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Ten Actions to Improve Inventory Management in Government

Lessons From VA Hospitals



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Ten Actions to Improve Inventory Management in Government: Lessons From VA Hospitals

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Foreword

On behalf of the IBM Center for The Business of Government, we are pleased to present this report, *Ten Actions to Improve Inventory Management in Government: Lessons from VA Hospitals*, by Gilbert N. Nyaga, Gary J. Young, and George (Russ) Moran, all of Northeastern University.

In their study of eight Department of Veterans Affairs (VA) medical centers in New England, the authors examined the current use of best practices in inventory management in government, based on a case study of VA hospitals. The authors found five major challenges to improving inventory management in the public sector.

The key to improving inventory management within the Department of Veterans Affairs specifically, and more widely throughout the federal government, is to apply best practices now used in the private, public, and nonprofit sectors. Such best practices include using predictive analytics, adopting process mapping, establishing a culture of continuous improvement, adopting more effective staff training approaches, and building a culture of teamwork.

The authors are optimistic that change is possible within the VA system. They write, “Based on the study, we believe a number of opportunities exist to improve inventory performance in the public sector, even in the face of many institutional limitations. We set forth 10 recommendations that take into account not only findings from our study of the VA, but also best practices from the private sector that have been identified through research that we or others conducted.”



Daniel J. Chenok

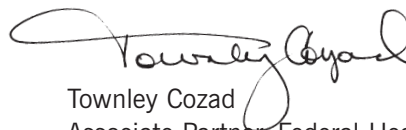


Townley Cozad

This report continues the IBM Center's long interest in both the issue of inventory management and acquisition. Recently Zachary S. Huitink and David M. Van Slyke examined the Better Buying Power initiative in the Department of Defense in their report *Beyond Business as Usual: Improving Defense Acquisition through Better Buying Power*. We hope that the inventory management leaders, as well as top agency leaders, will find the findings and recommendations in this report helpful in furthering efforts to improve inventory management in government.



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Executive Summary

Inventory management is a long-standing challenge for many federal, state, and local government agencies. As inventory often accounts for a substantial portion of the assets at these agencies, ineffective inventory management impedes service delivery and constrains operating budgets. This report highlights institutional and operational challenges and opportunities for effective inventory management in the public sector, taking into account findings from a study we conducted of eight medical centers at the U.S. Department of Veterans Affairs (VA). The challenges for government include:

- Using the latest IT systems and predictive analytics
- Improving the contracting process regarding inventory
- Standardizing what can be inefficient inventory processes
- Increasing the amount of supply chain talent
- Raising the priority assigned to inventory management
- Performance measurement

Despite these challenges, several practical approaches can significantly enhance inventory performance in the public sector. Findings from our study indicate some approaches are already in use at VA medical centers and could be expanded. This report offers 10 recommendations for improving inventory performance in the public sector:

1. Adopt easy-to-use software applications and training to encourage use of existing legacy systems
2. Apply predictive analytics in inventory management to ensure adequate supply
3. Enhance supplier collaboration to improve inventory replenishment processes
4. Adopt process mapping
5. Adopt “A-B-C” classification of inventory and regular cycle counts
6. Conduct inventory performance benchmarking and create communities of practice to share them
7. Establish a culture of continuous improvement in inventory management
8. Adopt more effective staff training approaches and build a culture of teamwork
9. Establish greater accountability mechanisms for senior leadership
10. Establish more effective channels of communication on inventory issues

Introduction*

As federal, state, and local government agencies strive to improve their efficiency and effectiveness, a significant challenge for many such agencies is inventory management. Inventory management in the public sector has been a long-standing concern as inventory accounts for a substantial portion of the public sector's assets and budgets. The Government Accountability Office (GAO) has issued numerous reports over time about ineffective inventory management in federal agencies including the Department of Defense (DOD), Department of Veterans Affairs (VA), and the Environmental Protection Agency (EPA). These reports attribute inventory management problems to a number of factors, including:

- Duplication of inventory systems
- Lack of system integration
- Inadequate staff training on inventory practices and principles
- Insufficient attention to oversight

Oversight agencies at the state level have also found concerns with inventory management within the public sector. For example, the Office of the Inspector General for California recently issued a report pointing to significant problems with inventory management in the California Department of Corrections and Rehabilitation. Table One presents other examples of government reports that found inventory management problems as an area needing improvement in the public sector.

This sample of reports indicates that improving inventory management can be a significant enabler for many government organizations to perform efficiently and effectively. Excessive levels of inventory come with high carrying costs that drain agency operating budgets. Moreover, an effective understanding of available inventory may enhance mission delivery, including patient care in the case of the VA or national security in the case of the DOD.

Indeed, many government agencies have policies on inventory management that—if fully implemented—would likely result in significant performance improvements. In addition, previous investigations, including those by GAO, report on not only the extent of inventory management challenges in government agencies but also offer practical recommendations for improvements, many of which are based on best practices from the private sector. While certainly there are examples of improvements across government agencies that entail adoption of best practices for inventory management, implementation of such best practices throughout the public sector has not been widespread. As such, inventory management performance in the government continues to be an area requiring greater action.

* This report is based in part on a study that the authors conducted with support from New England Veterans Engineering Resource Center and the Department of Veterans Affairs. The views expressed in this manuscript do not necessarily represent the views of the Department of Veterans Affairs or the United States government.

Table 1: Government Reports on Inventory Management at the Department of Veterans Affairs

Report	Inventory Challenge
GAO-13-336 (April 2013): VHA has taken steps to address deficiencies in its logistics program, but significant concerns remain.	VA medical centers and networks had partially complied with new VHA requirements regarding managing medical supplies and equipment, standardizing items, and monitoring of logistics programs.
11-00312-127 (March 30, 2012): VHA Audit of prosthetics supply inventory management	Prosthetics inventory at VA medical centers exceeded current needs for almost 47 percent of items, translating to about \$35.5 million in purchases of excess inventory, and inventory was too low for 11 percent of items.
GAO-02-447G (March 2002): Best practices in achieving consistent, accurate physical counts of inventory and related property	Inventory count accuracy, processes, and procedures lag practices in the private sector. Implementing best practices from leading-edge private sector entities is challenging.
GAO/NSIAD-00-30 (January 2000): Opportunities exist to expand the use of defense logistics agency best practices.	There are obstacles in implementation of initiatives on best practices from the private sector in the Defense Logistics Agency.

In this report, we discuss improvement opportunities for inventory management in the public sector. The report is based, in large part, on a multi-year analysis we conducted of inventory management practices in the New England region of the Veterans Health Administration, which is the component of the VA that provides healthcare services to eligible veterans. It is well documented that the U.S. healthcare delivery system, in both private as well as public sectors, lags behind other sectors of the U.S. economy in terms of inventory and supply chain management.¹

As mentioned earlier, ineffective management of inventory has major implications on both cost and service delivery. In particular, inventory shortages undermine service delivery while excess inventory leads to increased costs. Thus, a key objective of inventory management is to ensure that an appropriate amount of inventory is available to meet set service levels while keeping costs at a minimum. In the healthcare sector where the focus tends to be more on inventory availability, not cost, there is excess inventory accumulation resulting in very high inventory costs and other inefficiencies. We chose to study the VA because:

- It is a very large and important government agency for which effective inventory management has been a long-standing challenge.

