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**Cold-Chain Logistics: A Study of the
Department of the Defense OCONUS
Pre-Pandemic Influenza Vaccine
Distribution Network**

**By: Daniel “Travis” Jones, and
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December 2007**

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**COLD-CHAIN LOGISTICS: A STUDY OF THE DEPARTMENT
OF THE DEFENSE OCONUS PRE-PANDEMIC VACCINE
DISTRIBUTION NETWORK**

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ABSTRACT

The purpose of this MBA project is to suggest a standardized distribution process for the DoD of the Pandemic Influenza vaccine, filling an existing void in the *National Strategy for Pandemic Influenza*. Also, this project is intended to foster the communication and planning process for vaccine distribution between all stakeholders, including the DLA, COCOMs, and regional commanders. Currently, no DoD pre-pandemic vaccine distribution plan exists. This project identifies the essential infrastructure assets needed to develop a cold-chain distribution network for vaccine in a military application. Furthermore, the key communication and transportation elements needed for successful execution of this network are identified, including a discussion on information and vaccine flow through the distribution network. These ideas are organized into a model to provide an easily usable decision-making tool for cold-chain network design. Finally, an example using the model is provided, with PACOM as the example area of operation.

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LIST OF ACRONYMS AND ABBREVIATIONS

AOR:	Area of Operation
ASD(HA):	Assistant Secretary of Defense for Health Affairs
CDC:	Centers for Disease Control and Prevention
COCOM:	Combatant Commander
CONUS:	Continental United States
CRAF:	Civil Reserve Air Force
DLA:	Defense Logistics Agency
DoD:	Department of Defense
DSCP:	Defense Supply Center Philadelphia
GAO:	Government Accountability Office
GPS:	Global Positioning System
ISC:	Insulated Shipping Container
JHSS:	Joint Health Services Support
MHSS:	Military Health Services System
MOOTW:	Major Operations other than War
MTW:	Major Theatre of War
PACOM:	Pacific Command
PI:	Pandemic Influenza
PV:	Private Vendor
RFID:	Radio Frequency Identification
USD:	Under Secretary of Defense
USD (P&R):	Secretary for Defense for Personnel and Readiness
USTRANSCOM:	United States Transportation Command
VMI:	Vendor Managed Inventory
WHO:	World Health Organization

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Daniel “Travis” Jones and Christopher “Craig” Tecmire

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Christopher “Craig” Tecmire

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I. INTRODUCTION

A. BACKGROUND

1. *Joint Vision 2020*

It is necessary for acquisition specialists to research and understand the direction Department of Defense (DoD) logistics initiatives are headed, so that all recommended process improvements can be consistent with, and can integrate with, the future vision of the United States military's top leadership.

The Joint Chiefs of Staff recently published *Joint Vision 2020*, in which they outlined their vision for the United States military for the next twenty years. The overall goal of the Joint Chiefs in this document is: "The creation of a force that is dominant across the full spectrum of military operations—persuasive in peace, decisive in war, preeminent in any form of conflict" (Director of Strategic Plans & Policy, 2000, p. 16). In order to achieve "full spectrum dominance," the Joint Chiefs identify four key operational capabilities that must be developed through innovation and technology: Dominant Maneuver, Precision Engagement, Focused Logistics and Full Dimensional Protection. Figure 1 provides a summary graphic of the four capabilities and how they are driven by innovation and information superiority (Director of Strategic Plans & Policy, 2000).

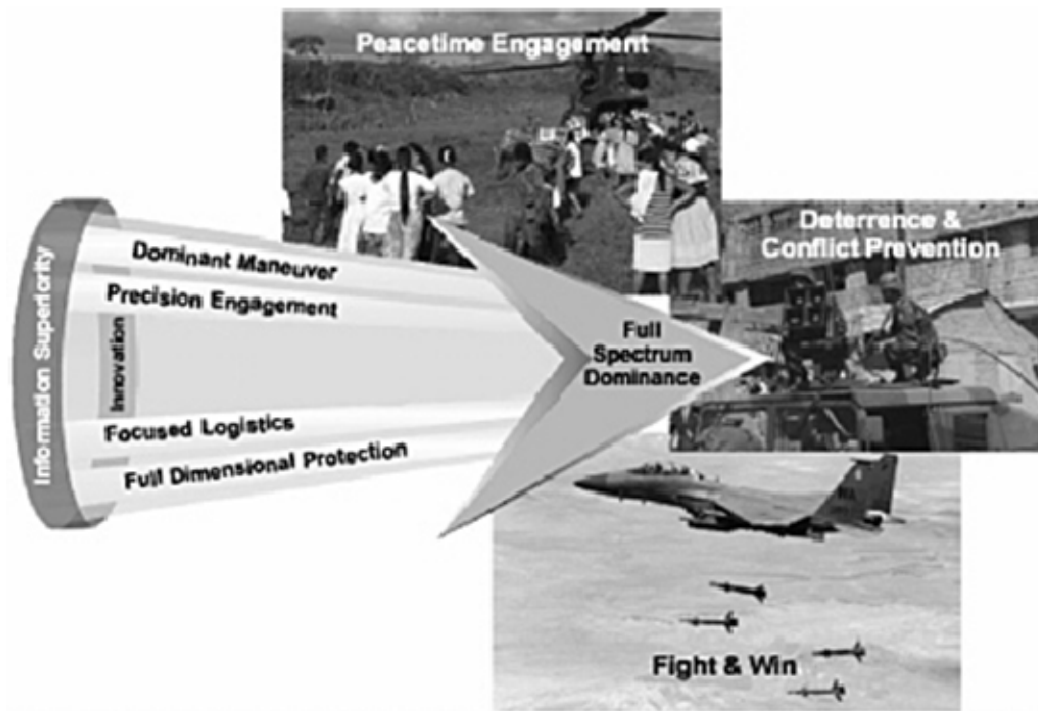


Figure 1. Joint Vision 2020 Overview

(From Director of Strategic Plans & Policy, 2000)

“Focused Logistics” is identified as one of the main capabilities of *Joint Vision 2020* and is defined by the Joint Chiefs as “the ability to provide the joint force with the right personnel, equipment, and supplies in the right place, at the right time, and in the right quantity across the full range of military operations” (Director of Strategic Plans & Policy, 1998, p. 16). The Joint Chiefs envision the accomplishment of focused logistics by the use of real-time, web-based information systems that provide Total Asset Visibility to all members of the supply chain (Director of Strategic Plans & Policy, 1998).

The concept of focused logistics was first introduced in the *Joint Vision 2010*, the predecessor to *Joint Vision 2020*. In the *Joint Vision 2010* document, a detailed ten-year plan for the Department of Defense logistics was laid out; this is referred to as the “Joint Logistics Roadmap.” In *Joint Vision 2020*, the Joint Logistics Roadmap was still addressed and endorsed as a viable plan for execution and as the appropriate course for DoD logistics. Figure 2 provides a graphical overview of focused logistics initiatives (Director of Strategic Plans & Policy, 1998).

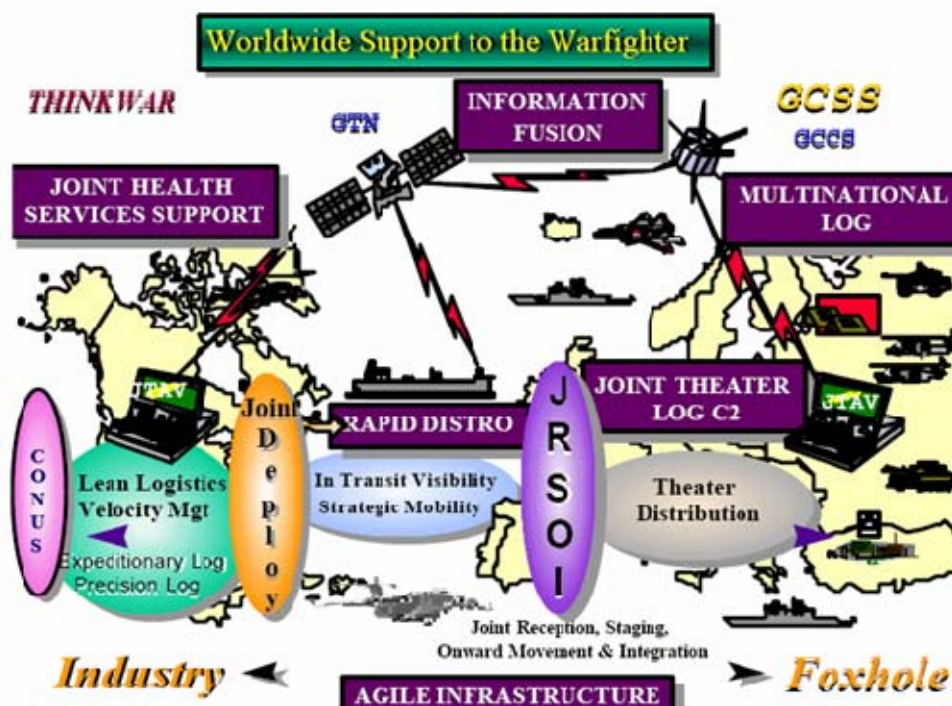


Figure 2. Focused Logistics Overview

(From Director of Strategic Plans & Policy, 1998, p. 16)

The Focused Logistics Roadmap is extremely detailed and lengthy, and many of the items in it pertain more to warfighting issues such as weapons systems and troop movements than to logistics. However, there is one key item of the Focused Logistics Roadmap that will definitely affect medical logistics in the DoD. Joint Health Services Support (JHSS) is one of the six tenets of the Focused Logistics Roadmap. JHSS calls for the formation of the Military Health Service System (MHSS) to provide health services to the Armed Forces. It is positioned as the nation's benchmark health care delivery system for the 21st century—emphasizing readiness, health promotion, and managed care for all Armed Service personnel. The MHSS will be committed to jointly face the challenges inherent in a new world order, as well as challenges brought about by revolutionary changes in health care. The mission of MHSS is to provide top-quality health services, whenever needed, in support of military operations and to members of

the Armed Forces. As the world's preeminent military health service system, the MHSS is accountable to the American people for support of national security and the health of military personnel. Today and in the future, the MHSS is committed to readiness for military operations in a dynamic global environment, provision of top-quality, cost-effective health care, development of leaders who excel in a changing world, and innovative application of new technologies (Director of Strategic Plans & Policy, 1998).

