12 Medical Supply Chain Inventory Management Strategies

Data Capture, Just-in-Time Strategies, and Economic Order Quantity Analysis

David Edward Marcinko and David J. Piasecki

CONTENTS

Introduction .................................................................................................................................... 298
Automated Data Collection ............................................................................................................ 299
ADC Technologies ......................................................................................................................... 299
  Bar Codes .................................................................................................................................. 299
  Bar-Code Scanners .................................................................................................................... 300
    Laser or CCD ........................................................................................................................ 300
    Autodiscrimination .............................................................................................................. 300
    Keyboard-Wedge Scanners ................................................................................................. 300
    Fixed-Position Scanners ..................................................................................................... 300
  Portable Computers ................................................................................................................... 300
  Batch versus Radio Frequency ................................................................................................. 300
  Hand-Held Devices ................................................................................................................... 301
  Vehicle-Mounted Devices ....................................................................................................... 301
  Wearable Systems ..................................................................................................................... 301
  Voice Technology .................................................................................................................... 301
  Optical Character Recognition ................................................................................................. 301
  Light Systems ............................................................................................................................ 302
Integration of ADC Technologies .................................................................................................. 302
  Real-Time Locator System ...................................................................................................... 302
  Screen Mapping/Screen Scraping ............................................................................................ 302
  Speech-Based Technology ....................................................................................................... 302
  Terminal Emulation .................................................................................................................. 303
  Warehouse Management System ............................................................................................ 303
Radio-Frequency Identification ...................................................................................................... 303
RFID Comparisons to Bar Codes ................................................................................................. 303
Electronic Product Code ................................................................................................................. 305
  Some EPC Myths ..................................................................................................................... 305
RFID versus Wi-Fi for Hospital Inventory Tracking Systems ....................................................... 306
INTRODUCTION

Inventory cost accounting methods are seldom used by medical practitioners. After all, doctors, hospitals, and health care organizations provide a service, and generally do not sell things.

However, inventory is playing an increasingly important role in the financial viability of procedurally based practitioners, clinics, and hospitals. This occurs because these health care entities maintain, dispense, and use durable medical equipment (DME) more abundantly than ever before. Voice systems, radio-frequency identification (RFID), optical character recognition (OCR), pick-to-light and laser scanners, charge-coupled device (CCD) scanners, hand-held batch and radio-frequency (RF) terminals, vehicle-mounted computers, and wearable computers are now all part of the modern health care system inventory data collection and management picture.

Ironically, the financial challenge of hospital inventory management was first articulated in the Efficient Healthcare Consumer Response Report in 1996. The report identified $11.6 billion of cost-saving opportunities in the American health care system directly due to inefficient product movement and ineffective inventory control and materials management. Now, more than 10 years later, this situation has only grown worse. As material costs have increased, our overburdened health system cannot afford such inefficiency.

For example, DME stock-out emergencies are real and costly. Moreover, inventory models such as economic order quantity (EOQ) costing have been in existence long before modern data capture inventory costing methods, just-in-time (JIT) inventory controls, total quality management protocols, and the other supply chain inventory management (SCIM) initiatives often used to prevent them.

SCIM is a method of accounting that takes into consideration raw materials, the construction of useful products, and the distribution of those products. Physician proceduralists, medical dispensers, and hospitals must understand SCIM, because a health care entity’s profitability will suffer if it has too much, or too little DME inventory on hand. DME can be a cost center or a revenue driver, depending on its management.
Perpetual or periodic inventory costing methods are the traditional ways to account for DME usage. With perpetual costing, a new unit price is recalculated with each order. With periodic costing, the cost of inventory is determined once, at the end of the period.

How can the health care entity determine the proper DME inventory level? One uncommonly used, but increasingly important, approach is the EOQ method.

Some astute clinic and hospital administrators are just now using EOQ to manage their DME inventory. They are increasing their financial benefits by determining the most cost-effective answers to the questions:

1. How much inventory should I order?
2. When should I order the inventory?
3. How can I increase efficiency and reduce channel costs?

In other words, how can a hospital or health care organization optimize inventory levels, reduce expenses, and still improve patient care and safety?

AUTOMATED DATA COLLECTION

Automated data collection (ADC), also known as automated data capture, automated identification (AutoID), or automated identification and data capture, consists of many different technologies. Bar codes, voice systems, RFID, OCR, laser scanners, and vehicle-mounted and wearable computers are all part of ADC management and inventory activities.

However, the fear of six-figure project costs often prevents many small- to mid-sized hospitals and health care systems from taking advantage of these technologies. The key to implementing cost-effective ADC systems is to know what technologies are available and the amount of integration needed to implement them. Applying this processing knowledge in a health care organization will help in developing the scope of any project. Limiting projects to or prioritizing by those applications that have a high benefit/cost ratio allows these operational improvement technologies within a reasonable budget.

For example, adding a keyboard-wedge bar-code scanner to an existing personal computer (PC) or blade terminal in a nursing station is a very low-cost method for applying ADC to existing hospital reporting applications. This type of hardware is inexpensive and the only real programming required is to add a bar code to the proper form (work order, pick and delivery slip, etc.).

ADC TECHNOLOGIES

Some of the current hospital data capture technologies include the following:

BAR CODES

There are two major categories of bar codes: one dimensional (1D) and two dimensional (2D). 1D bar codes are the ones most familiar and consist of many different symbologies including universal product code (UPC), Code 128, Code 39, and Interleaved 2 of 5, just to name a few. The symbology used may be dictated by hospital or pharmaceutical supply chain partners through a standardized compliance label program or, if only used internally, can be chosen by the central supply manager based upon specific application.

2D bar-code symbologies are capable of storing more data than their 1D counterparts and require special scanners to read them. Although continued growth in the use of 2D bar codes is expected, most hospital and health care applications will continue to use 1D symbologies simply because the technology is less expensive and only enough data are needed in the bar code to access the associated records in an inventory system database.
BAR-CODE SCANNERS

Laser or CCD
There are primarily two technologies used to read bar codes. Laser scanners use a laser beam that moves back and forth across the bar code reading the light and dark spaces. Laser scanners have been in use for decades and are capable of scanning bar codes at significant distances. CCD scanners act like a small digital camera and take a digital image of the bar code, which is then decoded. CCD scanners offer a lower cost, but are limited to a shorter scan distance (usually within a few inches; however, the technology is advancing quickly and devices with longer scan distances are becoming available). Because of the scan distance limitations, users in a hospital storage or warehouse environment will likely find laser scanners to be their best choice. However, for applications where bar codes are read from documents—such as in a pharmacy production-reporting application—CCD scanners are acceptable.

Autodiscrimination
Autodiscrimination describes the functionality of a bar-code reader to recognize the bar-code symbology being scanned, thus allowing a reader to read several different symbologies consecutively. Most scanners come with this functionality and also allow reprogramming to read only certain symbologies (this prevents someone from scanning the wrong bar code when multiple bar codes are present).