Project Methodology

The study setting was the VA's New England region, which consists of eight medical centers and over 35 community health centers. The VA New England division treats more than 240,000 veterans annually and employs approximately 10,000 individuals. Each medical center has its own logistics department responsible for inventory management. We conducted an in-depth study of inventory management practices at the eight medical centers and their affiliated community health centers in 2014. Our study focused on broad issues in inventory management including processes of determining how much inventory is ordered, when and in what quantities, where it is stored, and monitoring of inventory levels and records for accuracy. The project's research approach is discussed further in the Appendix.

1. Schneller, E.S. and L. Smeltzer. *Strategic Management of the Health Care Supply Chain*. San Francisco: Jossey-Bass, 2006.

- It is a key element in the U.S. healthcare delivery system, given its scale and linkage to private-sector healthcare delivery organizations including academic medical centers.

At the VA, we saw an opportunity to study inventory management in a setting where significant opportunities for improvement are likely to exist. At the same time, while our study focused on inventory management at VA medical centers, we believe many of the observed challenges, practices, improvement opportunities, and related best practices are applicable to government agencies engaged in activities other than healthcare delivery. Some of the findings are also potentially applicable to healthcare delivery organizations outside the government.

The report is divided into three main parts:

- Section One: General institutional and operational impediments to effective inventory management in the public sector
- Section Two: Key findings on inventory management practices observed at the VA
- Section Three: Ten recommendations for improvements across five broad categories of inventory challenges and findings at the VA as summarized in Table 2 below

Table 2: Summary of Recommendations

	Inventory Management Challenges in the Public Sector	Key Findings on Inventory Management at the VA	Recommendations
1	Use of latest IT systems and predictive analytics	Data management and predictive analytics	<ul style="list-style-type: none"> • Adopt easy-to-use software applications and training to encourage use of existing legacy systems • Apply predictive analytics in inventory management to ensure adequate supply
2	Contracting process	Inventory ordering and ineffective coordination with suppliers	<ul style="list-style-type: none"> • Enhance supplier collaboration to improve inventory replenishment processes
3	Standardization of inventory management processes	Inventory handling processes	<ul style="list-style-type: none"> • Adopt process mapping • Adopt “A-B-C” classification of inventory and regular cycle counts • Conduct inventory performance benchmarking and create communities of practice to share them • Establish a culture of continuous improvement in inventory management
4	Performance measurement		
5	Supply chain talent	Staff training and deployment	<ul style="list-style-type: none"> • Adopt more effective staff training approaches and build a culture of teamwork
6	Priority assigned to inventory management by senior leadership	Prioritization by senior leadership	<ul style="list-style-type: none"> • Establish greater accountability mechanisms for senior leadership • Establish more effective channels of communication on inventory issues

Inventory Management Challenges in the Public Sector

As previously noted, the public sector appears to need improvement in many areas of inventory management. While a number of factors contribute to this condition, we discuss six key challenges that provide context for our own review of inventory management at the VA.

Use of the Latest IT Systems and Predictive Analytics

As GAO and others² have highlighted, government agencies have lagged the private sector in adopting IT systems that facilitate effective inventory data capture, analysis, and tracking. This is often reflected in incomplete or inaccurate inventory data in many government agencies because the capture and recording of the data are not fully automated.

In many cases, government agencies use legacy systems that are old and in great need of replacement or overhaul. Recording, updating, and/or retrieving data in these systems is often cumbersome. In some cases, the systems are not even interoperable within the same agencies, let alone able to interface with more advanced systems of suppliers. Because many government agencies face severe budgetary constraints, their legacy systems are not updated, improved, or replaced in a timely manner. As a result, they are unable to capitalize on the best practices in inventory data management that are driven by the latest IT systems capabilities, especially at a time when people are growing accustomed to very user-friendly apps and software systems.

Contracting Process

The contracting process in the public sector often contributes to the inefficiencies noted for inventory management. Compared to the private sector, public sector supply chain decisions have to comply with many and often varied rules (e.g., federal, state, and/or local) that are designed to advance nonprocurement-related social-political goals and also to ensure a level playing field and nondiscrimination. The emphasis is not necessarily on cost efficiency. In many government agencies, procurement rules require that preference be given to certain businesses—such as small businesses and those owned by the disabled, minorities, veterans, and women—when awarding supply contracts over more established, large firms. While this requirement serves the important social and political goal of business inclusivity and supports under-represented or emerging businesses, the preferred businesses may not be the lowest cost providers and may not have the best service performance.

In addition, public sector purchasing and supplier contracting often entail multiple governmental units which have a great deal of autonomy in making supply chain decisions. Because purchasing decisions are often carried out independently by each organizational unit, there is limited

2. Gansler, J.S., Luby, R.E., and Kornberg, B., "The Road to Transforming Supply Chain Management in Government." In *Transforming Government Supply Chain Management*, edited by Gansler, J.S. and Luby, R.E. IBM Center for The Business of Government, 2004.

opportunity to adopt practices that could ensure greater efficiency, such as consolidating orders, delivery, and transshipments between units. This siloed purchasing can result in a limited volume of items purchased from a single supplier, which reduces opportunities for volume discounts and greater supplier collaboration.

The duration of contracts and limited flexibility in contracting in the public sector can also impede the adoption of effective inventory practices. In the private sector, buyers and suppliers may sign long-term commitments in situations where the supplier makes substantial dedicated investments to the exchange. However, in the public sector, contracts tend to be shorter-term and renewal is not necessarily guaranteed even where the supplier meets contract expectations. Moreover, the contracting process is not often sufficiently flexible to allow for the negotiations needed for the level of resource commitment required in supplier collaborations. Another challenge in this area is uniformity of the enterprise's contracts or blanket purchase agreements. Because there is local initiative to contract, the propensity to do things locally rather than using enterprise agreements persists and undermines the benefit of standardized bulk purchasing. Discipline across the enterprise is critical to success.

Standardization of Inventory Management Processes

With respect to inventory management, another key challenge for the public sector is the lack of standardized inventory processes. While government agencies often issue guidelines regarding inventory management practices and responsibilities, in reality many inconsistencies exist across agencies and facilities so that standardization is never achieved.

The goal of standardizing inventory management processes is to ensure that specific performance targets are achieved and resources are deployed appropriately. Because many inventory processes can be objectively defined and quantified, there are opportunities to set specific standards that guide inventory decision making across agencies. For example, the VA issues guidelines on inventory turnover targets for different inventory items. Such process standardization can be effective in streamlining inventory practices and resource deployment across otherwise disparate entities. However, because of significant variations within and among agencies regarding operational needs, staffing levels and personnel skills, and services provided, standardization of inventory processes has not been effective in the public sector.