2. The State of Medical Logistics in the DoD

The history of medical material management in the DoD dates back to 1850 (Augustitus & Stevenson, 2000). Medical logistics within the context of the DoD has become a problem of enormous proportions and a costly endeavor. Within the DoD, medical logistics is concerned with providing logistical support of organic medical assets to both fixed medical facilities (such as clinics and hospitals) and to operational units (such as ships and deployed units).

A key definition of military logistics is that it allows for acquisition of assets, sustainment of forces, distribution of assets in a timely manner, and also for proper disposal (Naval Doctrine Publication, 1995). Sustainment includes the idea that adequate logistics support is available for continuous operations with minimal interruptions (Naval Doctrine Publication, 1995). Distribution is the allocation and delivery of goods in a manner that will allow for maximum combat effectiveness using supply-chain and strategic transportation principles (Naval Doctrine Publication, 1995).

The DoD medical logistics system of the past did not fully support all of the above definitions, which caused leaders to realize that the system needed to change. In the past, medical logistics has been controlled primarily through the federal supply system at the depot level. End-users submitting requisitions were at the mercy of an archaic system that was implemented to increase the amount of standardization among all services. This system increased inventory costs and provided minimal standardization among product lines or products (Augustitus & Stevenson, 2000).

DoD inventory management initiatives and efforts were focused on ensuring that there was enough war-reserve material available should a major conflict occur during the

Cold War. Within this system, medical materials involve large cost because of the shelf-life of perishable items, such as pharmaceuticals, and the use of assemblages (standard templates of issue) to provide initial supplies for operational units (Augustitius & Stevenson, 2000).

Today, we find the DoD utilizing methods such as Prime Vendor (PV) and Vendor Managed Inventory (VMI) to provide needed medical supplies at a competitive price and delivery time. These initiatives also marked the beginning of a new era in medical supply-chain management. Since there has been a reduction of depot-level stock, many outside the medical community, namely at the Combatant Commander (COCOM) level, do not have confidence in the sustainment capability and surge capacity of Class VIII (medical material) during a major theater war (MTW) or major operations other than war (MOOTW) (GAO, 1996).

A decade ago, business-process efficiency was not the highest priority in the DoD, but the situation is changing. Although the DoD does not have a profit motive or competition for market share, its business functions can be very similar to those in the private sector; in addition, severe budget constraints have dramatically raised the priority level of DoD business-process efficiency. The gap between DoD and private-sector business practices has become increasingly relevant.

3. 20th Century Pandemics

Every year, United States citizens die from infections caused by the influenza virus. Influenza and pneumonia were ranked number seven on the list of causes of deaths among the United States population in 2000 (CDC/NCHS, 2002). Usually, the virus kills mostly small children, the elderly, and those with existing medical conditions. However, three times in the last 100 years there has been an influenza pandemic, or a world-wide epidemic, which affected the United States. These were caused by new influenza “A” virus subtypes that emerged during the 20th century and spread around the world within one year of being detected (Gurr, 2006).

a. *Spanish Influenza*

The first to affect the United States was the “Spanish Influenza” in 1918-1919. The origin of the 1918-1919 pandemic virus is not clear, but it is believed to be caused by a type “A” (H1N1) virus (Snacken, Haaheim, & Wood, 1999). The Spanish influenza epidemic caused an estimated 22 million deaths around the world according to the Centers for Disease Control and Prevention (CDC). Over 12,000 deaths were reported in Philadelphia alone in September and October of 1918 (Lynch, 1998). The disease caused a panic in Philadelphia because it hit healthy young adults—accounting for half of the reported deaths. Influenza “A” (H1N1) viruses still circulate today after being introduced again into the human population in the 1970s (Gurr, 2006).

b. *Asian Influenza*

In 1957-1958, there was an influenza pandemic called the “Asian Flu.” The Asian influenza was caused by an influenza “A” (H2N2) type virus (Snacken et al., 1999). This virus was first identified in China in February 1957 and spread to the United States in the summer of the same year. An estimated 1 million people died worldwide from the Asian influenza; 70,000 of those were in the United States. A world-wide scare occurred in April 2005 when this influenza virus strain was mistakenly sent out to 3,747 laboratories in 18 countries as part of their certification process. All parties were asked to destroy the virus upon receipt (CIDRAP, 2005).

c. *Hong Kong Influenza*

The “Hong Kong Flu” occurred in 1968-1969 and was caused by an “A” (H3N2) type virus (Snacken et al., 1999). It is estimated that 750,000 people world-wide died of the virus, and 34,000 of those deaths occurred in the United States. Influenza “A” (H3N2) viruses still circulate today. Both the 1957-1958 and 1968-1969 pandemics were known to be caused by viruses containing a combination of genes from a human influenza virus and an avian influenza virus (Gurr, 2006).

d. Avian Influenza

The latest recorded (as of this writing) multiple deaths resulting from the Avian Influenza “A” (H5N1) occurred in China, Indonesia, Thailand, Vietnam, and Turkey—with over 60 reported human deaths and 140 total cases. So far, this strain has not produced human-to-human infection, but is feared to be a likely pandemic influenza of the 21st century.

4. United States Pandemic Influenza Strategy

The Homeland Security Council, in November 2005, broadly defined the *National Strategy for Pandemic Influenza* in the following statement:

The *National Strategy for Pandemic Influenza* guides our preparedness and response to an influenza pandemic, with the intent of (1) stopping, slowing or otherwise limiting the spread of a pandemic to the United States; (2) limiting the domestic spread of a pandemic, and mitigating disease, suffering and death; and (3) sustaining infrastructure and mitigating impact to the economy and the functioning of society. (2005, p. 2)

Three pillars of the *Strategy* are derived from this broad statement—including Preparedness and Communication, Surveillance and Detection, and Response and Containment (Homeland Security Council, 2005).

In May 2006, the President issued the *National strategy for pandemic influenza implementation guide* that provides a directive framework to the *National Strategy* and assigns preparedness and response tasks to Federal departments and agencies. The Implementation Guide acknowledges that because preparedness for a pandemic requires the establishment of infrastructure and capacity, a process that can take years, significant steps must be taken to initiate that preparedness. The Implementation Guide translates the *National Strategy* into over 300 tasks that will allow all Federal departments and agencies to fully engage their personnel and resources by taking specific, coordinated steps to achieve the goals of the *National Strategy* (Homeland Security Council, 2006).

An influenza pandemic—a novel influenza virus with the ability to infect and be passed efficiently among humans—could significantly impair the military’s readiness, jeopardize ongoing military operations abroad, and threaten the day-to-day functions of the DoD due to a large percentage of sick or absent personnel. The vulnerability of US armed forces to an influenza pandemic was demonstrated during World War I when at least 43,000 US service members died (about half of all of the deaths of US service members during World War I) due to influenza or influenza-related complications; another one million service members were hospitalized, which limited the military’s ability to continue ongoing missions (GAO, 2007, p. 1).

According to the World Health Organization (WHO), it is not a question of if, but when, another influenza pandemic will occur. During the peak weeks of an outbreak of a severe influenza pandemic, the Homeland Security Council estimates that 40% of the US workforce might not be at work due to illness, the need to care for family members who are sick, or fear of becoming infected. DoD military and civilian personnel and contractors would not be immune; the Department would face an absentee rate similar to the rest of the population (GAO, 2007, p. 1). To address the potential threat of an influenza pandemic, as well to follow the guidance of the National Implementation Guide, the DoD began its department-wide planning and preparedness efforts.

The *Department of Defense implementation plan for pandemic influenza* developed from the HSC’s Implementation Guide for the *National Strategy*, was designed to provide guidance and to address key issues within the DoD in regard to Pandemic Influenza response planning. One of the key issues addressed is the scope of agency responsibility. The DoD, during a pandemic influenza event, is responsible for the care and well-being of military forces, DoD civilians, DoD contractors, dependents, and beneficiaries. This document also provides a standard set of planning assumptions to be employed by all DoD activities when developing policy and plans for pandemic influenza (DoD, 2006a).

The focus of this project is to evaluate the current Pandemic Influenza Strategy of the DoD, with particular emphasis on the cold-chain management process of the current DoD medical supply chain. In addition, this project examines emerging processes and

technologies in the private sector to determine if industry innovations can be adopted to enhance and further streamline the DoD cold chain of pandemic influenza vaccinations.

B. RESEARCH QUESTIONS

1. Primary Research Question:

How can pre-pandemic influenza vaccine be distributed to military personnel while minimizing time and risk factors and ensuring cold-chain integrity?

2. Secondary Research Questions:

- How can duplication of effort be minimized by the incorporation of an integrated response among the military services and defense agencies?
- What technologies can be employed to sustain an optimal distribution chain for the pandemic influenza vaccine?
- How can the medical logistics community, the Defense Logistics Agency (DLA), and COCOMs cooperate to implement the new process?

C. METHODOLOGY

The methodology used in this research project will consist of the following steps:

- Conduct a literature search of books, journal articles, magazines, and material from the World Wide Web regarding supply- and cold-chain management.
- Conduct a thorough review of existing cold-chain technologies in the DoD and the private sector.
- Conduct a review of current DoD cold-chain processes and procedures, including current pandemic influenza distribution procedures.
- Prepare a summary and make recommendations.

D. SCOPE OF PROJECT

The audience for this project includes DoD and service-specific policy makers, COCOM planning personnel, and DLA personnel. The main emphasis of this project is to analyze the pre-pandemic influenza vaccine distribution strategy for the DoD and COCOMs, with the given constraint of cold-chain management concepts. This project addresses the establishment of a pre-pandemic influenza cold-chain network, leveraging the inherent capabilities of each stakeholder.