Keyboard-Wedge Scanners
Keyboard-wedge scanners connect between a computer keyboard and the computer and send American Standard Code for Information Interchange data to the computer as if the scanner were a keyboard. More simply put, the computer does not know that a scanner is attached and treats the data as though they were key strokes from the user. The advantage of this is that there is no need for special software or programming on the computer. In its simplest application, one hooks the scanner up, makes sure the cursor is in the correct field, scans a bar code containing the data (such as a work order number, an item number, or a location), and the data will immediately appear in the field on the screen. Keyboard-wedge scanners offer a low-cost entry into the world of ADC for hospitals and can provide increases in accuracy and productivity in many stationary data entry applications. There are also wireless versions of keyboard-wedge scanners available.

Fixed-Position Scanners
Fixed-position scanners are used where a bar code is moved in front of the scanner as opposed to the scanner being moved to the bar code. Applications include DME counters and automated pharmaceutical conveyor systems. Many fixed-position scanners are omni-directional, which means that the bar code does not have to be oriented any specific way to be read.

PORTABLE COMPUTERS
Portable computers come in a vast variety of designs with varying levels of functionality. However, there is a lack of progress in portable terminal design, especially with the hand-held units used in many health care settings. On the plus side, costs have come down over the years and evolving technologies are being developed for devices such as personal digital assistants, smartphones, iPads, and computerized physician order entry systems that will soon make portable data collection and ordering terminals smaller, lighter, and more functional.

BATCH VERSUS RADIO FREQUENCY
Batch terminals are used to collect data into files on the device and are later connected to a computer to download the files. RF terminals use radio-frequency waves to communicate live with the
host system or network. Batch devices were heavily used in the past, and still have viable hospital legacy applications today, but the introduction of wireless standards has made RF technology much more affordable and easier to maintain and implement.

**Hand-Held Devices**

Hand-held terminals generally have very small liquid crystal display that is usually difficult to read, as well as very small, with confusing keypads into which it is difficult to enter data. This does not mean that these cannot be valuable tools in a hospital operation, only that one must consider all the factors when implementing this type of technology. Hand-held devices often come with integrated bar-code scanners, but can be used without a scanner or with a separate scanner.

**Vehicle-Mounted Devices**

Vehicle-mounted devices have several advantages over hand-held devices including larger screens and larger keypads similar to a standard keyboard on a portable computer. Generally, vehicle-mounted devices use a separate wired or wireless bar-code scanner to input data.

**Wearable Systems**

Wearable systems will likely have the most growth in the coming years. Currently, offerings in wearable systems are limited and include devices such as Symbol Technologies’ WS Series™ that is strapped to the wrist/forearm and uses a small ring-type laser scanner for reading bar codes; or the Talkman™ from VoCollect that is designed for voice systems. Wearable systems provide the functionality of hand-held devices while still allowing workers to use both hands.

**Voice Technology**

Voice technology (a.k.a. speech-based systems) has come of age in recent years and is now a very viable and desirable solution in hospital and DME warehouse ADC applications. Voice technology is really composed of two technologies: voice directed, which converts computer data into audible commands, and speech recognition, which allows user voice input to be converted into data. Portable voice systems consist of a headset with a microphone and a wearable computer.

The advantages of voice systems are hands-free and eyes-free operation that allows people to communicate with a computer the way people communicate with each other. Applications for voice systems include order picking, quality inspection, shipping, receiving, and cycle counting.

Speech-recognition capabilities have been gradually improving through better software and hardware, but it is not yet a perfected technology. To compensate for problems associated with speech recognition, one should limit the speech input to a fairly short list of keywords and phrases for commands, and primarily numeric characters for voice data input. Alpha characters would have to be spoken phonetically (Alpha, Bravo, Charlie, Delta, . . .) to maintain an acceptable level of accuracy.

**Optical Character Recognition**

For years, OCR has been used in mail sorting and document management, but has had very little application in hospital warehouse operations primarily because it is not as accurate as bar-code technology. As hardware and software improve, we may see this “old” technology make a comeback. The primary advantage of OCR is that it can read the same characters that a human can read, eliminating the need to have both a bar code and human readable text on labels, documents, and so on. It also provides the ability to input data from documents that do not include bar-coded information.
LIGHT SYSTEMS

Although some may argue whether or not a pick-to-light system is an ADC technology, the fact is it accomplishes some of the same tasks.

For example, *pick-to-light systems* consist of lights and LED displays for each pick location. The system uses software to light the next pick and display the quantity to pick. Pick-to-light systems have the advantage of not only increasing accuracy, but also increasing productivity. Because hardware is required for each pick location, pick-to-light systems are easier to cost-justify, where very high picks per stock keeping unit (SKU) occur. Hospital chart flow racks and horizontal carousels are good applications for pick-to-light. In batch picking, pick-to-light is also incorporated into the cart or rack that holds the charts that are picking into (put-to-light).

INTEGRATION OF ADC TECHNOLOGIES

While hardware costs of ADC equipment continue to come down, the cost of integration will often prove to be the project buster. Software and integration costs will often be several times the cost of the hardware, especially in smaller health system operations where only a few devices will be used.

Integration of ADC technologies is also far from standardized. For example, when implementing an RF system with portable terminals, one integrator may create a program on the terminals that will write directly to the file on the host system, another may create programs on a separate server to do this, another may write or modify a program on your host system and use terminal emulation software, and another may use a screen mapping tool to reformat an existing program to be used on the portable device. Make sure to speak with several integrators to ensure the best solution. Moreover, make sure to participate heavily in equipment selection and program/process design (prompts, data input) to ensure a system that provides the highest levels of accuracy and productivity.

REAL-TIME LOCATOR SYSTEM

A real-time locator system (RTLS) uses RFID technology that provides the objects they are attached to the ability to transmit their current location. The system requires some type of RFID tag to be attached to each object that needs to be tracked, and RF transmitters/receivers located throughout the facility to determine the location and send information to a computerized tracking system. While it sounds like a great way to eliminate “lost” inventory, the systems are still too costly for most inventory tracking operations and are more likely to be used to track more valuable assets.

SCREEN MAPPING/SCREEN SCRAPING

This software provides the functionality to change the arrangement of data fields on a computer screen that accesses a mainframe computer program. Screen mapping is frequently used in combination with terminal emulation software to “remap” data fields from a standard mainframe program to be used on the smaller screen of a portable hand-held device.

SPEECH-BASED TECHNOLOGY

Speech-based technology, also known as voice technology, is really composed of two technologies: (1) *voice directed*, which converts computer data into audible commands, and (2) *speech recognition*, which allows user voice input to be converted into data. Portable voice systems consist of a headset with a microphone and a wearable computer.
TERMINAL EMULATION

Software used on desktop and portable computers is available and allows the computer to act like a terminal connected to a mainframe system. If you have a networked desktop PC and are accessing mainframe programs (green screen programs), you are using terminal emulation. Terminal emulation is also a common method used to connect portable computers (as in pharmacy bar-code ADC systems) to mainframe software.

WAREHOUSE MANAGEMENT SYSTEM

Computer software designed specifically for managing the movement and storage of materials throughout the health care system warehouse or chain of command generally controls the following three operations: (1) put-away, (2) replenishment, and (3) picking. The key to these systems is the logic to direct these operations to specific locations based on user-defined criteria. Warehouse management systems are often set up to integrate with ADC systems.