In addition, the process of implementing standardization goals is often underfunded and disjointed not only at individual offices and departments within an agency, but also across agencies. For example, both the DOD and the VA have specific guidelines published in handbooks that stipulate inventory management procedures that personnel handling inventory should apply or implement throughout the agencies.³ However, as the previously cited GAO reports suggest, even with good guidelines on standardizing inventory practices, most government agencies have not fully implemented the guidelines or put them into practice.

Performance Measurement

Another challenge is lack of effective performance measurement in the public sector. Because performance measurement facilitates monitoring, controlling, and directing of processes and behavior in an organization, this limitation in the public sector directly impacts inventory management and overall performance. Even though many public sector agencies issue performance

3. United States Government Accountability Office, *VHA has Taken Steps to Address Deficiencies in Its Logistics Program, but Significant Concerns Remain*, GAO-13-336, April 2013.

guidelines on performance targets and metrics (e.g., inventory turnover targets in VA), the metrics used are not often clearly defined or adequately applied throughout an agency. Collection of performance data is also often incomplete so that performance records are not always accurate or comprehensive enough for effective decision making. Moreover, even when data are available, they are not always shared within and between organizations or agencies. Given this lack of complete data and appropriate metrics on performance, it is not only difficult to assess weaknesses in inventory management processes and outcomes, but it is also difficult to benchmark performance against industry best practices in many cases.

Supply Chain Talent

Government agencies are having difficulty recruiting top talent for supply chain management positions.⁴ This is, in part, because compensation and career progression opportunities for personnel in supply chain operations are less attractive compared to the private sector.

In many cases, the frontline personnel handling inventory in government agencies have limited formal training in inventory management and often learn on the job. As such, a skills gap exists that impedes diffusion of best practices for inventory management throughout the public sector. Furthermore, the on-the-job training approach common in government agencies tends to perpetuate organizational cultures that may not be receptive to innovative practices common in the private sector.

Priority Assigned to Inventory Management by Senior Leadership

The previously noted GAO reports suggest that senior leadership at government agencies does not often assign a high priority to inventory management. The inventory function is often seen as merely providing a supporting role to agencies' primary service delivery goals. As a result, there is less oversight of inventory processes and resource allocation so the function is not prioritized, including with respect to staffing.

4. Husted, C. and Reinecke, N. "Improving public-sector purchasing." McKinsey & Company, 2009.

Key Findings on Inventory Management at the VA

To understand how government agencies operate in the presence of these general inventory management challenges, we conducted an in-depth study of inventory practices at the VA. We did a modified comparative case study of medical centers in the VA's New England region, which consists of eight medical centers and over 35 community health centers treating more than 240,000 veterans annually. The Appendix presents a description of the study methodology.

We found many similarities and some differences among the medical centers regarding inventory management practices and performance. Although certain inventory practices are governed by the VA's system-wide policies, medical centers have considerable discretion to manage their own inventory. In discussing our findings, we draw connections to general public sector challenges highlighted in the preceding section.

Data Management and Predictive Analytics in Managing Inventory

A key issue the VA faces in managing inventory is the need to improve data management and predictive analytics capabilities. Central to this issue is updates to the agency's IT system for inventory management, the Generic Inventory Package (GIP), which was developed in the 1990s specifically for the VA. This is a robust system for managing receipt, distribution, and maintenance of medical supplies used throughout a medical center. However, due to usability and recording or retrieving inventory data issues, logistics personnel often work around it rather than with it. For example, in one medical center, a member of the logistics staff told us that it is easier for him to record items on a piece of paper and then update information in GIP at a later time. Indeed, many logistics personnel that we interviewed expressed frustration in using the GIP system and pointed to data entry discrepancies as a common problem.

Also, like many older government systems, the VA's IT system was designed as a standalone technology and as such, it cannot be readily updated and/or interface with other systems such as those of the agency's suppliers. This is a major limitation considering the development of newer IT systems with greater functionality, which often are designed to interface with other systems. System interoperability facilitates more effective data sharing and attendant data analysis. However, because the GIP system is not able to interface effectively with other systems, there are limits to how much the VA can leverage capabilities of its suppliers in inventory management.

Beyond the issue of routine data management for inventory, we found that the medical centers we studied do not make sufficient use of predictive analytics for inventory usage. Predictive analytics involves using statistical techniques and other data mining tools to identify patterns in current and historical data, and then to make predictions about future trends or outcomes. The use of predictive analytics is increasingly a common practice, especially in the private sector. While substantial amounts of inventory data are captured and recorded in GIP, we did not see any examples where the VA's logistics personnel use predictive analytics to process data in

ways that facilitate trend analysis in inventory usage and supply replenishment. This is partly because the GIP system lacks advanced data analytics capabilities and also has the previously mentioned limitations regarding inventory data capture and processing.

Despite these limitations, we found that personnel, especially at two medical centers, are finding ways to stretch the capabilities of the GIP system. For example, at one center, personnel consistently use barcode scanners and update inventory data in GIP in a timely manner, which improve their accuracy for tracking inventory. At another center, inventory managers were testing a Graphical User Interface (GUI) application that would be embedded in the GIP for the purpose of creating a more user-friendly format for entering and retrieving data in GIP.

Inventory Ordering and Coordination with Suppliers

In general, we found that the VA is unable to fully leverage its relationships with suppliers in relation to inventory replenishment for three primary reasons:

- Fragmented ordering
- Financial controls that hinder efficient supply replenishment
- Limited coordination between the VA and its suppliers

Fragmented ordering. Inventory at the VA is generally categorized into six areas:⁵

- Medical and surgical
- Dental
- Imaging
- Laboratory
- Environmental management service
- Engineering

Each of these areas typically controls its own budget. Thus, while procurement of standard items (i.e., frequently used items that have an established turnover rate) is accomplished through the same prime supplier (distributor) in a given region (i.e., medical centers in a geographic region, such as the New England system), determining replenishment needs and frequency is done at the department level. As previously noted, this is not uncommon for government agencies. However, the fragmentation in ordering means potential opportunities to consolidate supply procurement and delivery, which could lower costs, are not used.

Financial controls that hinder efficient supply replenishment. The medical centers receive supplies of standard items from one prime supplier according to daily, semi-weekly, or weekly schedules depending on the types of items and each medical center's needs. Standard items are those that are frequently used and that have an established turnover rate⁶ such as catheters, syringes, antiseptic wipes, gauges, exam/surgical gloves, swabs, etc. These include on-demand items that are not scheduled for regular deliveries and that may not be supplied by a prime supplier as part of a contract, yet may be needed from time to time. However, a purchase order is generated for nonstandard items or one-time purchase items that are not available from the prime supplier.

5. Department of Veterans Affairs, Veterans Health Administration, "VHA Inventory Management," *VHA Handbook* 1761.02, October 20, 2009.