E. ORGANIZATION

Following the project introduction in Chapter I, Chapter II contains data gathered from an extensive literature review used to survey the background of supply-chain and cold-chain management. Chapter III provides a detailed analysis of the evolution of DoD pandemic influenza policy and strategy. The key aspect of this chapter is to trace the mandate for pre-pandemic influenza vaccine distribution. Chapter IV develops a decision process for cold-chain logistics design in a responsive military environment. Chapter V wraps up the project with discussion of the generalization of the decision process from Chapter IV, conclusions, and further recommendations.

F. BENEFITS OF STUDY

The primary benefit of this study is to create a distribution strategy for the DoD of a Pandemic Influenza vaccine, filling an existing void in the *National Strategy*. Also, this project is intended to foster the communication and planning process between all stakeholders, including the DLA, COCOMs, and regional commanders. Currently, no vaccine distribution plan exists. The intent here is to recommend such a plan and a model for decision-making in relation to cold-chain management within a theatre of operation.

II. EVOLUTION OF THE SUPPLY-CHAIN MANAGEMENT WITH PARTICULAR EMPHASIS ON COLD-CHAIN MANAGEMENT

A. CHAPTER OVERVIEW

This chapter focuses on supply-chain management, which has gained popularity in the civilian sector as a valuable tool for improving efficiency in logistics and for increasing productivity. This chapter also discusses the evolving concept of cold-chain management—with particular emphasis on maintaining required temperature and validation. It presents an overview of both supply-chain management and cold-chain management and how each has become an important management tool in many industries.

B. SUPPLY-CHAIN MANAGEMENT

Over the past two decades, supply-chain management has grown into a popular management tool in industries that rely on manufacturing, production, and distribution functions, such as food retailing, the DoD, and the automotive industry. Increased competition and globalization have caused companies to place a greater emphasis on the efficiency and responsiveness of their supply functions (Kelly, Morledge, & Wilkinson, 2002, p. 201).

Prior to supply-chain management, manufacturing companies focused their competitive strategy on providing a product and brand name that people would associate with quality. Very few leaders and top managers of companies were worried about the details of the logistics involved in how raw materials were purchased, received, and warehoused. As long as the production line was moving and products were being made at a sufficient rate to meet demand, the details of managing supplies were important, but usually delegated to the logisticians in a company. Focus on the actual manufacturing of the product was important to the top management of a company, but the follow-on

logistics of warehousing the finished products and moving the manufactured product to its purchasers were, again, delegated to lower management.

Traditional corporations, prior to supply-chain management, maintained separate departments that were, for the most part, independent of one another. For example, companies would have departments for marketing, purchasing, manufacturing, and distribution. These departments usually had different objectives, which did not always mirror and complement one another. Also, each department placed focus on its portion of the business, without emphasizing the overall company process. This mindset created efficiently run departments within the company, but not necessarily the most efficient system for the company as a whole.

While the companies in this era were still concerned about cost, they were more focused on finding a savings in the production of their merchandise, and not necessarily in the warehousing and the internal logistics associated with the production. The typical logistics manager of the 70's and early 80's was concerned with ensuring that production was sufficient to meet the demand, and it was common practice to accept the fact that hidden costs would creep into the logistics system; these hidden costs would be tolerated by the company (Oliver & Webber, 1982). Therefore, waste and inefficiencies in the supply system were generally viewed and accepted as necessary costs for doing business; for the most part, the markets allowed it because everyone did it.

The recent boom in the use of internet and computer technology has ushered in the new era of globalization, causing the entire marketplace to change. With the birth of globalization came the growth of competition. Quality was now something that was assumed and expected by an increasingly demanding and knowledgeable customer. Therefore, making a quality, brand-name product was no longer a guarantee for success; those companies who wanted competitive advantage in the global economy had to find a new way to achieve it.

The growth of globalization and increased competition caused many changes in the manufacturing industry. Firms were now looking for a way to gain a competitive advantage in this new marketplace. Those companies who were able to apply technology

and effective management to their entire supply process, from raw materials to delivery of the end-product to the client, gained a competitive advantage. This new advantage first demanded the breakdown of cultural and organizational barriers that existed among the various individual departments in the company. Secondly, the company had to insure that everyone viewed the process as a system of interlinked organizations working together under a common strategy, for a common purpose, and for the same goals.

The companies who were able to successfully map and efficiently manage their supply chains gained a competitive advantage over others in their industry. This led to an increase in the level of competition in their respective industries. The increased competition, in turn, caused more companies to place emphasis on their supply chains in order to stay competitive in their industry, which led to the widespread growth and popularity of supply-chain management.

One leading company that has leveraged the latest in information technology to develop their supply-chain competitive advantage is Wal-Mart. Wal-Mart was able to develop an efficient supply chain by developing automated links with its multitude of suppliers. Through the use of barcode technology, the suppliers are automatically notified in real-time when one of their items is sold at Wal-Mart. The supplier then knows the remaining inventory at the store and knows when to provide a re-supply. This system of VMI created strategic relationships with suppliers and allowed Wal-Mart to gain efficiencies, which it could, in turn, pass along to the customers in the form of “everyday low prices.” K-Mart, the main competitor of Wal-Mart, tried to match Wal-Mart in prices to remain competitive in the industry, but did not have the same efficiencies in their supply chain. This was ultimately a contributing factor to K-Mart declaring bankruptcy in 2002 (Bradley & Ghemawat, 2002).

Throughout the evolution and growth of the supply-chain management concept, there have been many definitions of what is included in a supply chain. The following definition by Ganeshan and Harrison (1995) provides a concise and inclusive explanation of a supply chain:

a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into

intermediate and finished products, and the distribution of these finished products to customers. Supply chains exist in both service and manufacturing organizations, although the complexity of the chain may vary greatly from industry to industry and firm to firm. (p. 1)

Supply-chain management has become a complex subject, with many companies mapping and monitoring their complex, sometimes global, supply chains. Figure 3 provides a simplified, generic illustration of the basic supply chain for the manufacturing industry (Jones & Riley, 1985). This figure illustrates how the entire process, from raw materials to finished products, is taken into consideration in supply-chain management.

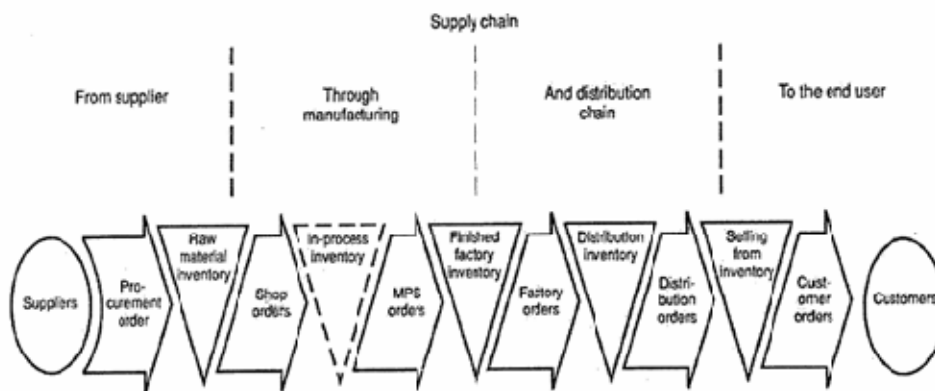


Figure 3. Generic Manufacturing Supply Chain
(From Jones & Riley, 1985)

C. WHAT IS A COLD CHAIN

A cold chain is a temperature-controlled supply chain (“Cold Chain,” 2007). A wide variety of food, pharmaceutical, and chemical products are degraded by improper exposure to temperature, humidity, light or particular contaminants. Some products, such as pharmaceuticals, require more than a simple cold chain. Such products require end-to-end management and visibility of the required temperature parameters. The Cold Chain

Program Manager for the Defense Logistics Agency (DLA), Defense Supply Center Philadelphia (DSCP), defines cold-chain management as follows:

Cold Chain Management is the science of preparing medical temperature sensitive products for shipment utilizing approved systems and procedures, ensuring that required temperatures are maintained throughout the supply chain and the validation of those conditions are met during all phases of distribution until issue or administration. (2007, p. 4)

Two principle tenets are taken from this definition: the maintenance of the required temperature and validation of operating conditions. These two important aspects are accomplished through the combination of technology and protocols.

D. MILITARY COLD CHAIN

In 1998, the military lost over 200,000 doses of anthrax vaccine due to freezing in an inadequate cold chain (DLA, 2007a). This, coupled with other high loss rates of vaccines, spurred the military to develop a cold-chain management system. The DLA utilizes a simple passive container system, while heavily leveraging standardized, proven, and externally validated protocols, knowledgeable personnel, fast transit time, and dependable and accurate temperature-monitoring devices. Passive containers utilize insulation and gel packs to provide cooling. No hazardous refrigerants or power sources are needed.

The Endurotherm system is the insulated shipping container (ISC) and polar pack refrigerant of choice for the DLA. The combination of container, insulation, and refrigerant seen below is validated to maintain the required 2°C - 8°C (36°F - 46°F) temperature for 72 hours, exceeding current shipping contract times (Dallas,¹ personal communication, May 24, 2007).

¹ Dana Dallas is the Cold Chain Program Manager for DLA at DSCP.