RADIO-FREQUENCY IDENTIFICATION

RFID refers to a device attached to an object that transmits data to an RFID receiver. A device can be a large piece of hardware the size of a small book like those attached to ocean containers, or a very small device inserted into a label on a package. RFID has advantages over bar codes such as the ability to hold more data, and to change the stored data as processing occurs. Moreover, it does not require line-of-sight to transfer data, and is very effective in harsh environments where bar-code labels will not work. RFID is not without its own problems, however, as RF signals can be compromised by materials such as metals and liquids.

Although RFID technology is receiving much current attention, it still tends to be cost-prohibitive for most hospital inventory tracking applications. As chip prices go down, there will be continued growth in the application of RFID, but, as in the case of 2D bar codes, many warehouse applications simply do not require this added functionality. The low-cost 1D bar code will likely continue to be the technology of choice for many hospital inventory tracking applications.

Smart labels are labels with integrated RFID chips. The idea is to produce labels (probably with bar codes) as well as programming the RFID chips embedded in the label. This would provide all current functionality (human- and machine-readable text and bar codes) as well as adding RFID functionality.

Slap-and-ship describes an approach to complying with vendor requirements for physical identification of shipped goods. Most recently, slap-and-ship has been used to describe complying with RFID requirements (such as those from large health care systems); however, it is also applicable to any compliance labeling requirement (such as compliance bar-code labels). Slap-and-ship implies meeting the customer’s requirement by applying the bar-code labels or RFID tags, but not utilizing the technology internally.

Anti-skimming bills were recently approved by California and Washington State relative to RFID privacy and are focused on making it illegal for criminals or businesses (or criminal businesses) to read and use personal information from RFID-enabled items such as driver’s licenses and credit cards without the owner’s consent.

RFID COMPARISONS TO BAR CODES

Advantages:

1. **RFID technology does not require line-of-sight reading.** Unlike a bar code, an RFID tag can be read through other materials (though some materials may cause problems). Theoretically, this means one could take a pallet of mixed products, all of which contain
individual RFID tags, and have an RFID reader read all the tags within the palletized load without having to physically move any of the materials or open any cases.

2. **RFID tags can hold more data than bar codes.** The operative word here is “can.” As the data-storage capacity of RFID tags increases, so does the cost of the tags. Therefore, many RFID tags will not hold any more data than a bar code.

3. **RFID tag data can be changed or added to as a tag passes through specific operations.** Once again, cost comes into play as read-only tags are much less expensive than read/write tags. Therefore, limited use of this functionality is seen.

4. **RFID tags are more effective in harsh environments where bar-code labels have problems.** RFID tags can be sealed within a plastic enclosure, eliminating many of the problems that plague bar codes in harsh environments where they are exposed to chemicals, heat, abrasion, dirt, and grease buildup.

5. **A large number of RFID tags can be read almost instantaneously.** Though it may seem as though the tags are all read at once, they are actually read sequentially (one at a time); however, this happens so fast that it is virtually imperceptible.

**Disadvantages:**

1. **Cost**—This is the biggest hurdle to RFID tags replacing bar codes for item-level tracking of low-cost health care products. A bar code can be produced on an item for less than 1 cent, yet the most optimistic proponents of RFID are still “hoping” for 4- or 6-cent RFID tags sometime in the future. Moreover, even if a 5-cent tag is achieved, it is still a significant cost to add to the manufactured cost of low-cost consumer goods. Even with higher cost products, the benefits of RFID must be greater than the additional cost.

2. **RFID signals may have problems with some materials.** Metals [oxygen canisters] and liquids [nitrous oxide] can cause problems when trying to read RFID tags. Tag placement is becoming a science in and of itself since—depending on the product—even a case-level RFID tag may have to be placed in a specific location on the case and cases stacked in a specific orientation to get a consistent read.

3. **Though RFID does not require of line-of-sight, it is also not restricted by it.** With the proper bar-code equipment, one can selectively read a single bar-coded case on a shelf more than 10 ft. away. This cannot be done with RFID because an RFID reader will read all tags within its range. Even though one can get directional RFID readers, they are still not as selective as a visual device (bar-code scanner). There are still many warehouse applications that require this line-of-sight capability.

4. **RFID tags can fail.** The unique issue with RFID failure is the automated nature of RFID optimized processes. If an RFID tag is damaged, how does one know that all the tags have not been read?

5. **RFID speed.** The smart label scenario (using labels with integrated RFID chips) appears to be the most likely one for mass RFID use for case and unit tracking of inventory. Unfortunately, it takes more time to print, program, and verify an RFID-enabled label than to simply print a bar-code label. In addition, RFID smart labels seem to have some serious quality problems. Failure rates (inability to properly program and read the tag) are anywhere from 10% to 30%. For automated print-and-apply applications, this could be a serious problem.

6. **RFID standards are still being developed.** No business entity would want to invest in an RFID system that is based on soon-to-be-obsolete specifications. Most RFID systems currently in place are based upon proprietary technology where the readers are designed to read only RFID tags from a specific manufacturer. Compare this to bar-code technology, where standards have been in place for decades. Most bar-code scanners are designed to read all standard bar-code symbologies.
ELECTRONIC PRODUCT CODE

Electronic product code (EPC) is an emerging RFID standard developed by the AutoID center. It is the RFID version of the UPC bar-code standard. Like UPC, EPC is intended to be used for specific product identification as well as case and pallet identification. However, EPC goes beyond UPC by not only identifying the product as an SKU, but also providing access to additional data (via the EPC network) about the origin and history of the specific units. The EPC tag itself identifies the manufacturer, product, version, and serial number. It is the serial number that takes EPC to the next-generation level by providing the key to data related to specific lots/batches/units. It potentially allows tracking of the specific unit’s history as it moves through the supply chain. These unit-level data are stored somewhere else (the Internet or other network), but a standardized architecture allows access to the data much like one would access a Web page (though this would be happening automatically behind the scenes). This architecture is known as the EPC network.

EPC has become increasingly important because it is the standard being utilized by the Department of Defense for the upcoming RFID standardization considerations.

Some EPC Myths

1. Misconception 1—EPC is strictly an RFID standard. Granted, RFID is part of EPC, but there is a lot more to EPC. Most notably is the EPC network, which is where all the data related to EPC will exist. This is a significant change in item-based data management and should not be taken lightly.

2. Misconception 2—The use of RFID for EPC tags will allow them to hold more data than bar codes. This is simply not true. RFID tags could hold more data than a bar code, but under the EPC standard, they will not. The data in the EPC RFID tag simply act as an address to the rest of the data and work in a way that is similar to the way a URL provides access to a Web page. The EPC network essentially takes the concept of the Internet and applies it to inventory data. When an RFID reader reads a tag, it will pass this address to software that can then access the additional data residing on servers that could exist anywhere in the world. What kind of data will exist on the EPC network? Just about anything related to the DME item or container. For example, it might include detailed item information, such as description, ingredients, size, weight, cost; manufacturing information about the specific lot, such as when and where it was produced and expiration dates; and distribution information about where it has been, including addresses, dates, and times. The data could be as detailed as including environmental factors such as temperatures during manufacturing or storage. This data flexibility is accomplished through the use of a new computer language called physical markup language (PML) that is essentially a variation of the more commonly known extensible markup language (XML) that is essentially a variation of the more commonly known extensible markup language. The purpose of PML is to provide a standard vocabulary to represent and distribute information about AutoID-enabled objects.

