standards. Other major industries such as grocery and retail have embraced these standards for years. The data provided from this study suggests that between 43.2% and 62.5% in the population of the study are likely to have the GTIN. The resulting suggestion of supply items having a GTIN does not overwhelmingly support incorporating the GTIN in a materials management information system (MMIS). Organizations should look for federal mandates on the use of a global identification number or conduct further return on investment analysis prior to determining whether or not to include this identification in
current systems. This study should be repeated on a yearly basis until standards have been fully required by law or adapted by all manufacturers in healthcare.

**Recommendations**

The results of this study provide the basis for the following recommendations.

1. Evaluate current supplies for the existence of the GTIN and GTIN barcode prior to making any major system changes.
2. When exploring new systems that involve the documentation of supplies or serve as a materials management information system, validate that the systems have the capability to have a discrete data field for the GTIN.
3. Ensure that systems such as an EMR have the ability to scan barcodes for accurate and timely supply usage documentation.
4. Educate your organization on the potential impact of unique identification for supplies.
5. Determine what would be the actual requirements for updating current information systems to accommodate a global standard.
6. Gain further insight and understanding of the GS1 data standards.
REFERENCES

Ballard, J. (2012, 02 23). (M. Moore, Interviewer)