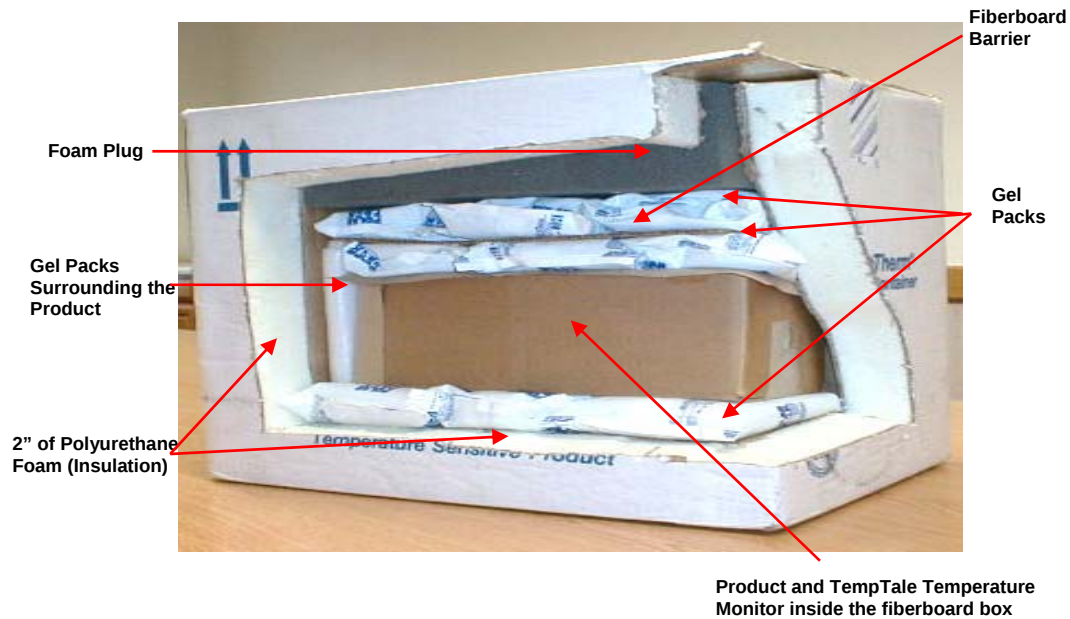


Figure 4. Endurotherm Package

(From DLA, 2007a)

The ISC unit is available in four sizes, while the gel packs are limited to two sizes. The exact sizes available and their specifications are listed in the Appendix. Each unit is packaged according to one of three standard protocols based on the following basic steps.

Endurotherm (ISC) Box Packing Steps

The packing or layering of the Endurotherm boxes is the same for all three sizes (large, medium and small).

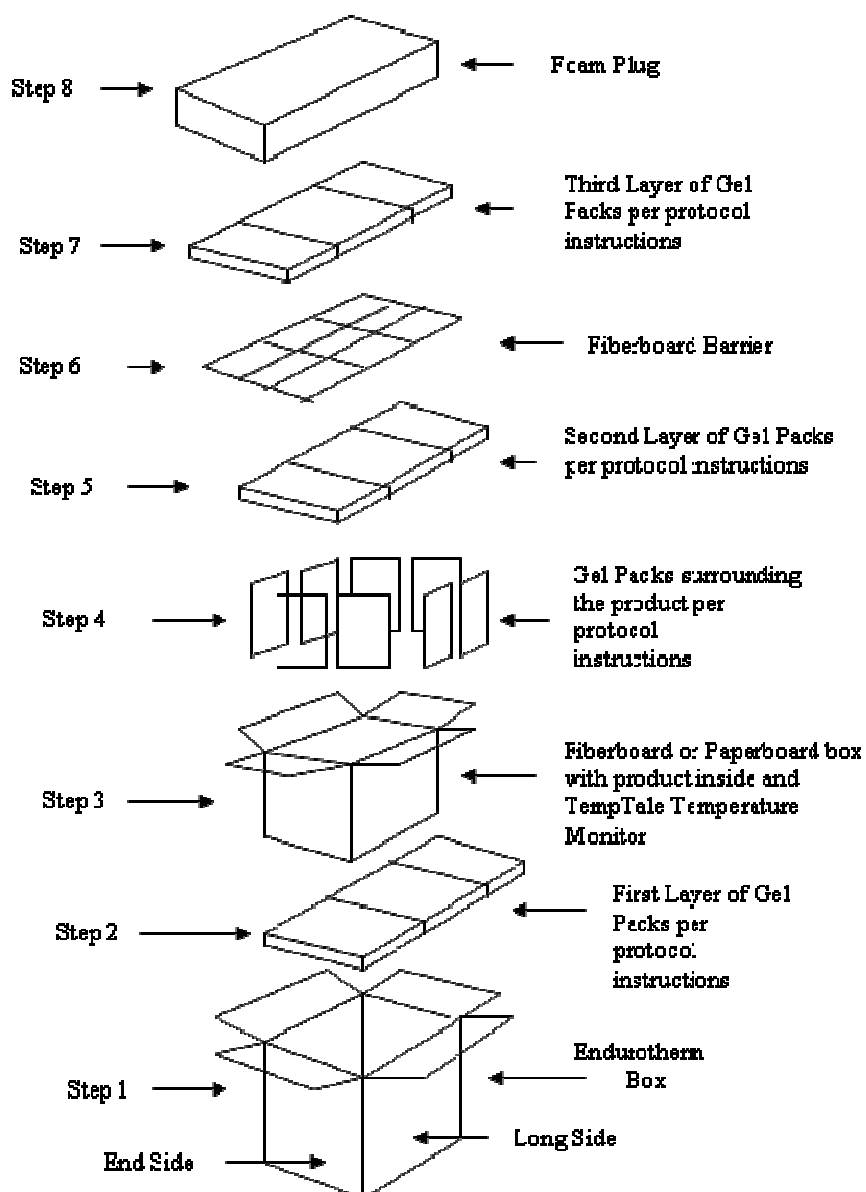


Figure 5. Endurotherm (ISC) Box Packing Steps

(From "Packing protocols," 2007)

According to DMMonline, the basic packing protocols are the same, regardless of container size. The primary difference, as noted in the diagram, is in the specific number and relative temperature of gel refrigerant packs used. The expected temperature in the receiving region will determine the specific number and relative temperature of gel refrigerant packs used. Expected receiving temperature is divided into three categories: Cold, Moderate, and Warm. Based on temperature categories and box sizes available, the DLA only utilizes 12 unique packaging protocols for its entire cold-chain management system.

The last essential element in the military cold chain is temperature monitoring and verification. The DLA accomplishes this vital step with the use of a Temptale temperature monitor, produced by Sensitech. This device will record unit temperature for the duration of the transit, and one can download the record to a computer upon receipt to verify proper temperature control was maintained. A graphical output, as shown below, is one of the available reports from Temptale technology (DLA, 2007a). This example report displays temperature vs. time since the device was initialized, providing valuable verifiable information.

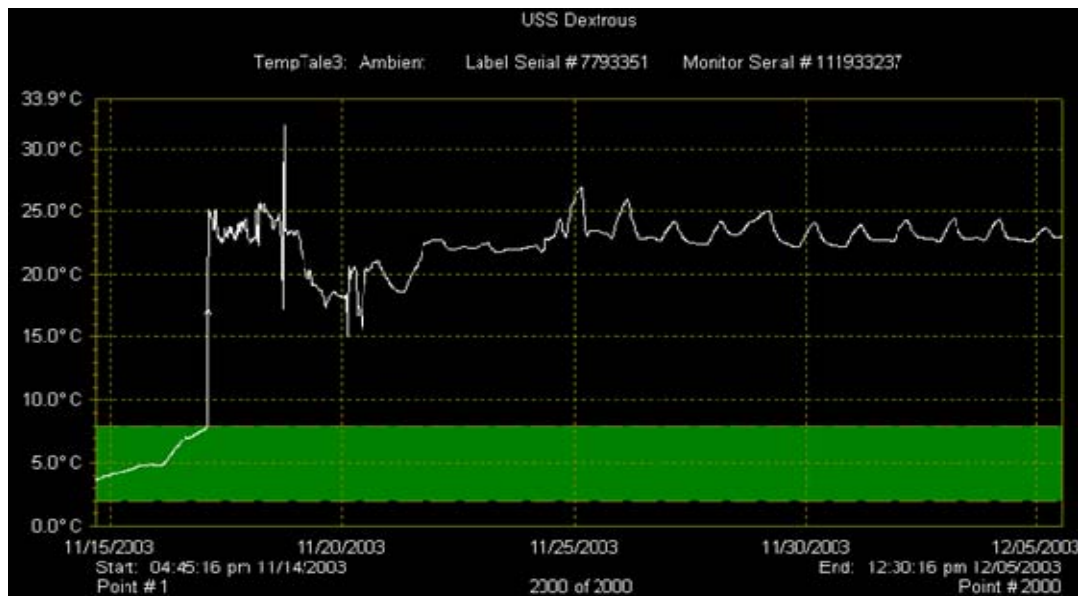


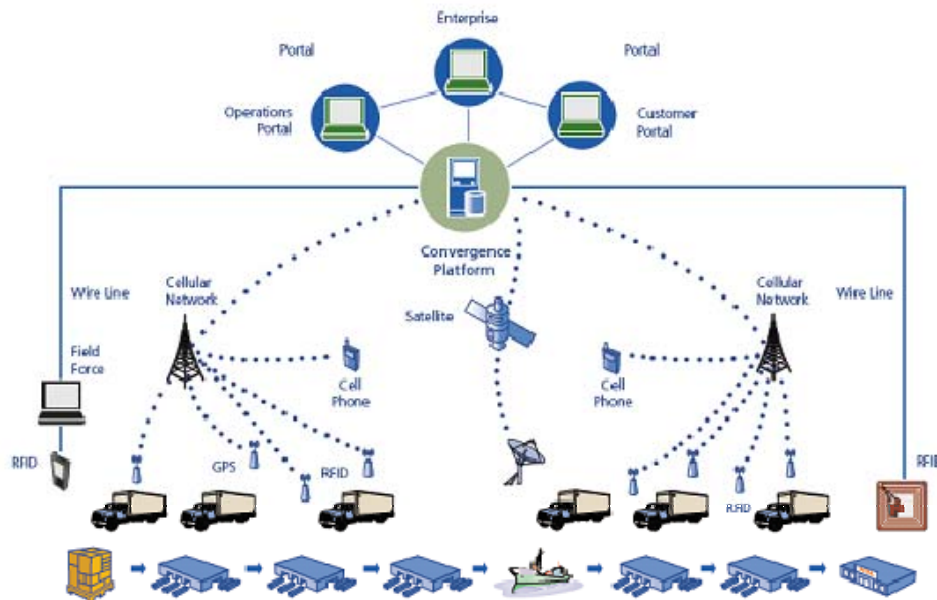
Figure 6. Temptale Temperature Monitor Readout

(From DLA, 2007a)

E. COLD-CHAIN TECHNOLOGY ADVANCES

Cold-chain management can vary greatly in level of complexity. Sensorlogic, Inc., provides an example below of a completely integrated and highly sophisticated cold chain. Such a system allows for product visibility throughout the cold chain by monitoring with radio frequency identification (RFID) and global positioning satellites (GPS), interconnected through a common computer network. All stakeholders have access to exact real-time temperature and location information on demand (Deloitte, 2007).