3. Misconception 3—Data in the tags will be changed as they pass through the supply chain. Once again, RFID technology is capable of this functionality, but the EPC standard is not utilizing it. Data will only be written to the tag once under the EPC standard. Any changes in status or other update information will be written to the EPC network, not the tag.

4. Misconception 4—The use of RFID for EPC tags will allow them to be more durable than bar codes. Probably not; while more expensive RFID tags encased in a plastic shell are more durable than bar codes in harsh environments, the lower cost, unprotected RFID circuits glued to a paper label that are more likely to be used do not share these durability characteristics.
RFID VERSUS WI-FI FOR HOSPITAL INVENTORY TRACKING SYSTEMS

The two wireless technologies currently competing to provide hospitals with better systems for managing equipment inventories are wireless-fidelity (Wi-Fi) and active RFID. Wi-Fi is the name of the popular wireless networking technology that uses radio waves to provide wireless high-speed Internet connections. The Wi-Fi Alliance is the non-profit organization that owns Wi-Fi (registered trademark) and the term specifically defines Wi-Fi as any “wireless local area network products that are based on the Institute of Electrical and Electronics Engineers’ 802.11 standards.” Yet, less than 5% of North American health care facilities are equipped with these real-time locating systems; therefore, the market is currently up for grabs.

The advantage of Wi-Fi-based RTLSs is that most hospitals already have Wi-Fi networks in place, and many medical devices are equipped with Wi-Fi functionality. Moreover, Wi-Fi vendors such as AeroScout, Ekahau, and PanGo market their products based on a standards-based non-proprietary functionality. The downside of Wi-Fi systems is that hospitals will need to install additional access points to bring the needed functionality to existing networks.

On the other hand, RFID vendors such as RF Code and Radianse point to the wide application of RFID for asset tracking, and to the technology’s longevity in the industry. Still, RFID tags remain suspect because their ability to efficiently track DME may not be private or secure. Increasingly, Wi-Fi seems more ubiquitous than RFID.

Finally, of the three Wi-Fi major vendors, only Ekahau makes a point of stressing that its inventory system is based only on Wi-Fi and not RFID; therefore, the issue is not clear cut. Perhaps, it will take both technologies to deploy RTLSs for hospital emergency rooms, intensive care units and operating rooms, etc. (1).

GENERAL RECOMMENDATIONS

As a general recommendation, RFID is not yet practical for most small- to mid-sized health care entities or medical clinics looking to automate their inventory-related transactions (though it does work for other applications such as with returnable containers and asset tracking).

Despite the hype over RFID, bar codes are not becoming obsolete and are still very effective at quickly and accurately identifying products, locations, and documents. Unless there exists an application where bar codes simply do not work, or where RFID offers a significant advantage over bar codes, use bar codes. Even if an application that cries out for RFID exists, hospital material management administrators may want to consider waiting (if possible) as the cost of the technology comes down.

According to Robert M. Wachter, MD, professor and chief of the Division of Hospital Medicine and associate chairman of the Department of Medicine, and Lynne and Marc Benioff, endowed chair in Hospital Medicine, University of California at San Francisco, and chief of the Medical Service at UCSF Medical Center [personal communication]:

Ultimately, of course, we need both bar coding and RFIDs, and we need rigorous studies looking at what works and what doesn’t. But, you have to start somewhere. Even though the evidence continues to trail, based on what I know today, if I was a hospital ready to get into the IT game, I’d go with bar coding first.

In the next few years, standards will be finalized, hardware prices will drop, software will become more readily available, and, more importantly, the bugs will be worked out of all these systems (2).

HEALTH CARE INVENTORY MANAGEMENT

Health care inventory is a term that describes medical items used in the delivery of health care services or for patient use and resale, and like DME, a certain safety margin of stock should always be
available. Inventory ranges from normal administrative office supplies to highly specialized chemicals and reagents used in the clinical laboratory. It should be distinguished from capital supplies such as major equipment, instruments, and other items that are not used up faster than inventory or related inventory wastes (3).

Historically, asset utilization ratios provided information on how effectively the enterprise used its inventory assets to produce revenues, or deplete its cash. For example, the inventory turnover ratio (ITR) determines the total volume of inventory turnover (change) during a pre-determined accounting period (month or quarter). It is defined as cost of inventory purchased for the period, divided by average inventory (AI) at cost.

Dunn and Bradstreet, the supply chain management (SCM) and consulting company, does not provide exact comparatives for private health care ITR. Nonetheless, ITR is useful as an internal performance indicator of inventory turnover speed and cash flow enhancement. Currently, however, for public hospitals, 60–75 days is estimated to be the average time for inventory turnover.

The main problem with traditional ITR, similar analyses such as AI and inventory control point, and the usual inventory costing methods [e.g., last-in first-out (LIFO), first-in first-out (FIFO), specific identification, average costs, and even JIT inventory costing, is that they do not embrace SCIM. This occurs because sources of profit or loss are not recognized in the traditional inventory cost accounting equation

\[
\text{Cost of goods sold} = \text{beginning inventory} + \text{net purchases} - \text{ending inventory}
\]

**INVENTORY METHODOLOGIES**

A good SCIM system offers opportunities for improved efficiency in any health care organization. The following traditional methods of inventory cost accounting and management are useful when one is calculating the cost of supplies (as opposed to medical items for resale and DME).

**LAST-IN FIRST-OUT**

The LIFO inventory costing method means that the last items purchased are the first to be used (at least for cost calculations if the inventory consists of identical units). In times of rising prices, a lower total cost inventory is produced with a higher cost of goods sold. The last items purchased are most often the most expensive, and used first for the calculation. This happens because LIFO increases an expense (cost of goods sold) and decreases taxable income. Given the same revenue, higher expenses mean less profit. Deflation has the opposite effect.

**FIRST-IN FIRST-OUT**

The FIFO inventory costing method means that the first items purchased are the first to be used (at least for cost calculations if the inventory consists of identical units). In times of rising prices, a higher total cost inventory is produced with a lower cost of goods sold. This happens because FIFO decreases an expense (cost of goods sold) and increases taxable income. Deflation has the opposite effect.

**SPECIFIC IDENTIFICATION**

Specific identification is used for larger pieces of equipment, as it traces actual costs to an identifiable unit of product and is usually applied with an identification tag, serial plate, or RFID scanner. It does not involve flow-of-cost analysis. It does, however, permit the manipulation of income because health care entities state their cost of goods sold, and ending inventory, at the actual cost of specific units sold.
Average Cost

Average costing calculates ending inventory using a weighted average unit cost. When prices are rising, the cost of goods sold is less than under LIFO, but more than that under FIFO; hence, income manipulation is also possible.