6. Ibid.

Each facility has a daily spend limit for these types of purchases; that limit was \$3,000 at the time of our study. If the purchase price exceeds the limit, exceptions have to be approved or purchases have to be done through a formal contracting process. Interviewees brought up this spending limit as a major issue at almost all the medical centers we studied, primarily because it contributes to significant delays in replenishment of the nonstandard items. This challenge is reportedly especially prevalent toward the end of a fiscal period (i.e., quarter or year) because as a matter of the VA's policy, purchases are not allowed several weeks before the end of a fiscal period.

Although logistics personnel anticipate this “fiscal downtime,” the daily spend limit often inhibits efficient emergency order processing. Because all medical centers follow these same fiscal procedures, limited flexibility exists in handling the nonstandard orders. This lack of flexibility is compounded by limited coordination among medical centers, preventing emergency orders from being readily shared or transshipped from one center to another.

Limited coordination between the VA and its suppliers. Because forecasts are not used, the VA has difficulty in determining appropriate replenishment levels, and it is also challenged to share such information with suppliers ahead of time. This means the VA cannot leverage the potential benefits of coordination with suppliers in a more comprehensive manner with a view to improve the replenishment process. The result is that inventory replenishment processes, including deliveries to VA facilities, take a long time, which leads to excess inventory in some cases, potential shortages in other cases, and potentially expensive emergency orders.

Inventory Handling Processes

During our study, we found that many inventory problems in the VA are attributable to a lack of standardized processes and a lack of effective coordination between logistics personnel and other staff members. First, despite the agency's adoption of system-wide guidelines and policies on inventory management,⁷ there is a lack of process standardization. While the processes of handling inventory once it was delivered to a facility from the supplier were fairly well defined, the actual implementation of these processes varied across medical centers. For example, some centers had well organized storage areas with shelf spaces clearly labeled for specific items. In other facilities, this was not the case. Indeed, even electronic recording of inventory (i.e., in the GIP system) was not standardized in practice. In several medical centers, automated inventory data capture using barcode scanners and regular updates in the GIP system is not practiced even though it is a VA-prescribed standard process. In other cases, although VA's inventory management guidelines recommend that both medical supplies inventory and engineering inventory be managed by logistics personnel, this reportedly is not the case. Instead, logistics personnel only manage the medical supplies inventory. In effect, inventory control process standards across medical centers are not consistently enforced.

Second, there is a need for effective coordination in handling inventory within the medical centers. Typically, inventory supplies from suppliers are received at a central warehouse area (typically a room on the facility's ground floor or within the facility campus) where cartons are broken down and items are delivered to a primary storage area. From primary storage, items are delivered to secondary storage areas (e.g., operating rooms, supply closets, etc.). Once items leave the primary storage, they are considered to be “used.” That is, inventory processing is designed such that use is recorded at the primary storage, not the secondary storage area. In most cases, this two-level inventory processing is not synchronized so use of items in

7. Department of Veterans Affairs, Veterans Health Administration, “Logistics Management Procedures,” *VHA Handbook 7002/1*, April 14, 2011.

secondary storage (e.g., supply closets) is correctly reconciled with records in primary storage. For example, nursing staff will frequently remove inventory items from supply closets and not record it. This lack of coordination makes it difficult for logistics personnel to track inventory.

Third, the communication between logistics personnel and clinical staff can be strengthened to improve inefficient inventory management. We learned that anticipated inventory requirements for clinical procedures are not always communicated to logistics personnel in a timely manner. Instead, item requirements are communicated on very short notice, which means logistics personnel stock more excess items than necessary to mitigate uncertainty. This lack of effective communication and coordination between clinical and logistics personnel results in inventory decisions that are often not consistent with the VA's guidelines and policies.

We did, however, learn of various initiatives at medical centers to streamline processes and improve coordination and communication regarding inventory. One such initiative entails using web-based portals through which personnel in functional units keep the logistics department informed about supply use and schedules of future activities that have implications for inventory. Another initiative entails assigning logistics personnel (e.g., supply technicians) to specific clinical units, which enables them to develop familiarity with nurses working in those units. At one medical center, the names, pictures, and contact information for supply technicians in charge of replenishing supply closets are posted at the closets to enable nurses to contact the appropriate person if they have a question. The logistics personnel carry pagers for immediate communication whenever they are on duty.

To address inventory waste at another medical center, the logistics personnel have designated a bin where unused (unopened) items taken from shelves (i.e., recorded as used although not really used) are placed. The clinical staff check the bin for specific items that may be available before proceeding to the shelves to get new supplies; this practice reportedly has resulted in reduced waste. The VA should share such inventory best practices among VA medical centers in the region so that what works in one center can benefit another center.

Staff Training and Development

At all the medical centers we studied, we found that most logistics personnel develop their skills entirely on the job from the time they are hired by the VA. This insular approach for hiring and developing logistics staff reportedly impedes the VA's adoption of innovative practices for inventory management. We heard from many interviewees that training primarily through on-the-job experience contributes to an attitude among logistics personnel of "this is the way we have always done things around here." At two medical centers where we noted relatively better inventory performance, some logistics personnel had experience in the private sector (retail sector in particular) prior to joining the VA. From this experience, they had brought to the medical centers new ideas for inventory management that reportedly contribute to these centers' relatively strong performance in this area of operations.

VA has created its own training program for logistics (i.e., the VA Supply Chain Management School, which is located within the VA Acquisition Academy). This program serves upper-level logistics managers only and could be expanded to offer content addressing day-to-day inventory management challenges encountered by frontline personnel. An additional and related VA training resource is its logistics mentoring program. Through this program, frontline personnel based at any medical center contact select inventory managers who have trained at the Acquisition School. They can discuss matters related to inventory management. However, this reportedly rarely happens. One manager who has gone through the training and participated in the

mentoring program told us she has never received an inquiry during as much as 12 months following her completion of the program.

The limited outreach to the VA Supply Chain Management School's trainees may be because of a lack of communication about the program throughout the VA, so many frontline personnel are not familiar with it (this was noted by our interviewees). The frontline logistics staff may also not be enthusiastic to contact managers with whom they are not familiar, especially because some inventory problems are local (i.e., relate to a specific medical center). It is also probable that the frontline logistics staff could do more to reach out to managers outside of those in their own facility. Either way, gaps in training likely contribute to inefficiencies in inventory management.

Beyond logistics training, we also noted that opportunities for promoting logistics personnel generally are not clear. We found that many logistics personnel have been on the same job for a very long time with few opportunities for promotion to the next level. Because of the lack of promotion opportunities, high performing logistics staff sometimes leave the VA for opportunities in the private sector, thereby depriving the VA of the valuable talent needed to change inventory management practices. Staff stagnation in one position may also contribute to the noted lack of innovation for the VA's inventory management, because over time staff members become complacent in managing activities. They may not be motivated to try new ways or best practices that potentially enhance performance. Training and opportunities for promotion within the VA can enable innovation and adoption of best practices in inventory management.