Figure 3: Example of Intelligent Cold Chain Technology Architecture



Source: Sensorlogic, Inc.

Figure 7. Example of an Intelligent Cold-Chain
(From Deloitte, 2007)

Technological advances in cold-chain management are not limited to tracking and computer systems. Several companies have made great leaps in the transport and storage arena. One such example is from Carrier Transport, Refrigeration Container, & Power Generation division. Carrier has developed the LINE product family. Its most advanced system provides for full atmospheric control, integrated RFID, GPS, and satellite communication, and multiple safety and security sensors (Carrier, 2007). A system such as this is known as an active system due to its use of refrigerants and power sources.

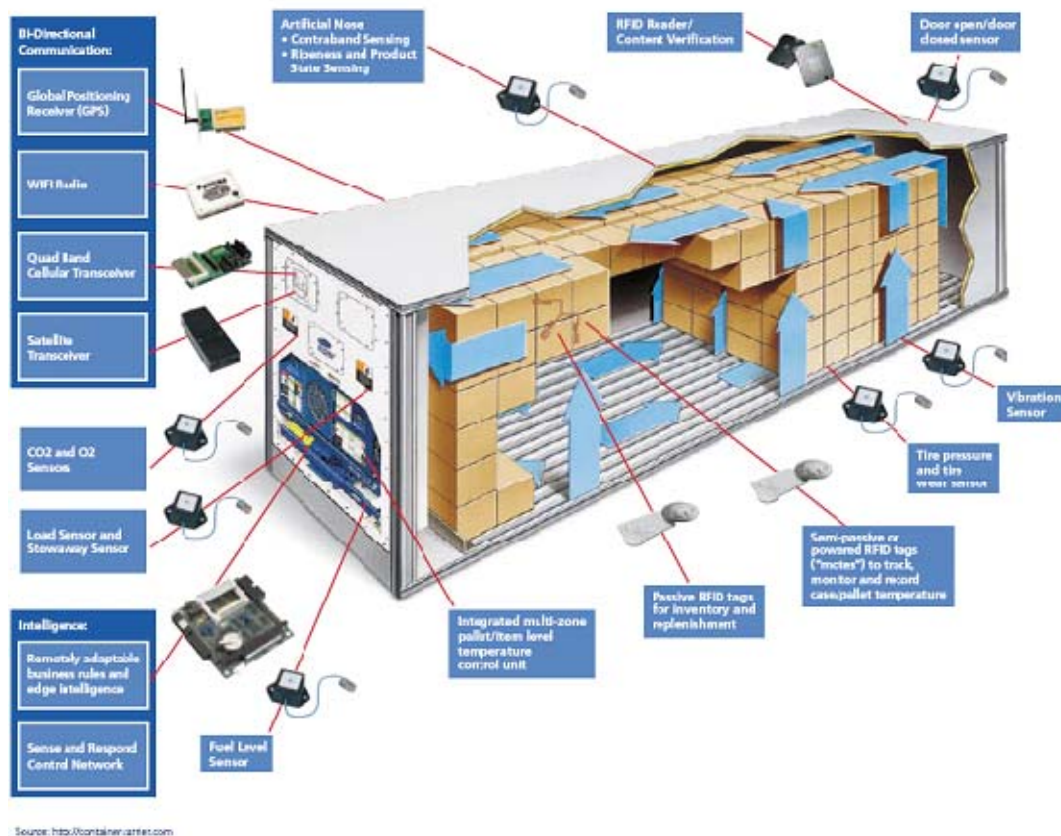


Figure 8. Carrier's Advanced Cold-Chain
(From Carrier, 2007)

F. CHAPTER SUMMARY

This chapter introduced the management of products requiring refrigeration during transportation and distribution. Also discussed was the evolving concept of cold-chain management—with particular emphasis on maintaining required temperature and validation. The commercial technology discussed in this section is highly advanced; however, it requires a large infrastructure investment which can be cost prohibitive. None of these technologies have been through the military acquisition process or have been validated for shipping aboard military transport (Dallas, personal communication, May 24, 2007). Finally, this chapter investigated some of the available technology for accomplishing temperature control and validation.

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III. EXISTING POLICIES

A. CHAPTER OVERVIEW

This chapter focuses on policies that have been implemented by the federal government to prepare our nation to fight an influenza pandemic. This chapter will also discuss in detail how these policies affect and mandate DoD pandemic influenza planning, while paying specific attention to the mandate of a transportation/distribution plan of vaccines and antivirals.

B. NATIONAL STRATEGY FOR PANDEMIC INFLUENZA

On November 1, 2005, President George W. Bush approved the *National Strategy for Pandemic Influenza* with the following statement:

Once again, nature has presented us with a daunting challenge: the possibility of an influenza pandemic. A new strain of influenza virus has been found in birds in Asia, and has shown that it can infect humans. If this virus undergoes further change, it could very well result in the next human pandemic. We have an opportunity to prepare ourselves, our Nation, and our world to fight this potentially devastating outbreak of infectious disease. The *National Strategy for Pandemic Influenza* presents our approach to address the threat of pandemic influenza, whether it results from the strain currently in birds in Asia or another influenza virus. The *Strategy* outlines how we intend to prepare for, detect, and respond to a pandemic. It also outlines the important roles to be played not only by our federal government, but also by the state and local governments, private industry, our international partners, and most importantly individual citizens, including you and your families. While your government will do much to prepare for a pandemic, individual action and individual responsibility are necessary for the success of any measures. Not only should you take action to protect yourself and your families, you should also take action to prevent the spread of influenza if your or anyone in your family becomes ill. Together we will confront this emerging threat and together, as Americans, we will be prepared to protect our families, our communities, this great Nation, and our world. (Homeland Security Council, 2005, p. i)

These strong words shared by the President obviously make a pandemic a unique circumstance—necessitating a strategy that extends well beyond health and medical boundaries, to include the sustainment of critical infrastructure, private-sector activities, the movement of goods and services across the nation and the globe, and economic and security considerations.

The *National Strategy for Pandemic Influenza* guides the nation’s preparedness and response to an influenza pandemic, with the intent of:

1. Stopping, slowing or otherwise limiting the spread of a pandemic to the United States.
2. Limiting the domestic spread of a pandemic, and mitigating disease, suffering and death.
3. Sustaining infrastructure and mitigating impact to the economy and the functioning of society. (Homeland Security Council, 2005, p. 2)

With the intent of a broad strategy, the *National Strategy for Pandemic Influenza* relies on three fundamental pillars to accomplish this intent.

1. Pillars of the National Strategy

The pillars of the *National Strategy* are detailed in the sections below:

- Preparedness and Communication: Activities that should be undertaken before a pandemic to ensure preparedness and the communication of roles and responsibilities to all levels of government, segments of society and individuals.
- Surveillance and Detection: Domestic and international systems that provide continuous “situational awareness,” to ensure the earliest warning possible to protect the population.
- Response and Containment: Actions to limit the spread of the outbreak and to mitigate the health, social and economic impact of a pandemic. (Homeland Security Council, 2005, p. 3)

a. *Pillar One: Preparedness and Communication*

Preparedness is the underpinning of the entire spectrum of activities, including surveillance, detection, containment and response efforts. The purpose of this pillar is to ensure support of pandemic planning efforts, and to clearly communicate expectations to individuals, communities and governments (whether overseas or in the United States), recognizing that all share the responsibility to limit the spread of infection and, thus, protect populations beyond their borders (Homeland Security Council, 2005, p. 4). The following fundamental concepts construct Pillar One:

1. Planning for a Pandemic
2. Communicating Expectations and Responsibilities
3. Producing and Stockpiling Vaccines, Antivirals, and Medical Material
4. Establishing Distribution Plans for Vaccines and Antivirals
5. Advanced Scientific Knowledge and Accelerating Development (Homeland Security Council, 2005, pp. 4-6)

b. *Pillar Two: Surveillance and Detection*

Early warning of a pandemic and the ability to closely track the spread of avian influenza outbreaks is critical to ensure rapid employment of resources to contain the spread of the virus. An effective surveillance and detection system will save lives by allowing the US to activate response plans before the arrival of a pandemic virus to the US, to activate additional surveillance systems, and to initiate vaccine production and administration (Homeland Security Council, 2005, p. 7). The following fundamental concepts construct Pillar Two:

1. Ensuring Rapid Reporting of Outbreaks
2. Using Surveillance to Limit Spread (Homeland Security Council, 2005, p. 7)

c. Pillar Three: Response and Containment

The US recognizes that a virus with pandemic potential anywhere represents a risk to populations everywhere. Once health authorities have signaled that sustained and efficient human-to-human spread of the virus has occurred, a cascade of response mechanisms will be initiated from the site of the documented transmission to locations around the globe (Homeland Security Council, 2005, p. 8). The following fundamental concepts construct Pillar Three:

1. Containing Outbreaks
2. Leveraging National Medical and Public Health Surge Capacity
3. Sustaining Infrastructure, Essential Services and the Economy
4. Ensuring Effective Risk Communication (Homeland Security Council, 2005, pp. 8-9)

2. Implications of the Pillars

The pillars of this strategy only reflect the federal government's approach to the pandemic threat. While the *Strategy* provides tactical direction for the departments and agencies of the US government, it does not attempt to catalogue and assign all federal responsibilities. Of particular interest to our project is the Pillar One concept that expresses the need for establishing distribution plans for vaccines and antivirals. The Homeland Security Council (2005) specifically addresses that it is essential for the US to prioritize the allocation of countermeasures (vaccines and antivirals) that are in limited supply and to define effective distribution procedures during a pandemic (p. 5).