JIT Management

Although technically not a costing technique, JIT inventory management means that inventory supplies like DME are delivered as soon as needed by the health care organization, the prescribing doctor, or the patient. In JIT, inventory is “pulled” through the flow process. This is contrasted to the “push” approach used by conventional SCIM. In the push system, DME is already on-site, with little regard to when it is actually needed. In the JIT “pull” system, the overriding concern is to keep a minimum cost inventory; so that means having a system in which inventory is obtained on an as-needed basis. The key elements of JIT consist of six parts:

1. A few dependable vendors or suppliers willing to ship with little advanced notice
2. Total sharing of demand information throughout the supply chain
3. More frequent orders
4. Smaller size of individual orders
5. Improved physical plant (hospital or clinic) layout to reduce travel flow distance
6. Use of a total quality control system to reduce flawed medical products

Using the JIT method, inventory is delivered when needed, rather than in advance, saving handling and storage costs. The health care entity never needs to stockpile inventory, and cash flow is enhanced. JIT is further characterized as follows:

1. Little or no work orders
2. Little or no tracing of materials
3. Fewer inventory accounts or accounts payables
4. Reduction or elimination of work-in-progress or handling activities
5. No tracing of overhead and direct labor costs

JIT requires a dependable working relationship with suppliers and the precise calculation of inventory needs, especially for the following:

1. Sterile surgical packs
2. Gastrointestinal and gastrourinary instrumentation
3. Orthopedic and obstetrics–gynecology inventory
4. Invasive heart and lung equipment
5. Radioisotopes and trace radiographic materials
6. Equipment for almost all pre-schedule medical interventions and procedures

This means that, when JIT inventory monitoring is used, health care managers are better prepared with the proper inputs to control and reduce inventory, including when dramatic bursts or declines occur. This means a more rapid and higher cash flow balance, rather than inventory balance.

Each of these traditional methods of inventory cost accounting is adequate for most health care facilities, but as inventory orders and costs continue to increase, EOQ costing may be the most effective means of accounting for inventory in DME-intensive organizations.
ECONOMIC ORDER QUANTITY PROCESS

Economic order quantity costing is a determination of the number, amount, or quantity of DME orders that minimize total variable costs required to order and hold items as inventory (4). Therefore, how does a health care organization determine current inventory costs and proceed to implement a SCIM policy, such as EOQ costing? The approach involves the following steps:

1. Perform an inventory of all DME in the clinic, hospital department, or ambulatory surgical center by physical, electronic, or other counting or inventory tracking means.
2. Analyze how much DME inventory quantity is on hand.
3. Determine associated inventory and ordering costs for the DME on hand.
4. Perform an EOQ cost analysis.

In-house staff or an external inventory management team can achieve these goals.

Therefore, why are some clinic managers, supply chain managers, central supply directors, and hospital administrators still not taking advantage of EOQ, a basic DME inventory process? A small part of the answer lies in the concept of economies of scale, as most medical office and clinics are still small businesses incapable of large-scale SCIM initiatives. This will change going forward, as the pace of industry mergers, consolidation, and acquisitions increases, and multiple offices and clinics form larger enterprise business units and hospital networks, which require more DME and improved inventory fiscal control.

Even with larger health care systems and hospital chains, a larger “part of the answer lies in the poor results sometimes received due to inaccurate EOQ processes input data. Accurate product costs, activity costs, forecasts, history, and lead times are crucial in developing DME inventory models that work.”

EOQ costing assumes

1. Constant demand rate
2. Constant lead time
3. Entire quantity is received at once
4. Constant unit costs
5. No limits on size of inventory

The mathematical formula for EOQ is the square root of $\frac{2SO}{C}$, where inputs $S$ is the annual usage or purchases in units, $O$ is the cost per order, and $C$ is the annual carrying cost per unit.

$$EOQ = \sqrt{\frac{2(\text{Annual usage in units})(\text{Order cost})}{\text{Annual carrying cost per unit}}}$$

$S = \text{Annual Usage or Purchase in Units}$

Although typically annual purchases in units and cost per order are historically known, better management of inventory will benefit from forecasting and a reduction in lead times. This will allow a health care organization to operate with less safety stock and can also reduce inventory levels and annual use.

$O = \text{Order Cost}$

Order cost is the sum of the fixed costs incurred each time an item is ordered. In the EOQ calculation, order cost is represented as a fixed dollar amount per purchase order (PO) line.
It is important to note that order costs are only the costs related to processing the purchasing transaction. Order cost may include costs associated with entering a requisition or PO, approval steps, expediting, processing the receipt, vendor invoice processing, and vendor payment. Any cost that changes based on the order quantity would not be considered part of order cost, which includes time spent unloading trailers and counting receipts.

Order cost can change based on the characteristics of the product being received. For example, when processing receipts of very small items delivered in parcels, the time spent unloading and opening the parcel and the time spent putting the product away may be included in order cost because the labor used is primarily due to the purchasing transaction. However, if processing multiple DME cartons or pallets of a product, most of the time, spent unloading and putting the product away is actually due to the quantity ordered and, therefore, would not be included in order cost.

Sourcing activities such as processing vendor quotes would not be included in order costs unless this cost is incurred every time an order is placed. Though often difficult, a portion of freight costs can be included in order cost provided you can accurately calculate how much of the freight cost is fixed (due to the transaction) rather than variable (due to the quantity ordered).

**C = Annual Carrying Cost per Unit**

Carrying cost is the cost associated with having inventory. In the EOQ calculation, carrying cost is represented as the annual cost per average on-hand inventory unit. This is usually calculated as a percentage of unit cost. It would include interest costs on loans for inventory, insurance, and inventory storage costs. Though interest and insurance may be the same percentage for all items, storage costs may vary based upon the characteristics of the specific product.

You should only apply costs that change based on the quantity of inventory stored. In some cases, you may choose not to include any storage costs in the calculation. This is especially true if storage costs are fixed and changes in inventory levels do not actually change these costs.

Risk costs such as risk of obsolescence, damage, or spoilage may also be included in carrying costs. Like storage costs, these costs likely vary by product or product group.

Several primary components of carrying costs may represent a source of lost profits. These include rent, utilities, insurance, taxes, employee costs, and the interest rate and opportunity costs of having office space or capital tied up in DME. In fact, research by Jones suggests that hospitals and other companies do indeed understate carrying costs because only variable costs are considered while other costs like handling, accounting and administrative, and depreciation are not. Yet these costs may be more significant in the EOQ equation than the variable costs.

**Example:**

A large ambulatory surgery center performs orthopedic bone surgery and uses about 10,000 self-absorbing bone fixation pins every year. Historically, it is known that the cost per pin is $200, and the annual inventory carrying cost per pin is $10. Using the EOQ formula, we can determine when and how many bone fixation pins are required for the organization.

**EOQ Solution Calculation:**

According to the above formula, the EOQ is 632, as follows

\[ \sqrt{\frac{2(10,000)(200)}{10}} \]

\[ 2(10,000)(200)/10 = 400,000 \]

\[ \text{Square root of } 400,000 = 632 \]
This means that there are 16 orders per year or 10,000 divided by the 632 EOQ. The time between each order is 3.3 weeks or 52 weeks divided by the 16 orders. Therefore, the vital economic questions of when and how much DME to order have been answered.