Prioritization by Senior Leadership

Because, as noted, medical centers have considerable discretion regarding inventory decisions, the role of medical centers' senior leadership in influencing inventory performance is significant. The senior leadership (i.e., the medical center director (CEO) and associate director) determines resource allocation priorities, including the number of personnel hires in different units. They also influence major initiatives, including those related to inventory management, considering their oversight role on resource deployment. We noted differences among medical centers as to the level of engagement between medical center senior leadership and the logistics officers (i.e., chief logistics officers) on inventory issues. Our interviewees indicate that senior leadership may view inventory management as a low-level support function. However, at the two medical centers where inventory performance has been relatively strong, we noted that senior leadership is more engaged with logistics officers in discussing inventory issues and performance.

In addition, effective leadership at these two medical centers appears to have trickled down to the leadership of the logistics departments. At the well-performing medical centers, the logistics managers provide clear direction for what needs to be done to improve inventory performance and empower frontline personnel to try new ways of achieving desired goals. At one center, the junior logistics staff led the redesign of existing processes in the engineering area, which resulted in substantial inventory reduction, better space utilization, a better ordering process, and overall better inventory control for the engineering unit. Because junior staff are empowered to own these inventory processes, they are reportedly highly motivated to improve them, resulting in much more effective inventory management.

RFID and Inventory Management

Our study found little evidence that radio-frequency identification (RFID) was being used at the eight VA medical centers we studied. RFID technology is a real-time location system that is increasingly being adopted in inventory management. It entails the use of tags fitted with radio-frequency electromagnetic fields that enable recording of item data, such as the stock keeping unit (SKU) number, manufacturer, expiry date, etc. The data in tags is transmitted and captured using RFID readers. There are two types of RFID tags: passive and active. Passive tags have no power of their own, are cheaper, and rely on a reader to transmit data. Active tags have an integrated battery so they continuously transmit information on their own. Because they are more expensive, they are ideal for use with expensive equipment such as hospital beds.

RFID technology has wide applications in inventory management because it enables tracking in real time. In healthcare, it is used to track inventory usage, monitor inventory movement throughout a hospital, track patient and staff that have RFID tagged wristbands or ID badges, track medical-surgical devices and pharmaceuticals, etc. Many hospitals that have adopted RFID technology report benefits including: cost savings, increased efficiency and productivity, reduced errors with elimination of manual data entry and counting, improved patient safety, optimized inventory stocking and replenishment levels, higher equipment utilization, reduced inventory waste, timeline performance metrics, and fewer inventory problems such as stock-outs and hoarding. Thus, RFID technology has potential to greatly improve inventory performance. A previous IBM Center report by David C. Wyld, *RFID: The Right Frequency for Government*, concluded that RFID has great potential for transforming government inventory practices.

However, adoption of the technology has been slow in part because of the high cost of implementation and limitations in IT systems integration. The cost of installing RFID infrastructure such as readers, integrated IT systems, and tags can be prohibitive. Moreover, because public sector systems are often old, there are issues with system interoperability (e.g., RFID application system and other inventory systems), which leads to a higher cost and implementation complexities. Implementation also requires substantial changes to current processes such as ordering, workflow, billing/payments, etc. Staff resistance to changes associated with RFID implementation, such as privacy concerns, can derail the adoption.

To enhance implementation, there is a need to:

- Engage cross-functional teams
- Create a buy-in from staff involved in RFID application and use
- Integrate the RFID system and other IT systems
- Set performance targets
- Provide appropriate infrastructure

As RFID technology improves, prices are decreasing and the trend is likely to continue. Thus, there is potential for more widespread application of RFID in the public sector in general and specifically the VA.

Recommendations

Our study of inventory management at the VA produced findings consistent with, and amplified findings from, previous investigations of inventory management in the public sector. Based on the study, we believe a number of opportunities exist to improve inventory performance in the public sector, even in the face of many institutional limitations. We set forth 10 recommendations that take into account not only findings from our study of the VA, but also best practices from the private sector that have been identified through research that we or others conducted.⁸

Recommendation One: Adopt Easy-to-Use Software Applications and Training to Encourage Use of Existing Legacy Systems

There are, undoubtedly, weaknesses in the public sector's existing IT systems for managing inventory. It is not likely that the systems can be updated or overhauled in a timely manner to address the weaknesses noted earlier. Consequently, creativity is necessary to enhance the legacy systems' use in inventory data capture, analysis, sharing, and predictive analytics.

We recommend adopting software applications that can be embedded to improve the legacy systems' functionality for a fraction of the cost it would take to overhaul the system. Such applications have the potential to extend the legacy systems' life by facilitating greater use. In particular, Graphical User Interface (GUI) applications provide an interface that users may find more visually appealing and less cumbersome while processing data in the legacy system. Because the GUI is embedded into the legacy system and merely provides a better user experience, it will not require major legacy system modifications, but it will extend the system's life and use. While the development of a GUI can be a helpful and cost effective short-term solution if done correctly, it should also be accompanied by appropriate change management, training, and a program of accountability. These three activities have the potential to improve performance. While they may increase costs, the increase likely will be marginal if done correctly.

As previously noted, at the time of our study one medical center was piloting a GUI application. The application reportedly shows great promise for a reasonably low cost. Some of the applications are readily available in the marketplace and could be customized for a specific legacy system at a relatively low cost.

At the same time, there is need to invest more in training not only on use of new software applications but also on use of existing legacy systems. In our interviews at VA, we noted that

8. (i) Nyaga, G., Young, G. and Zepeda, D. "An Analysis of Intra- and Inter-Organizational Arrangements on Hospitals' Supply Chain Efficiency." *Journal of Business Logistics* 36(4): 340-354, 2015.; (ii) Nyaga, G.N., Whipple, J.M., and Lynch, D.F. "Examining Supply Chain Relationships: Do Buyer and Supplier Perspectives on Collaborative Relationships Differ?" *Journal of Operations Management* 28(2): 101-114, 2010.; (iii) Closs, D.J., Nyaga, G.N., and Voss, M.D. "The Differential Impact of Product Complexity, Inventory Level, and Configuration Capacity on Unit and Order Fill Rate Performance." *Journal of Operations Management* 28(1): 47-57, 2010.

some personnel were not fully aware or comfortable applying some functions in the legacy system. This had the effect of undermining use of the system leading to other problems noted such as inaccuracies in inventory records. Such training should be routine (not a one-time exercise) so that personnel have an opportunity to ask questions and develop greater familiarity with system functionalities that they do not use regularly. Training may also include staff exchange or detailing arrangements where personnel from one facility are sent to other facilities to see how personnel in those facilities use the legacy systems. This could be a way to enhance sharing of best practices on the use of software applications within an agency or organization.

Recommendation Two: Apply Predictive Analytics in Inventory Management to Ensure Adequate Supply

Government agencies should make much greater use of predictive analytics for inventory management. Predictive analysis can be used to forecast demand more accurately, determine appropriate replenishment levels, and improve inventory availability. Moreover, the information generated can be linked to key performance metrics and displayed in dashboards, thereby enhancing visibility of inventory plans and performance. This can also lead to improved budgeting processes because resources are allocated based on optimal inventory levels, accurate usage trends, and projected replenishment needs. Adoption of predictive analytics in inventory management can also facilitate data sharing within an organization and with suppliers, thereby substantially improving inventory management.