C. NATIONAL STRATEGY FOR PANDEMIC INFLUENZA IMPLEMENTATION PLAN

In May 2006, President George W. Bush signed the *National Strategy for Pandemic Influenza Implementation Plan* with the following personal remarks:

On November 1, 2005, I announced the *National Strategy for Pandemic Influenza*, a comprehensive approach to addressing the threat of pandemic influenza. Our strategy outlines how we are preparing for, and how we will detect and respond to, a potential pandemic. Building upon these efforts, the *Implementation Plan (Guide) for the National Strategy for Pandemic Influenza* ensures that our efforts and resources will be brought to bear in a coordinated manner against this threat. The plan describes more than 300 critical actions, many of which have already been initiated, to address the threat of pandemic influenza. Our efforts require the participation of, and coordination by, all levels of government and segments of society. State and local governments must be prepared, and my Administration will work with them to provide the necessary guidance in order to best protect their citizens. No less important will be the actions of individual citizens, whose participation is necessary to the success of these efforts. Our Nation will face this global threat united in purpose and united in action in order to best protect our families, our communities, our Nation, and our world from the threat of pandemic influenza. (Homeland Security Council, 2006, p. i)

It is evident that the presence of a strategy does not ensure success, particularly since *Strategy* must be translated into tangible actions that fully engage the breadth of the federal government. The implementation plan provides a common frame of reference for understanding the pandemic threat and summarizes key planning considerations for all partners. It also requires that federal departments and agencies take specific, coordinated steps to achieve the goals of the *Strategy* and outlines expectations of stakeholders in the US and abroad.

1. Implementation Plan Structure

The implementation guide for the *National Strategy for Pandemic Influenza* further clarifies the roles and responsibilities of governmental and non-governmental entities—including federal, state, local, and tribal authorities and regional, national, and international stakeholders—and provides preparedness guidance for all segments of society. The plan addresses the following topics:

- Chapters 2 and 3 (US Government Planning and Response)
- Chapters 4 and 5 (International Efforts and Transportation and Borders)
- Chapter 6 (Protecting Human Health)

- Chapter 7 (Protecting Animal Health)
- Chapter 8 (Law Enforcement, Public Safety, and Security)
- Chapter 9 (Institutional Considerations)

The implementation plan represents a comprehensive effort by the federal government to identify the critical steps that must be taken immediately and over the coming months and years to address the threat of an influenza pandemic. It assigns specific responsibilities to federal departments and agencies, and includes measures of progress and timelines for implementation to ensure that we meet our preparedness objectives (Homeland Security Council, 2006, pp. vii-viii).

2. DoD-specific Transportation Responsibilities

The first priority of DoD support, in the event of a pandemic, will be to provide sufficient personnel, equipment, facilities, materials, and pharmaceuticals to care for DoD military and civilian personnel, dependents, and beneficiaries to protect and preserve the operational effectiveness of our forces throughout the globe (Homeland Security Council, 2006, p. 52). Specifically, from Chapter Six of the national implementation guide the DoD has mandated the following transportation responsibilities:

1. Pillar One: Preparedness and Communication (6.1.6.3):
DoD, as part of its departmental implementation plan, shall conduct a medical requirements gap analysis and procure necessary material to enhance military health system sure capacity within 18 months. Measure of performance: gap analysis completed and necessary material procured. (Homeland Security Council, 2006, p. 119)
2. Pillar One: Preparedness and Communication (6.1.7.4):
DoD shall establish stockpiles of vaccine against H5N1 and other influenza subtypes determined to represent a pandemic threat adequate to immunize approximately 1.35 million persons for military use within 18 months of availability. Measure of performance: sufficient vaccine against each influenza virus determined to represent a pandemic threat in DoD stockpile to vaccinate 1.35 million persons. (Homeland Security Council, 2006, p. 120)
3. Pillar One: Preparedness and Communication (6.1.13.4):
DoD, in coordination with Health and Human Services and Veterans Affairs, and in collaboration with state, local and tribal governments and private sector partners, shall assist in the development of distribution plans for medical

countermeasure stockpiles to ensure that delivery and distribution algorithms have been planned. Measure of performance: distribution plans developed. (Homeland Security Council, 2006, p. 122)

4. Pillar One: Preparedness and Communication (6.1.13.8):
DoD shall supply military units and posts, installations, bases, and stations with vaccine and antiviral medications according to the schedule of priorities listed in the DoD pandemic influenza policy and planning guidance, within 18 months. Measure of performance: vaccine and antiviral medications procured; DoD policy guidance developed on the use and release of vaccine and antiviral medications; and worldwide distribution drill completed. (Homeland Security Council, 2006, p. 123)

Given the highly distributed nature of a pandemic, the need to deliver vaccines and antivirals quickly presents significant logistical challenges, many of which may be unresolved. It is necessary to develop and exercise pandemic influenza countermeasure distribution plans in each of the states and territories, as well as to construct public-private partnerships to ensure the seamless, efficient, and timely distribution of these countermeasures (Homeland Security Council, 2006, p. 107).

3. Summary

Managing transportation and distribution decisions in a pandemic will require extraordinary cooperation between the varied and diverse organizations of each sector. In many cases, decision-makers will be simultaneously managing complex and competing interests. State and local governments, for example, acting within their authorities, may impose restrictions or closures of transportation systems without consulting or coordinating with federal entities; this clearly would have considerable impact on efforts to move critical pharmaceuticals or essential supplies. It is, therefore, evident that the DoD must enact a specific pandemic influenza response plan to ensure successful countermeasure transport in the event of an influenza pandemic.

D. DEPARTMENT OF DEFENSE IMPLEMENTATION PLAN FOR PANDEMIC INFLUENZA

The *Implementation Guide for the National Strategy for Pandemic Influenza* provides guidance for federal departments and agencies to implement preparedness and response tasks for a pandemic influenza outbreak. In response, the *Department of Defense Implementation Plan for Pandemic Influenza* was issued in August of 2006, to provide planning and implementation guidance to the Office of the Secretary of Defense, COCOMs, Military Departments, and DoD agencies. In the document's conclusion, the Assistant Secretary of Defense for Homeland Defense states, "It is imperative that DoD develop policies and plans that provide for an active, layered defense and coordinate with our federal partners to ensure that governments at all levels domestically and abroad are prepared to face a pandemic threat" (DoD, 2006a, p. 18).

The Secretary of Defense's principle responsibility in responding to a pandemic is to protect US interests at home and abroad. This DoD-specific *Implementation Plan* sets forth DoD guidance and addresses key policy issues for pandemic influenza planning. This guidance will enable the Combatant Commander, Military Services, and DoD agencies to develop plans to prepare for, detect, respond to, and contain the effects of a pandemic on military forces, DoD civilians, DoD contractors, dependents, and beneficiaries (DoD, 2006a, p. 3).

1. DoD-specific Transportation Responsibilities

Annex (A) of the *Department of Defense Implementation Plan for Pandemic Influenza* lists all National plan action numbers assigned to the DoD in the National implementation guide. There are 114 total tasks, 31 of which are to be primarily enacted by the DoD. Of the four specific transportation tasks the DoD was tasked with in the National implementation plan, the DoD was mandated as the lead agency on the following three: (1) 6.1.6.3; (2) 6.1.7.4; and (3) 6.1.13.8, and was assigned as a support agency on 6.1.13.4. Annex (A) also delineates the Office of Primary Responsibility (OPR) for various activities. OPRs will coordinate all actions with all appropriate offices

within the Office of the Secretary of Defense, the Joint Staff, COCOM, Military Services, and DoD agencies. Specifically, the following transportation action plan numbers were assigned to the following OPRs:

1. 6.1.6.3: Office of the Assistant Secretary of Defense for Homeland Defense
2. 6.1.7.4: Office of the Assistant Secretary of Defense for Health Affairs
3. 6.1.13.8: Office of the Assistant Secretary of Defense for Health Affairs
4. 6.1.13.4: Office of the Assistant Secretary of Defense for Health Affairs (Department of Defense, 2006)

2. Summary

The four specific transportation tasks passed to the DoD are currently in the planning process. After extensive research, including numerous phone conversations with the applicable Offices of the Assistant Secretaries of Defense, we concluded that these offices are currently in the planning process, but nothing has been officially promulgated in writing.

E. COMBATANT COMMANDER'S ROLE

Though the *Department of Defense Implementation Plan for Pandemic Influenza* was originated from the Office of the Secretary of Defense, it is merely a policy tool that is intended to guide the planning process for the Joint Staff and, ultimately, each COCOM (DoD, 2006a). As operational commanders, the DoD's COCOMs are an essential part of the Department's pandemic influenza planning. There are currently nine COCOMs—five with geographic responsibilities and four with functional responsibilities. To ensure proper pandemic planning, it is paramount that COCOMs have lines of communication that stretch well beyond operational responsibilities. In a recent Government Accountability Office (GAO) report, numerous challenges were identified that hindered the planning and preparedness efforts of COCOMs (GAO, 2007). Specifically germane to our project, the GAO found that limited detailed guidance from

other federal agencies on the support expected from the DoD, lack of control over the DoD's stockpile of antivirals, and reliance on military services for medical material caused some of the biggest planning obstacles (GAO, 2007, p. 8).

Planning officials from three COCOMs and two service subcomponents recently stated, "Planning to provide support at the last minute could lead to a less effective and less efficient use of resources" (GAO, 2007, p. 8). Though it is difficult to plan for an influenza pandemic and to mitigate the effects of factors that are beyond their control, the COCOMs' ability to protect their personnel and perform their missions during an influenza pandemic may be at risk. The GAO gives the following example: if a nation decides to close its borders at the start of a pandemic, the COCOMs and the installations for which they are responsible may not be able to obtain needed supplies, such as vaccines and antivirals (GAO, 2007, p. 8).