The key to optimizing order quantities is getting the inputs to the calculation correct. These include accurate product costs, forecasted annual demand, order costs, and carrying costs. Most problems with EOQ outputs are the result of incorrect order cost and carrying cost inputs. To some extent, computer technology has actually contributed to problems with order quantity calculations by automating the process and hiding the key inputs (order costs and carrying costs) in secured system setup areas. In some cases, these inputs are simply “plugged in” during the initial system setup to get the system up and running and are never actually reviewed on a continual basis.

When implementing the EOQ calculation, it is also important to project the short-term and long-term effects the EOQ calculation will have on warehouse space, cash flow, and operations. This is accomplished by comparing the output of the EOQ calculation with your current ordering practices. If the EOQ output shows overall increases in order quantities, you may choose to “temporarily adjust the formula until arrangements can be made to handle the additional storage requirements and compensate for the effects on cash flow. If the projection shows inventory levels dropping and order frequency increasing, you may need to evaluate staffing, equipment, and process changes to handle the increased activity.” For hospitals, medical offices, surgical centers, or emerging health care organizations with extensive inventories, a phased approach is highly recommended.

You should focus on cost reduction and not necessarily inventory reduction. Reducing order and re-order costs through process changes, e-procurement, vendor managed inventory, vendor certification programs, and technologies such as bar codes and RFID, will ultimately result in inventory cost reduction.

**Re-Order Point**

Once you have calculated the EOQ for the health care organization’s inventory, you will need to figure out the re-order point (ROP) for new shipments. The ROP for new inventory orders is calculated as follows:

\[
ROP = (\text{average use per unit of lead time} \times \text{lead time}) + \text{safety stock}
\]

**Example:**

A hospital chain with lead time of 1 week uses 6400 delivery room birthing sets per 50-week year \((6400/50) \times 1 \text{ week} + 0 = 128 \text{ ROP}\). If lead time and average use are certain, no safety stock (quantity zero) is needed.

If competition, a variable birth rate, or some other factor changes and now demands a safety stock of 150, the new ROP is \(128 + 150 = 278\).

**Assessment of EOQ**

EOQ may be a useful technique if there is an opportunity to change the current DME ordering policy of a medical office or clinic, or if the current policy is inadequate. Though it may appear that this technique would solidify purchase quantity, there are still other factors to consider because the EOQ equation makes these unrealistic assumptions:

1. Lead time is known
2. Demand is a fixed constant
3. No shortages occur
4. No quantity discounts are permitted

For example, a hospital or clinic still needs to review the likelihood of a stock out (quantity of an inventory item falling to zero), use of safety stock levels, the length of time DME is kept on hand, quantity discounts that vendors may offer, and product volume within the practice or health enterprise.

When a quantity discount is expected, this formula may be used:

$$\text{Total cost} = \text{Carrying Cost (CC)} + \text{Order Costing (OC)} + \text{Product Cost (PC)}$$

$$= C \times (Q/2) + Q \times (D/Q) + PD$$

where

- $D = \text{discount}$
- $P = \text{unit price}$
- $Q = \text{order quantity}$

A methodical approach in calculating EOQ with discounts may be summarized as follows:

1. Compare the EOQ when price discounts are ignored and costs are based on the new formula above. Note: $EOQ = \text{square root of } 2OS/C$
2. Compute the cost for those amounts greater than the EOQ at which price reductions occur
3. Select the value of $Q$ that results in the lowest total costs

Moreover, clinic and hospital goals and strategies may sometimes conflict with EOQ methodology. Measuring DME performance solely by inventory turnover is a mistake. Some health care entities have achieved aggressive goals in increasing inventory turns only to find that their bottom line has shrunk due to increased operational costs.

While EOQ may not apply to every DME inventory situation, some health care entities will find it beneficial in at least some aspect of their operations.

Whenever there is repetitive purchasing of DME, you should consider using the EOQ equation to determine appropriate order amounts.

The process here is to divide the year into the increments in which annualized sales are relatively constant (i.e., summer, spring, fall, and winter). Then, the EOQ model can be applied separately to each period. During the transition between seasons, DME inventories would either be run-down or built-up, with special seasonal orders. Though EOQ is most effective with stable demand, seasonal demand can be managed by using shorter time periods or converting the EOQ quantity into a period order quantity (stated in number of days of demand). However, if you plan to use the EOQ method, be sure that usage and carrying costs are based on the same time period.

HOSPITAL MATERIALS MANAGEMENT INFORMATION SYSTEMS

The singular focus of any Hospital Materials Management Information System (HMMIS) is to deliver significant improvements in the ability of hospital facilities, networks, and other health care organizations to accurately optimize the processes and workflows associated with materials management systems and reduce the costs related to inventory, DME, pharmaceuticals, and (SCM) (5).

Strategically, hospitals must exploit contemporary technologies and connectivity with suppliers and trading partners to

1. Improve patient care and safety
2. Increase efficiency
3. Drive down costs
4. Optimize inventory levels
SOFTWARE SELECTION

Software selection and implementation services have become big business for consulting firms as well as the software vendors themselves. Even with outside assistance, selecting the right software for hospital operations and having a successful implementation can be an extremely difficult undertaking. Horror stories of failed enterprise resource planning (ERP) system implementations are unfortunately very common. Anyone who frequently reads business publications have read stories where large health care corporations, posting smaller than forecasted profits, cite problems associated with the implementation of a new software system as one of the causes. Whether these claims are legitimate or not is up to debate. What is true is that hospitals are highly dependent on information systems, and failures in the selection and implementations of systems can result in anything from a minor nuisance to a complete operational shutdown.

Those unfamiliar with business inventory management software should be prepared to be bombarded with acronyms and buzz words. E-business, Web-enabled, e-procurement, e-fulfillment, e-manufacturing, collaborative, modular, and scalable are just a sampling of the terms used to describe (sell) hospital software inventory products.

Health care enterprise inventory tracking software with implementation ranges in price from a few thousand dollars to millions. In fact, up until recently, if you were a medical clinic with annual revenues of less than $200 million, many of the top enterprise software vendors did not even consider you a potential customer. Fortunately, this arrogance has been tempered recently due to economic conditions (primarily the software vendors’ cash flow). Unlike 5 years ago, when the software vendors felt that they held all the cards, today, it is truly a buyer’s market. No matter how big or small an entity, many vendors will be vying for software dollars. That is the good news. The bad news is that you must sift through all these products to find the one that best meets your business needs.

The most important part of the software selection process is defining the processes within your health organization and determining functionality that is critical to your medical operation. Many times clients get distracted by the bells and whistles and forget about their core health care business functions. As a health care entity in the DME distribution fulfillment business, focus on functionality related to order processing, as well as warehouse and transportation management. Be wary of the software vendor that claims packages that work equally well in all environments. Most software packages are initially designed with specific situations in mind; asking the vendor about their biggest customers will often give you an idea as to the type of operation the software was designed to work (6).

When you look at the detailed functionality of a product, it will be important to have listed detailed functionality requirements of your health care operation. This is where hospitals often make mistakes by emphasizing functionality that they currently do not have, but would like, and overlooking core health care processes that their current system handles well.