Recommendation Three: Enhance Supplier Collaboration to Improve Inventory Replenishment Processes

We recommend that government agencies develop arrangements with suppliers through programs such as collaborative, planning, forecasting, and replenishments (CPFR) and vendor-managed inventory (VMI), as is the case in the private sector. Sharing forecasts and inventory use data with suppliers can expedite and target replenishments such that government agencies do not have to hold high levels of safety stock.

Although such purchaser-supplier collaborations are common in the retail and manufacturing settings, these arrangements do not appear to be widely used in either the public or health-care sectors despite them proving to be a best management practice with demonstrated benefits. Indeed, we learned that some regions of the VA are trying to move in this direction by engaging their prime suppliers in inventory planning. While the extent to which such collaboration and coordination can be effected may be limited by some of the previously noted institutional challenges that government agencies face, there is much to be gained if government agencies are able to leverage their suppliers' expertise in inventory management.

Recommendation Four: Adopt Process Mapping

Because many public sector inventory processes are not streamlined or clearly delineated, we recommend that government agencies adopt a *process mapping approach* not only to identify weaknesses but also to standardize effective processes and practices. In this approach, the current processes are reviewed and defined so as to identify problem areas and opportunities for improvement. This is a low-cost approach that also facilitates employee bonding and teamwork. Among the key steps in process mapping are:

- Identifying (mapping) the process (ask why things are done the way they are)
- Having a cross-functional team to gather information on processes

- Identifying problem areas and opportunities
- Identifying and implementing solutions

Because the logistics personnel know the current processes, they are likely to pinpoint areas of weakness that could be easy targets for immediate to short-term change at minimal cost.

Recommendation Five: Adopt “A-B-C” Classification of Inventory and Regular Cycle Counts

Alongside process mapping, we recommend adoption of “A-B-C” classification approach—a prioritized value system—to enable better understanding of the importance of different inventory items in providing services and more effective resource allocation. Without this understanding, it is likely that highly critical items could be missing when orders for less critical items are prioritized. A-B-C classification (premised on the Pareto principle or the 80/20 rule) is a commonly adopted inventory management approach. It is useful in prioritizing inventory handling and replenishments because items are segmented into three categories based on their level of importance or criticality to service provision, value, usage, or cost as follows:

- **Category A items:** Most important or valuable items. Although they typically account for 5 to 10 percent by volume, they account for 70 to 80 percent of value of all inventory items. These items are given the highest priority when ordering and stocking.
- **Category B items:** Important items that account for 10 to 25 percent by value but account for 20 to 30 percent of all inventory items. These items are as important as A-items so they have less priority.
- **Category C items:** Least important items, accounting for 5 to 10 percent of value but yet accounting for the greatest percentage of all inventory items by volume. These items are given least priority given their impact on service and value. Their reorder time is longer than for A-items.

By using this approach, A-items will be given highest priority compared to B- and C-items. This segmentation can enable more tailored planning and resource allocation by inventory category.

Besides A-B-C classification, there is need for regular *cycle counting*, an approach involving a physical count of inventory to ascertain records and correct any inaccuracies, ultimately improving inventory records. As previously noted, inventory record accuracy is a major concern, in part because of the way inventory data are captured. Performing cycle counts can clean the inventory database and identify weaknesses in inventory processes that contribute to high inventory data inaccuracy. It can also reduce overstocking inventory, as items in stock will be more accurately accounted for. Undoubtedly, better understanding of inventory levels, usage patterns, and the importance of different items could reduce inventory waste because unused inventory in one center could be transferred to another center in need, thereby reducing the risk of inventory obsolescence.

Recommendation Six: Conduct Inventory Performance Benchmarking and Create Communities of Practice to Share Them

There is a need to give more emphasis to benchmarking of inventory processes and performance against industry best practices. While there are different types of benchmarking, the two that we recommend are process benchmarking and performance benchmarking. Specifically, there is need to identify the best practices in inventory processes at the organiza-

tions or units that will be benchmarked against, and to determine appropriate metrics and performance targets (benchmarks) to achieve within a given period. Benchmarking can be internal (across different departments or units in an agency) and/or external (comparison with other agencies or organizations). There are many opportunities to share best practices across units within a government agency through the use of communities of practice.⁹ As we noted, based on our study, some medical centers are performing much better than others in inventory management, but their process innovations and other best practices are not shared across the centers. Thus, there is a need to develop mechanisms for sharing or replicating what works in one unit with other units.

At the same time, there is need to adopt well-established frameworks for conducting benchmarking. One such framework is the SCOR (Supply Chain Operations Reference) model.¹⁰ SCOR is a reference model that defines supply chain processes and metrics and enables communication of these practices within and across organizations. Because it provides a comprehensive assessment of processes and performance metrics, which is ideal in benchmarking, SCOR is widely used in commercial enterprises and increasingly in public sector, including at the Department of Defense (DOD).

Recommendation Seven: Establish a Culture of Continuous Improvement in Inventory Management

To fully exploit process mapping and benchmarking potential, government agencies should establish a strong organizational culture regarding continuous improvements in inventory processes. Because continuous improvement is employee-driven, it can be very effective for making changes to inventory processes at a very low cost. Frontline employees will lead the effort of not only identifying problem areas or weaknesses in current processes, but also in suggesting potential improvement actions. To encourage staff buy-in, establish incentives such as system-wide recognition or possibly monetary awards for teams, units, or facilities that come up with the most innovative or effective improvements in a given period of time. Enhancing a sense of ownership of process improvements is critical for continuous improvement to succeed and become an agency's culture.

Recommendation Eight: Adopt More Effective Staff Training Approaches and Build a Culture of Teamwork

A key step that government agencies can take toward a continuous learning environment for inventory management is requiring inventory personnel to complete certain training modules as a routine practice. In the financial sector, for example, it is not unusual for personnel to be required to complete specific online training modules within stipulated time frames as part of ongoing training. With respect to inventory management skills, public sector employees can be required to complete supply chain management certifications commonly used in the private sector, such as *APICs* and *SCM Pro*.¹¹ Additionally, government agencies could collaborate with local universities to develop inventory training programs that can be tailored to on-the-job training or specific skill gaps in the sector.

9. For more information on the use of communities of practice, see William Snyder and Xavier de Souza Briggs, *Communities of Practice: A New Tool for Government Managers*, IBM Center for The Business of Government, 2003.

10. SCOR framework (<http://www.apics.org/sites/apics-supply-chain-council/frameworks/scor>)

11. The American Production and Inventory Control Society (APICS) offers the professional designation APICS CSCP (Certified Supply Chain Professional) after completion of its certification program. Other certification programs include "Certification of Supply Chain Professionals" (SCM Pro).

Besides training, other low-cost approaches include staff exchanges (deploying staff to another unit for a given period) and shadowing arrangements (staff shadow another person to learn a best practice). There is also a need to develop clear career paths for upward mobility. Because staff turnover in the public sector is relatively low, there is a tendency for personnel to remain at the same job level for a long time.