1. Transportation/Distribution Issues

Planning officials from eight of the nine COCOMs expressed concern that their headquarters are tenants of military services' installations and, therefore, are reliant on the military services to distribute medical material and other supplies (GAO, 2007, p. 36). This factor has hindered the COCOMs' ability to fully address how their headquarters will receive medical material and other supplies during an influenza pandemic. Medical and planning officials on two COCOMs' staffs expressed concern with the variance among the military services' health-related policies and priorities. For example, each military service has a different doctrine or policy on pandemic influenza-related health issues, such as the distribution of vaccines, antivirals, and other drugs (GAO, 2007, p. 36). Although guidance from the Assistant Secretary of Defense for Health Affairs (ASD HA) is the same for all of the military services, it is applied differently among each service. In itself, this may be appropriate. However, certain differences in application of the guidance could have adverse consequences. For example, medical and planning officials from four of the COCOMs' staffs noted that the military services would determine how vaccines and antivirals would be used because these supplies would be provided through the military services (GAO, 2007, p. 36). This variance in policy

implementation could lead to different preparedness levels and could limit the operational control that COCOMs would have during a pandemic, which would directly impair their ability to carry out their missions.

F. CHAPTER SUMMARY

This chapter explored the evolutionary process of why and how a National Pandemic Influenza (PI) Strategy was formed. The chapter specifically traced the DoD's fundamental need and requirement of a PI distribution strategy, gave a glimpse into the planning of that distribution strategy, as well as identified the stakeholders in the DoD's policy. Finally, it highlighted the fundamental communication and execution discrepancies that exist between policy (Office of the Secretary of Defense) and planning (COCOMs).

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IV. DISTRIBUTION MODEL

A. CHAPTER OVERVIEW

The purpose of this chapter is to provide a pre-pandemic influenza vaccine distribution model. The goal of the model is to provide a framework for joint asset utilization, cold-chain management, and decision-making in regard to logistics. Also included in this chapter is a discussion as to the execution of this model.

This chapter will use the Pacific Command (PACOM) regions of Japan and South Korea, shown in the following map (Figure 9), as the example area of responsibility (AOR) for application of this model. PACOM has been selected due to the current level of reported H5N1 cases; the highest concentration and number of human avian influenza cases has been reported in Southeast Asia (WHO, 2007, July 27). This discussion has been further limited to the countries of Japan and South Korea because of the high concentration of US military forces in those locations; a focus on these locations also serves to limit the scope of this study in order to provide a reasonable illustration within the time and resources available for us. The final assumption of this model is that operational assets will be utilized in such a manner as to provide joint logistics and transportation throughout the AOR.



Figure 9. Example AOR

(After Constructed using Google Earth)

B. STOCKPILE TO AOR TRANSPORTATION

The first decision to be considered here is the means of shipment of vaccine to the AOR. Currently, the DoD's preferred method of shipment for medical supplies, including cold-chain items, is via contracted commercial vendors such as FedEx (Battaglia,² personal communication, August 2, 2007). These carriers provide the rapid transportation times needed for passive cold-chain containers. This shipping preference is further cemented in the Under Secretary for Defense for Personnel and Readiness [USD (P&R)] *Policy for the Release of Tamiflu Antiviral Stockpile during an Influenza Pandemic* (2006):

² Peter Battaglia is the Medical Material Executive Agent Troop Support Planner for Defense Supply Center Philadelphia.

Upon ASD (HA) approval, DSCP will implement Tamiflu shipment in support of mission-critical priorities in coordination with U.S. Transportation Command (TRANSCOM), with the goal of global delivery within 48 hours. Should the usual modes of DSCP logistics support be inadequate, TRANSCOM will be tasked with delivery of CONUS DSCP storage depots to designated CONUS locations, while Geographical COCOMs may be similarly tasked for delivery within their respective areas of responsibility (p. 2).

While the USD (P&R) clearly states that normal modes of DSCP logistics support are the preference for distribution, this is contrary to the *DoD Implementation Plan*. The following planning assumption is stated in the *DoD Implementation Plan*: “Civilian commercial air carriers will be impacted seriously and cannot be relied upon to provide support to DoD. The civil reserve air fleet (CRAF) will not be activated by DoD” (2006a, p. 62). However, the commercial vendors that participate in CRAF are essential to the first step in a successful distribution of vaccines. The mission of CRAF is to support DoD airlift requirements in emergencies when the need for airlift exceeds the capability of military aircraft (US Congressional Research Service, 2006, p. 4). Due to current DLA practice, cold-chain medical supply distribution is not a mission military assets are routinely used to completing (Battaglia, personal communication, August 2, 2007). By not utilizing commercial carriers in a pandemic situation, the DoD could greatly impact its ability to provide essential and timely support to troops worldwide. The CRAF mission, coupled with current practices and areas of expertise, makes commercial carriers the transportation means recommended for the Continental United States (CONUS) stockpile to AOR in this distribution model. Use of commercial carriers can be accomplished through current contract agreements or through the activation of CRAF.

C. AOR DISTRIBUTION HUB SELECTION

With the selection of a CONUS-to-AOR transportation means, an AOR entry point/distribution hub must be chosen. Decision-makers must take several factors into consideration when selecting this location. According to Applebaum, both the product requirements, such as storage and handling, and area requirements, such as distribution channels and infrastructure, must be evaluated (2007, p. 57). The following key

parameters have been selected for evaluation for this model: military airfield availability, cold-chain training level, cold-chain repacking supplies availability, cargo aircraft assignment, and helicopter availability.

Military airfield availability. According to the Under Secretary of State for Democracy and Global Affairs, Paula J. Dobriansky, a worst-case scenario of pandemic influenza could bring international trade to a standstill and create great social and political instability (2006). Such a scenario could greatly inhibit the ability of the United States government to support military personnel stationed overseas. To minimize the possible effects of foreign government infrastructure on this distribution model, only military airfields would be considered as points of entry to the AOR. It is assumed these airfields would be capable of receiving commercial aircraft and handling their cargo.

Cold-chain Infrastructure Aspects. Once the pre-pandemic vaccine has arrived at the AOR distribution hub, bulk breaking and proper cold repacking would be required. Proper interim active storage and subsequent repacking is essential in maintaining the integrity of the cold chain and the effectiveness of the vaccine. According to Mike Minto³ and Dana Dallas, the current cold-chain packing regulation, *DLAR 4145.21*, is outdated and does not ensure proper cold-chain controls (Minto, personal communication, July 19, 2007). A revision of *DLAR 4145.21* is being routed for approval. In the interim, selected locations have been trained based on the new draft regulation. Communication with the DLA by the COCOM staff is essential in identifying these properly trained locations in the AOR of concern. For this example, the AOR asset matrix below is annotated with the properly cold-chain trained and supplied locations available today.

Military Airlift Availability (Cargo Aircraft/Helo). The same resultant instabilities that necessitate the exclusive use of military airfields also impact the ability to distribute vaccine out of the distribution hub. Secure and dependable transportation methods must be selected to move vaccine farther into the AOR. The most controllable and dependable large-scale transportation method for this model is military airlift. Airlift

³ Mike Minto is the Supervisor Supply Management Spec. Accountability Support, DDC-J3/J4-TPP.

is required both to travel the distances involved in a large AOR, as well as to minimize transportation time to ensure the passive cold-chain containers in use are able to maintain proper environmental controls for their vaccine cargo. Exclusive use of military airlift in the AOR reduces the impact of foreign government, public, and infrastructure instabilities that may be present during a pandemic.

Installation	Air Field	Cold-chain Trained	Cold-chain Supplies	Cargo Aircraft	Helos
Japan					
Misawa Air Base (AB)	X				
Atsugi Naval Air Facility	X			X (C-2 deploy)	X
Yokosuka/Yokota AB	X	X	X	X (C-130, C-21)	X
Iwakuni Marine Corp Air Station	X			X	X
Sasebo Naval Base		X	X		
Okinawa					
Kadena AB	X	X		X	X
Korea					
United States Army Garrison (USAG) Red Cloud					
USAG Yongsan					
USAG Humphreys	X				X
USAG Daegu	X	X	X		X
Osan AB	X			X(C-12)	
Kunsan AB	X				

Table 1. AOR Asset Matrix⁴

Based on the criteria summarized in the AOR asset matrix, Yokosuka/Yokota AB is the recommended AOR distribution hub location for PACOM. This location maintains the necessary infrastructure, transportation, and cold-chain needs for vaccine distribution. Yokota AB is also desirable for this role as it includes the only airlift wing in PACOM (DoD, 2007c).

⁴ AOR Asset Matrix is populated using publicly available data regarding PACOM installations in South Korea, Japan, and Okinawa. The following websites are used: <http://www.usfk.mil/USFK/index.html>, <http://www.usfj.mil/>, <http://www.pacom.mil/>, <http://www.pacaf.af.mil/>. August, 2007. Cold-chain training level and supplies availability are sourced to Dana Dallas via personal communication.

D. INTRA-AOR DISTRIBUTION

As noted above, regional stability and infrastructure concerns heavily dictate the transportation methods selected for use within the AOR. Further limitations arise from geographical concerns. PACOM presents unique geographical limitations based on the number of islands, rugged topography, and limited road access of some areas. While some of these limitations apply specifically to PACOM, similar concerns arise in other AORs. These common constraints dictate the universal need for selecting airlift as the Intra-AOR transportation mode.

Intra-AOR airlift distribution can be broken into two major categories based on the type of aircraft needed to support the mission requirements: fixed-wing cargo planes for long-range or high-population support, or rotary-wing helicopters for short-range support. For this model, the aircraft considered for use would be limited to the C-130 and H-60. C-130 planning assumptions⁵ are as follows (US Air Force, 2007):

- Range: 1,000 nautical miles
- Normal Payload: 34,000 pounds
- Speed: 300 knots.

H-60 planning assumptions⁶ are as follows (US Navy, 2007):

- Range: 380 nautical miles
- Normal Payload: 2,600 pounds
- Speed: 180 knots.

Due to airfield availability, geography, and security considerations, several installations would necessitate C-130 support from Yokota AB. These bases include

⁵ Planning assumptions are derived from the most limiting of each factor for the various models of C-130 in service.

⁶ Planning assumptions are derived from Navy Fact file for H-60.

Misawa, Iwakuni, Kadena, and Osan. While the decision to use C-130 support is dictated by distance, the C-130 also maximizes the amount of vaccine transported while minimizing transit time.