For example, if you are awestruck with functionality that allows remote access to a medical charting system from an Internet browser on an ambulatory device—and as a result—overlook critical functionality related to order entry or demand planning, you may end up with a system that provides great visibility to the fact that patient revenues are failing. Never assume a software package “must” be capable of handling something considered a standard function. Some examples of detailed functional requirements are as follows:

1. E-commerce capabilities
2. Multi-facility demand planning
3. Postponement and configure-to-order functionality
4. Forecasting and demand planning
5. Back-order processing
6. Lot or serial number tracking
7. Forward pick location replenishment  
8. Batch or wave order picking  
9. Returns processing  
10. Back-flushing DME inventory  
11. Co-product processing  
12. Outsourcing specific operations  
13. Multiple stocking units of measure  
14. Product substitutions  
15. Blanket orders  
16. Shipment consolidation  
17. Multi-carrier rate shopping and manifesting  
18. First-in first-out processing

Do not settle for “yes, we can do that” responses from the software vendor. It is your responsibility to verify that not only can they do it, but also that they can do it to the level required. Ask detailed questions as to exactly how it works in their system. Look at the specific programs used to achieve the task and verify that the data elements required to achieve the task are present. Do not allow the software vendor to sidestep your questions by retreating into obfuscating technical jargon.

SOFTWARE IMPLEMENTATION

As with the selection process, ERP software implementation may also require outside assistance. Whether you use consultants from the software vendor, a business partner, or an independent firm, the implementation plan will likely be the same. It is very important to listen to consultants and be prepared to dedicate the resources outlined in the implementation plan. A common mistake made by health care entities going through their first major implementation is to underestimate the complexity of their operations, the extent of system setup and testing, and the impact the implementation will have on their operation. Here is an outline of a common scenario in single-hospital ERP implementations.

1. The consultants warn of the consequences of not dedicating adequate resources.  
2. Management publicly agrees but privately thinks the consultants are crying wolf.  
3. Implementation fails or goes poorly.  
4. Management claims “how could we have known?”

Do not let this be you. The only thing to assume about the implementation is that it will be much more difficult than expected, it will take longer than you expected, and it will cost more than expected.

Like most other projects, the success of a software implementation will be based upon the skill of the people involved, training, planning, and the effort put forth. Plan to have the most knowledgeable employees heavily involved in the system setup and testing.

Adequate time should be dedicated to make sure every aspect of every process is thoroughly tested. An example of a detailed testing program is listed below:

1. Does the PO receipt screen have all the information needed to perform the receipt such as vendor item number, item description, and unit of measure?  
2. What happens when we receive more than the PO quantity?  
3. What happens when we receive less than the PO quantity?  
4. What happens when we enter multiple receipts against the same line?  
5. What happens if someone tries to change the PO quantity after we have entered a receipt?  
6. What happens if one changes the PO quantity at the same time we are entering a receipt?
7. What happens when we reverse a receipt?
8. What happens when we reverse a receipt after it has been paid?
9. What happens if the ordered unit of measure is different from the stocking unit of measure?
10. What happens when we receive an early shipment?
11. What happens when we try to receive against a cancelled PO?
12. What happens when we change the receipt location?

After the system has been thoroughly tested, employee training begins. Remember, dealing with unexpected issues is the norm; you do not also need to be training employees after the system is supposed to be operating.

The training should consist of hands-on training and include written procedures for the tasks performed. For most positions, make sure that each employee has entered the equivalent of at least a full day’s transactions during the training. Using an actual day’s transactions is a good way to make sure that the variety of transactions an employee is likely to encounter have been experienced. The most common mistake made in training is a lack of adequate repetition. Just because someone was able to perform the task once during a training session on a Saturday, 3 weeks prior to “going-live,” does not mean that they will be able to perform the task with system start-up. If they have repeated the task many times over a series of training sessions, they are much more likely to remember how to do it.

Watch the data. During and immediately after the implementation, it is incredibly important to watch the data and make sure everything is working as planned. Monitor the status of orders, POs (like pharmacy), and delivery orders, paying specific attention to “stuck orders” or other exceptions. Conduct some aggressive cycle counting of fast-moving items to make sure transactions are working correctly (7).

**POST-IMPLEMENTATION FUNCTIONALITY**

Do not let it end with the initial implementation. A new system likely has additional functionality that can improve business processes. Once comfortable with a new system, go back to the system documentation and start reviewing detailed functionality. Review all business processes to determine opportunities for improvement. This should be a continuous process. It is very unlikely that initial implementation truly optimized the system for the health care organization.

In the end, the success or failure of any software selection/implementation project is directly related to the efforts put into it. Information systems are a critical part of managing health care operations, so do not shortchange the process.

**INTERNET BROWSER-BASED APPLICATIONS**

During the past few years, Web-based business applications have evolved using a Software-as-a-Service or cloud model. The ability to access software from any location that has Internet access is certainly attractive, but unfortunately, the downside to this approach seems to be that most systems suffer from cumbersome user interfaces and slow response times. Anyone that shops online should be familiar with using a program within a browser to place an online order. If you have been annoyed with having to go through three or more screens to place your order (and the delay as you wait for each page to load), just imagine conducting all your business activities this way.

In addition, these applications tend to be built around drop-down selection lists and mouse clicks. These can be extremely cumbersome when trying to execute high-volume data entry tasks of small items like pharmaceuticals. This is a problem that also plagues most graphical user interfaces (Windows-based software). Others include Chrome, Chrome ++ Linux, Unix, Macintosh, or open-source interfaces. While these programs are attractive and easy to learn, they are still far less productive than the older character-based mainframe applications where data entry was accomplished with keystrokes and navigation was accomplished with function keys.
CONCLUSIONS

HMMIS and EOQ strategies are not a panacea that solves all SCIM inventory cost problems or easily add to bottom line profits. There is much to consider before adopting an EOQ policy for all DME across an entire health care enterprise. Nonetheless, it is a good SCIM tool to consider when evaluating what ordering policy is best used for a DME-intensive health care organization.

CASE MODEL

INVENTORY SWITCHING AT THE ABC MEDICAL CENTER

The new administrator for the ABC Medical Clinic understood that all inventory costing methods were acceptable to use in his durable medical equipment (DME) department. Last-in first-out (LIFO), first-in first-out (FIFO), specific identification, and the average cost method are all attractive methods under different circumstances in the business cycle, and companies may use the method that best fits their circumstances.

For example, if ABC wished to reduce corporate income taxes in a period of inflation and rising prices, it would use LIFO. If matching DME sales revenue with the current cost of DME goods sold was desired, LIFO would also be used. Unfortunately, LIFO may charge against DME revenue the cost of DME not actually sold, and LIFO may allow the ABC Medical Clinic to manipulate net income by varying the time periods it makes additional DME purchases. On the other hand, FIFO and specific identification method allows a more precise matching of ABC revenue with historic DME costs. However, FIFO too, can promote “paperless-phantom profits,” while specific identification can promote possible income manipulation. It is only under FIFO that net income manipulation is not possible.

“Let’s go with FIFO,” the new administrator said to his Chief Financial Officer, Bert. “The profits will make us look good to the home office and we can always switch back to LIFO if inflation starts back-up again, right Bert?” he mused.

However, Bert was not amused because freedom of choice does not include changing DME inventory methods every few years, especially if only to report higher income. “The switching of methods violates the basic tenet of consistency, which requires the use of the same inventory cost and accounting methods in preparing financial reports and statements,” Bert emphatically stated.