Recommendation Nine: Establish Greater Accountability Mechanisms for Senior Leadership

Our study indicates gaps in levels of senior leadership engagement on inventory management. To bridge these gaps, senior leadership needs greater accountability with respect to inventory performance. The question, then, is how to achieve that accountability. One way is to institute inventory performance metrics and incentives in senior leaders' performance assessments and contracts. This way, senior leadership will be aware that their performance is partly tied to how inventory is managed in the agencies or the units they lead. This accountability is likely to trickle down to lower levels of management, thereby increasing the visibility of inventory issues and decisions.

Recommendation Ten: Establish More Effective Channels of Communication on Inventory Issues

Government agencies need to establish clear communication channels and support systems such that inventory issues are brought to the attention of senior leadership expeditiously. Such communication should cascade to all levels of the institution to facilitate a bottom-up identification of issues and suggested solutions. For example, as we noted from our study of the VA, frequent communication between senior leadership and logistics staff, and between logistics staff and clinical staff, appears to be a major contributor to better inventory management at two medical centers.

Among the approaches to enhance communication is holding regular meetings where personnel share their experiences and bring up issues that may be affecting inventory management. An additional approach is using dashboards, whereby inventory performance information is displayed and accessible to staff as well as to senior leadership. The dashboards can be generated and shared electronically as well as in work spaces, such as on bulletin boards.

Conclusion

Significant opportunities exist to improve inventory management in the public sector. However, such improvement will require substantial commitment on the part of senior managers and policy makers. It calls for changes in organizational culture and a realization that even with a push for standardization, *"one size does not fit all."* Each agency or department needs to understand the dynamics at play and to tailor inventory management practices to realize highest performance.

Our study demonstrates that while government agencies face substantial challenges in inventory management, opportunities exist to mitigate these challenges and enhance inventory performance. Our recommendations point to practical ways to address some of the challenges in spite of institutional limitations.

Afterword

Future Directions for Supply Chain Management: The Implication of the Internet of Things

By Townley Cozad

This IBM Center report, *Ten Actions to Improve Inventory Management in Government: Lessons from VA Hospitals*, addresses overarching governmental challenges facing supply chain management as illustrated by the authors' interviews in a series of VA hospitals. In many respects, the report's recommendations are foundational and a necessary precondition for future improvements. Absent substantive action to remedy these problems, improving the VA's supply chain management will be costly and will require sprinting to catch up to similar advances in technology being applied in the private sector.

What are some of the most significant trends in improving supply chain management more generally that can be a future roadmap for making the VA's medical supply chain management more efficient, affordable, and effective? In addition to building upon the foundation and making improvements in inventory management described by the authors of this report, the next step will be to embrace future trends in supply chain management. These advancements are radically changing the way supply chains are managed today, and they are grounded in the expansion of the Internet of Things.

To illustrate this point, a March 2016 report by Frost and Sullivan, *Supply Chain Evolution—Tectonic Shifts in the Value Chain: Emergence of the Industrial Internet of Things Is Poised to Disrupt Existing Supply Chain Operations*, identifies six themes that are expected to revolutionize current supply chain-related activities:

- Smart products
- Control on the go
- Track and trace
- Advanced supply chain management
- Big data and analytics
- Advanced logistics

In addition, the high growth of wireless sensors (with an estimated compound annual growth rate of 45-50 percent), coupled with the breadth of applications using cellular communication, has provided diverse value chain participants a means to monitor their movable assets.

In contrast to traditional industrial handheld devices, the high penetration of smartphones (estimated to have a compound annual growth rate of 14.7 percent) enables staff working

across the supply chain a cost-effective means to monitor key metrics and streamline maintenance, repair, and operations-related activities. In addition, the authors report that compliance with regulatory mandates across vertical markets and geographies has paved the way for wide-scale acceptance of track-and-trace solutions that allow key stakeholders to authenticate products at various transit points across the supply chain.

The industrial Internet of Things is leading to a number of significant departures from current supply chain management practices:

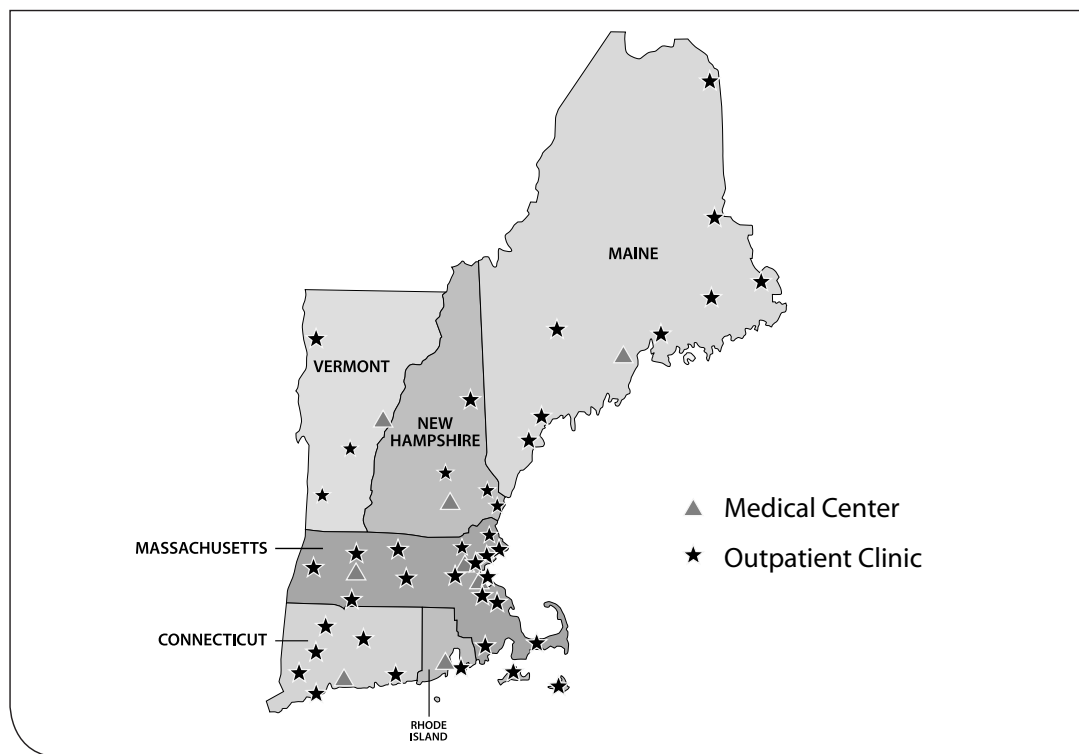
- **First, information technology and operations technology are converging in profound ways.** The cross-pollination of ideas, technologies, and processes between the worlds of IT and operations technology will form the crux of what is being called “the fourth industrial revolution.” The “Services 2.0” explores newer avenues for service innovations such as cloud-based service platforms and evaluating the potential for new profit centers. They also offer opportunity analysis for information and communication technology (ICT) in services. Similarly the “Industry 4.0 Business Ecosystem” will promote new interrelationships and interdependencies, giving way to unexpected business collaborations and partnerships in the future.
- **Second, supply chain management is evolving rapidly as well.** The dawn of the future factory is set to disrupt existing supply chain networks. Digitalization and increased connectivity are poised to disrupt and realign existing value chain networks in the future. The influx of big data across the supply chain, in particular unstructured data, has resulted in key value chain participants looking for state-of-the-art analytical platforms to convert raw data into actionable insights that improve the overall operational efficiency.
- **Third, the supply chain management market itself is moving with unprecedented speed.** There is no single-point path for success. A solid solution must integrate new concepts, processes, and cutting-edge technologies. An effective solution will also require a strategic vision that stipulates how these discrete pieces will come together to improve effectiveness and efficiency. The recommendations in this report will move the VA into a position where the private sector is today. The Frost and Sullivan study provides a glimpse at how the VA’s hospital supply chain management system can keep pace with the future pace of change in the field, which is occurring at an ever increasing pace.