Iwakuni would provide follow-on support to Sasebo Naval Base with organic helicopter assets. Sasebo Naval Base presents a challenge common among many DoD locations: no airfield exists onboard the installation. This lack of airfield mandates the use of helicopter support. While use of existing helipads or designated landing areas is desirable, there are several large parking lots and rooftops that could possibly facilitate a helicopter landing; however, an exact landing site would have to be evaluated and selected by a properly trained flight crew.

Osan is selected as the Korean distribution hub based on its central location. In addition, with the 731st Air Mobility Squadron located at this location, Osan is already established for regional logistics support (DoD, 2007b). If further cold-chain support is needed at this location, this can be provided by the 16th Medical Logistics Battalion located at Camp Carroll, Republic of Korea (DoD, 2007a). Airlift capability within Korea can be provided by numerous commands currently utilizing variants of the H-60 helicopter as directed by United States Forces Korea. All current military locations in Korea are within the 380-mile range of the H-60. Area commanders should continue the use of H-60s to distribute to the numerous outlying commands and posts.

The resultant PACOM distribution network for Korea and Japan is shown graphically below. The yellow arrows denote C-130 routes from Yokota Air Base. The red arrows denote H-60 helicopter routes from Iwakuni Marine Corps Air Station and Osan Air Base.



Figure 10. PACOM Distribution Network

E. EXECUTION

With the cold supply chain presented above, focus must now shift to the anticipated execution of this plan. Several key factors necessary for the success of this plan exist: communication, transportation time, and storage. Each of these is discussed here. Also, a template for execution of this plan is provided below.

Communication. From the initial command to execute this plan, communication is of foremost concern. In order to ensure the proper number of vaccine doses are secured and delivered, commands must expeditiously and accurately report the current number of personnel assigned to their command. This should be accomplished through normal reporting channels within the chain of command, culminating at the COCOM. The COCOM would then report these aggregate results to the DLA in order to secure the

proper amount of vaccine. Also, the COCOM would deliver results to the COCOM distribution hub. The information provided to the distribution hub should not be aggregated in order to better facilitate accurate repacking upon receipt of vaccine.

Transportation time. Rapid transportation time is essential when passive containers are being moved between active storage locations. Transit time between active storage locations cannot exceed the validated container time. This is especially of concern in intra-AOR distribution. Once repack is complete at the COCOM distribution hub, the journey to the in-theatre end-user begins. This transit needs to occur as rapidly as possible as there are no in-transit storage locations designed into this model. By utilizing air travel, this concern is mitigated, but container time will still need to be monitored until the doses are administered or transferred to another form of refrigeration on site.

Storage. While a vaccine is in transit within theatre, active storage locations would not be utilized; however, end-user storage capacity must be evaluated. End-user active storage capacity must be sufficient to provide for all expected vaccine doses. Along with capacity, active storage units must be able to adequately provide the required temperature range for pandemic influenza vaccine. These two criteria of capacity and capability can and should be evaluated ahead of time by end-user commands and be reported to COCOM. By accomplishing this evaluation early, commanders can alleviate one possible problem before this model must be executed. If active storage capacity and/or capability are found to be insufficient, better-suited refrigerators shall be secured through normal procurement channels. The successful completion of this procurement shall be reported to COCOM.

DLA		COCOM		Regional Commands
Secure shipper via USTRANSCOM.				Verify vaccine needed.
		Verify vaccine needed.		Communicate vaccine and supply needs to COCOM.
				Determine aircraft and sortie count needed at regional hub.
		Verify needed/available cold-chain supplies at repack/distro hub.		
Secure vaccine and needed supplies.		Communicate vaccine and supply needs to the DLA.		
		Determine aircraft and sortie count needed at hub.		
		Secure needed aircraft and aircrew.		
		Pre-stage vaccine repack supplies.		
		Vaccine arrives at hub.		
Ship vaccine/supplies to COCOM distro hub.				
		Store and repack. Ensure repacked per destination and quantity needed.		Vaccine arrives at regional hub.
Verify arrival at hub, including verification of TT4 device.		Ship to regional commands.		Store in refers/ refrigerators. Verify TT4 temps. Report temp issues to COCOM/DLA.
Provide technical assistance to commands as needed.				Distribute to subordinate commands.

→ Denotes key steps in the **communication** process. Accurate and timely communication is essential to ensure the proper numbers of vaccines and cold supplies are secured for use in theatre.

→ Denotes key steps in the **transportation** process. Total time out of active storage facilities must be less than the validated passive container time to prevent loss of vaccine.

Table 2. Execution Sequence

F. CHAPTER SUMMARY

This chapter provides a decision-making model for designing a vaccine cold-supply chain into a military AOR. This model considers airfield availability, cold-chain infrastructure, and military airlift capability—essential elements for executing a timely vaccine distribution network within foreign territories. Also discussed in this chapter is a general template for execution of this model—including key factors of success.

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V. DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

A. MODEL APPLICATION AS A UNIVERSAL PLANNING TOOL

The AOR Asset Matrix discussed in Chapter IV provides a framework for evaluating the essential assets available within any given AOR, and is shown below in Table 3. This is the primary tool for selecting the AOR distribution hub. All AOR installations are listed in the first column, with subsequent columns used to annotate the availability of the assets identified in this study as essential to the successful distribution of pre-pandemic influenza vaccine.

Installation	Air Field	Cold-chain Trained	Cold-chain Supplies	Cargo Aircraft	Helos
A	X	X	X	X	X
B		X			
C			X		
D	X			X	X

Table 3. AOR Asset Matrix

Distribution hub selection is then based on the location with maximum asset availability. In the above scenario, the hub would be placed at Installation A. If none of the installations evaluated meet the criteria for hub selection, the grouping size should be increased until an adequate hub can be found. Once the hub is selected, follow-on transportation methods must be decided. The transportation method decision should be based on the distance of installations from the distribution hub. If the follow-on installations are within the range of available helicopter assets, this should be the preferred method. If the follow-on installations are not within available helicopter capabilities, fixed-wing cargo aircraft should be used for transportation. Fixed-wing aircraft require the use of adequate airfield facilities. If such facilities are not available, contingency operations such as multiple-leg helicopter routes must be evaluated for use.

A final key consideration that must be addressed when applying this model is how to group installations. The first natural grouping in joint military operations is at the

COCOM level. This grouping divides the operational assets among the highest level operational commanders. Within COCOMs, the next logical split is among geographical commanders. For example, within PACOM, joint commands such as Joint Forces Korea and Joint Forces Japan provide a logical next division. Further grouping and division should be accomplished as each unique AOR demands. Factors such as personnel density, geography, and infrastructure for administering the vaccine must be considered by regional-level planners. Finally, COCOMs must ensure that an adequate number of distribution hubs are selected so as not to over-extend the capabilities of any one hub, and, thereby, break down the entire system.

B. CONCLUSIONS

An influenza pandemic could impair the military's readiness, jeopardize ongoing military operations abroad, and threaten the day-to-day functioning of the DoD due to a large percentage of sick or absent personnel. Our study found the following conclusions:

- The DoD is heavily dependent upon commercial vendors to provide the distribution of cold-chain assets.
- The DoD does not currently have the organic capability to provide a viable cold-chain distribution network.
- The DoD has been mandated by the *National Implementation Guide* to develop a distribution strategy. Our research shows there is currently no existing plan that encompasses the total distribution network from existing stockpile to distribution by the COCOM.
- There is a lack of communication and coordination across the DoD in the planning of the distribution strategy. The burden of the planning has been placed upon the COCOMs, with factors such as limited detailed guidance and reliance on military services for medical material hindering their planning efforts.

- Unity of effort does not yet exist. The many COCOMs' current distribution strategies for a pandemic influenza situation are not standardized and have not been practiced through practical application.

C. RECOMMENDATIONS

Moving forward from this study, we recommend each COCOM rapidly develop a distribution plan for pre-pandemic influenza vaccine. This study can be used as a driving template for all COCOMs, thus ensuring that all distribution plans are established using common criteria. Regardless of the planning tool used to design the distribution process, all COCOMs and stakeholders should use the same planning tool to ensure unity of effort. Furthermore, standardized cold-chain training developed by the DLA must be promulgated to all levels within the distribution network.

Once a distribution process is agreed upon and put in place, this process must be utilized. Like all large military operations, pandemic influenza prevention requires planning and practice are essential to success. It is naïve to believe that we, as a military force, can successfully vaccinate our personnel in a pandemic environment without first operationally testing and exercising the system. All COCOMs must develop and execute training exercises designed to test and evaluate the probable success of the vaccine cold chain put forth. Table-top exercises are not sufficient to test a system of this magnitude. Failure to properly verify the ability of this process to maintain cold-chain integrity could result in the loss of thousands of lives, and potentially threaten our national security.

D. RECOMMENDATIONS FOR FURTHER STUDY

Further study is needed to determine the need for security forces to protect and ensure the continuity of the distribution process. Along the same lines, further study is recommended to determine any effects of a pandemic situation on international relations and the subsequent effects on our ability to provide vaccine to military personnel in foreign countries. Also, a study of the potential for forward-deployment storage of pandemic vaccine would be beneficial. Finally, it is highly recommended that a study be

conducted to select the proper location and quantity of vaccination centers in order to efficiently and safely vaccinate patients, whether military or civilian.

APPENDIX

Shipping Specifications (DLA, 2007a):

Insulated Shipping Container Specifications:

<u>Model</u>	<u>Size</u>	<u>Cargo Space Dimensions</u>	<u>External Dimensions</u>
E-36-2	Small	10 3/4" L x 6 1/2" W x 4" H	15 1/2" L x 12" W x 14" H
E-65	Medium	12" L x 6 1/2" W x 6 1/2" H	18 1/2" L x 12 1/2" W x 17 1/2" H
E-186	Large	18" L x 14 1/2" W x 12" H	16 1/2" L x 12" W x 7" H
E-327	Extra Large	22 1/2" L x 19" W x 17 1/2" H	24" L x 24" W x 24" H

Polar Packs (Refrigerant):

<u>Size</u>	<u>Weight</u>	<u>Dimensions (in inches)</u>
Medium	24 oz	8 x 6 x 1 1/4"
Large	48 oz	10 1/4 x 8 x 1 1/2"

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