KEY ISSUES:

1. Is this sort of inventory costing and maneuvering permissible?
2. What is its justification?
3. How is it notated in financial reports?
4. Is this sort of thing ethical?

RESOLUTION

Companies may occasionally make changes in spite of the principle of accounting consistency if improved financial reporting is the justification for change. The company must make a full disclosure, usually in a footnote to its financial statements (see example below). This includes the reason(s) for change, descriptions of the changes, and potential effects on corporate net income. This “switch” in inventory methods is ethical, but should be done with the best interests of the organization in mind, and you should make full disclosure of any change in your financial statements.
SAMPLE FOOTNOTE

Note G: Changes in inventory accounting and costing methods: Effective with the year ending December 31, 2005, the ABC Medical Center changed its method of calculating DME inventory costs from the lower of average costs (or market) methods, to the FIFO method for substantially all DME inventory. Management believes that FIFO more accurately reflects income by providing a closer match of current DME costs, against current DME revenues.

CHECKLIST 1: Inventory Management

If you are a manager of central supplies, director of durable medical equipment, or an inventory control specialist in a health care organization, are you aware of these basic inventory management requirements for economic order quantity (EOQ) costing?

<table>
<thead>
<tr>
<th>Requirement</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do I recognize EOQ costing as a key parameter of supply chain inventory management?</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Do I determine the correct amount and delivery time for inventory orders and supplied items?</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Do I understand the balancing act between too much inventory (holding and opportunity costs) and too little inventory (stock outs and repurchasing costs)?</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Do I determine which inventory items to ignore and which items to manage?</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Is my annual inventory demand:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixed for each item?</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Variable for each item?</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Constant for each item?</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Is inventory waste occurring through repeated orders?</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Do I know my re-order point for each inventory item?</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Am I aware of my lead time for each inventory item?</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Is there a minimum quantity of each inventory item identified?</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Do I use the “rule of common sense” (e.g., do not spend $100,000 to avoid $10,000 of opportunity cost) in my inventory management duties?</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Is there a supplier purchaser in place for the facility?</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Is a purchase order system in place?</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Is a single facility, or centralized department, in place for multiple entity inventory supplies?</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Have I developed a plan to work with just-in-time suppliers or vendors and delivery schedules?</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Have vendor prices been checked recently?</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Are inventory order quantity discounts given?</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Is competitive bidding an option by vendors?</td>
<td>o</td>
<td>o</td>
</tr>
</tbody>
</table>

CHECKLIST 2: Inventory Dos and Don’ts

If you are a manager of central supplies, director of durable medical equipment (DME), or an inventory control specialist in a health care organization, you must monitor purchasing activities to ensure that the correct amount of inventory is ordered at the appropriate time for maximum financial efficiency:

<table>
<thead>
<tr>
<th>Requirement</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am I a manager of supply chain inventory control or central supplies and DME?</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Do I use last-in first-out costing?</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Do I use first-in first-out costing?</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Do I use specific identification costing?</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Do I use average cost methods?</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Do I use just-in-time (JIT) costing?</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Do I use economic order quantity (EOQ) costing?</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Do I understand JIT purchasing?</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Do I understand the implications of the above costing methods in periods of rising or declining inflation rates and inventory prices?</td>
<td>o</td>
<td>o</td>
</tr>
</tbody>
</table>
Do I understand the inventory flow process? o o
Do I recognize inventory revenues or inventory depletion rates? o o
Are inventory revenue and/or depletion rates constant? o o
Do I know the annual carrying costs per each unit of inventory? o o
Do I know the annual use or percentage of use for each unit of inventory? o o
Do I know the costs per order for each inventory segment or item? o o
Are the costs per order stable? o o
If not, can I obtain stability from vendors and suppliers? o o
If so, does the company’s board of directors have a supply chain inventory management (SCIM) or DME purchasing individual, manager, or committee? o o
Do I understand how JIT delivery allows the placement of orders so that new orders arrive when inventory approaches zero? o o
Do I use EOQ costing? o o
Do I know when to order DME inventory? o o
Do I know how much DME inventory to order? o o
Do I have a budget for supply chain management activities? o o
Is the inventory budget fixed? o o
Is the inventory budget variable? o o
Do I have discretion over the inventory budget? o o
Does it satisfy requirements for independence, authority, and economic DME resources? o o
Does it provide appropriate economic oversight during inventory audits? o o
Does it contain at least one inventory, SCIM, or EOQ costing financial expert input? o o

---

**CHECKLIST 3: Health Care Materials Management Information System Software Selection and Functionality Review**

As a central supply or health facility inventory manager, never assume a software package “must” be capable of handling something you consider a standard function.

Is the software program, or Software-as-a-Service (SaaS) application, under consideration capable of the following functions:

- Multi-facility demand planning? o o
- Postponement and configure-to-order functionality? o o
- Back-order processing? o o
- Forecasting and demand planning? o o
- Forward pick location replenishment? o o
- Lot or serial number tracking? o o
- Batch or wave order picking? o o
- Returns processing? o o
- Back-flushing durable medical equipment inventory? o o
- Co-product processing? o o
- Outsourcing specific operations? o o
- Multiple stocking units of measure? o o
- Product substitutions? o o
- Blanket orders? o o
- Shipment consolidation? o o
- Multi-carrier rate shopping and manifesting? o o
- First-in first-out processing? o o
Medical Supply Chain Inventory Management Strategies

Checklist 4: Using Automated Data Collection Technologies for Inventory

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is the software application under consideration CD-ROM based?</td>
<td>o o</td>
</tr>
<tr>
<td>Is the software application under consideration Internet based?</td>
<td>o o</td>
</tr>
<tr>
<td>If Internet delivered, is it secure and compliant under the Health Insurance Portability and Accountability Act of 1996 (HIPAA)?</td>
<td>o o</td>
</tr>
<tr>
<td>Is the software application under consideration delivered by a SaaS model?</td>
<td>o o</td>
</tr>
<tr>
<td>If SaaS delivered, is it secure, “always-on” and HIPAA compliant?</td>
<td>o o</td>
</tr>
<tr>
<td>Do I have a budget for the Hospital Materials Management Information System (HMMIS) software?</td>
<td>o o</td>
</tr>
<tr>
<td>Is the HMMIS budget fixed?</td>
<td>o o</td>
</tr>
<tr>
<td>Is the HMMIS budget variable?</td>
<td>o o</td>
</tr>
</tbody>
</table>

Checklist 4: Using Automated Data Collection Technologies for Inventory

As a central supply or health facility inventory manager, am I familiar with these hospital automated data collection technologies:

- Bar codes? o o
- Bar-code scanners? o o
- Are you familiar with these subtypes: Laser or charge-coupe device scanners? o o
- Autodiscrimination scanners? o o
- Keyboard-wedge scanners? o o
- Fixed-position scanners? o o
- Portable computers? o o
- Hand-held devices? o o
- Vehicle-mounted devices? o o
- Wearable systems? o o
- Voice recognition technology? o o
- Optical character recognition? o o
- Light systems? o o
- Electronic product codes? o o

References


- www.inventoryops.com/economic_order_quantity.htm.
- www.hfma.org.