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Appendix: Research Approach

We conducted a modified comparative case study of medical centers within the Veterans Health Administration. The study setting was the VA's New England region (see map below), which consists of eight medical centers and over 35 community-based outpatient clinics (CBOCs), six nursing homes, and two domiciliaries. The VA New England division treats more than 240,000 veterans annually and employs approximately 10,000 individuals. Each medical center has its own logistics department responsible for inventory management.

Figure A.1: Map of the New England VA system



Source: Northeastern University Healthcare Systems Engineering Institute (<http://www.coe.neu.edu/healthcare/ne-verc/index.html>)

We conducted an in-depth study of inventory management at the eight medical centers and their affiliated community health centers. A pilot study we had conducted indicates much variation among the medical centers in terms of inventory management, even though the medical centers were within the same VA region. Our data collection efforts at the medical centers were supplemented with additional information we previously obtained from private sector organizations in the healthcare, manufacturing, and retail sectors. We also performed a comprehensive review of the general literature on inventory management.

We conducted site visits to the medical centers and obtained several types of data from interviews with key informants, and administrative data in the form of documents and archival records. We also conducted phone interviews with key informants at sites we could not visit. Also, as part of each site visit, we conducted a walk-through of inventory processes where we had an opportunity to examine directly the ordering, procurement, storage, and distribution of supplies.

- **Interviews with Key Informants:** The key informants included members of the logistics staff (e.g., chief logistics officer, inventory managers, supply/distribution techs) and senior leadership for the New England VA regional office. We conducted more than 40 interviews in total between January and May of 2014 across eight facilities in the New England region. Each interview was conducted in accordance with a semi-structured interview format and covered a range of topics including inventory processes at the facility, staffing in the logistics department, relationships with suppliers, and use of information technology. A written record was produced for each interview. Following standard qualitative research methods, we coded the interview data for each medical center based on commonly expressed ideas and words.
- **Documents and Archival Records:** We also obtained reports and administrative records pertaining to inventory policies and procedures, logistics staffing, and inventory performance. These included published past studies and inventory performance data currently in the system.

To arrive at key findings, for each medical center we integrated results across the multiple types of data—interviews, documents, and archival records—to construct a case profile. We compared results across these case profiles to identify commonalities and differences. We also considered results in relation to the general literature review we conducted and our own previous research on inventory management in private sector organizations.

About the Authors

Gilbert N. Nyaga is an Associate Professor of Supply Chain Management at the D'Amore-McKim School of Business. He is also a faculty associate in the Center for Health Policy and Healthcare Research at Northeastern University. He received his PhD in Business Administration from Michigan State University. He is currently the Curriculum Coordinator in the Supply Chain Management and Information Group, D'Amore-McKim School of Business. He serves in the editorial boards of *Journal of Business Logistics* and *International Journal of Physical Distribution and Logistics Management*. He also serves or has served in different roles in the Council of Supply Chain Management Professionals including the Academic Strategies Committee, Research Strategies Committee, and executive board of the New England Roundtable.



Dr. Nyaga's research focuses on supply chain collaboration, logistics strategy, and healthcare supply chains. Specifically, his research addresses relational and integrative issues in supply chain exchanges as well as strategies applied in logistics operations. His research in the healthcare sector examines the application of supply chain strategies and the impact on clinical and operational performance. His published work appears in journals such as *Journal of Business Logistics*, *Journal of Operations Management*, *Journal of Supply Chain Management*, *Industrial Marketing Management*, and *Healthcare Management Review*. He has also presented his research at several supply chain and healthcare conferences. He has received research support from different sources including Northeastern University and the Veterans Engineering Resource Center (VERC), Department of Veteran Affairs. His research publications have received awards including the 2013 Harold E. Fearon Best Paper Award (*Journal of Supply Chain Management*) and 2010-2014 Jack Meredith Best Paper Finalist (*Journal of Operations Management*).

Gary J. Young is Director of the Northeastern University Center for Health Policy and Healthcare Research as well as Professor of Strategic Management and Healthcare Systems, Northeastern University. He is affiliated with the Health Services Research and Development Service of the Department of Veterans Affairs. Before joining Northeastern University, he was chairman of the Department of Health Policy and Management at Boston University and also worked as a healthcare attorney within the federal government and for a national healthcare consulting firm.



Dr. Young's research generally pertains to managerial, policy, and legal issues associated with the delivery of healthcare services. His published work has appeared in such journals as the *New England Journal of Medicine*, *Academy of Management Journal*, *California Management Review*, *Journal of Business Logistics*, *Health Affairs*, and *Journal of Health Politics, Policy and Law*. He has received financial support for his research from government agencies and private foundations including the National Science Foundation, Agency for Healthcare Research and Quality, Department of Veterans Affairs, and Robert Wood Johnson Foundation. He has received a number of awards for his research, including the John D. Thompson Prize for Young Investigators from the Association of University Programs in Healthcare Administration.

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He received a law degree and PhD in management from the State University of New York where he was a Baldy Fellow in Law and Policy.

George S. “Russ” Moran is an Executive Professor in Northeastern University’s High Tech MBA Program in the D’Amore-McKim School of Business, and he has been Adjunct Faculty to the Bouve College of Health Sciences MPH and Health Care Informatics programs at Northeastern University for the last 10 years. His courses have included Innovation & Enterprise Growth, Service Innovation and Operations Management, Strategic Management and Leadership in Healthcare, Management Issues in HIT, and The American Healthcare System. Mr. Moran also works with Northeastern University’s D’Amore-McKim School of Business Executive Education practice, and he has worked with clients such as IBM, Putnam Investments, BCBS of MA, EMC, and the Massachusetts Hospital Association. Mr. Moran has taught courses at Merrimack College and the University of Lowell, and he has been a guest lecturer at Harvard School of Public Health and Simmons College. He is a graduate of St. Anselm College with a BA in Sociology, and of the University of New Hampshire with a MA in Public Administration.



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