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Inventory management of pharmaceuticals in authorized medical dental allowance lists.

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THESIS

INVENTORY MANAGEMENT OF
PHARMACEUTICALS IN AUTHORIZED
MEDICAL/DENTAL ALLOWANCE LISTS

by

Elmer John A. Aguigam

December, 1991

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Pharmaceuticals stocked in Authorized Medical/Dental Allowance Lists (AMAL/ADAL) have an ongoing problem of expiration. Due to short shelf-life, Prepositioned War Reserve (PWR) pharmaceuticals inventory require constant monitoring to maintain medical support readiness. The problem associated with pharmaceuticals is the high cost of replacement and disposal. Numerous expired drugs were found in AMALs as a result of inaccurate inventory procedures. Current practices of the Medical Logistics Company were investigated and research was conducted for solutions on the pharmaceutical inventory problem. Cost-benefit studies for a stability program and a bar code system show potentially cost-effective measures to solve the shelf-life problem. The financial as well as the beneficial outcomes of increasing drug stability and implementing transactional

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inventory methods could help reduce the cost of shelf-life expiration.

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Inventory Management of Pharmaceuticals in Authorized Medical/Dental Allowance Lists

by

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ABSTRACT

Pharmaceuticals stocked in Authorized Medical/Dental Allowance Lists (AMAL/ADAL) have an ongoing problem of expiration. Due to short shelf-life, Prepositioned War Reserve (PWR) pharmaceuticals inventory require constant monitoring to maintain medical support readiness. The problem associated with pharmaceuticals is the high cost of replacement and disposal. Numerous expired drugs were found in AMALs as a result of inaccurate inventory procedures. Current practices of the Medical Logistics Company were investigated and research was conducted for solutions on the pharmaceutical inventory problem. Cost-benefit studies for a stability program and a bar code system show potentially cost-effective measures to solve the shelf-life problem. The financial as well as the beneficial outcomes of increasing drug stability and implementing transactional inventory methods could help reduce the cost of shelf-life expiration.

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GLOSSARY

Allowance. The quantity of equipment and supplies distributed throughout the MEF to provide a capability to perform the health care mission.

Authorized Medical Allowance List (AMAL). The authorized allowances of medical equipment and consumable supplies required to accomplish health care support under combat conditions.

AMAL Supply. The list of consumable supplies that are required to support a predetermined patient care load associated with a specific health care function i.e., sickcall, x-ray, operating room, etc.

D-Day Significant Drugs. Drugs carried by the Federal Medical Supply System that has been reviewed by a tri-service ad hoc committee of medical subject matter experts and reduced to those drugs and dosage levels which are considered essential for wartime casualty care. The drugs constitute the minimal requirements, adequate but austere, for the general medical and surgical care of casualties should D-day occur.

Defense Priorities and Allocation System (DPAS). A system of priorities and allocations with industry resources to assure the timely availability of supplies to meet current national defense requirements.

Medical Logistics Data (MLD). An accounting system for PWR medical and dental assets.

Module. The packaging of equipment or supplies which make an AMAL into a functional unit that is designed to establish a specific health care capability or to treat a predetermined number of patients.

Marine Corps Standard Supply System (M3S). A subsection of SASSY at the Medlog level that performs Class VIII ordering functions.

National Stock Numbers (NSN). Federal stock classification of materiel for stocking and requisitioning purposes.

Prepositioned War Reserve Stock (PWRS). That portion of the war reserve material requirement that approved plans state should be positioned or issued to the user prior to hostilities, at or near the point of planned use, to ensure timely support of a specific project or designated force during the initial phase of war, pending arrival of replenishment shipments.

Rotation. This involves the issuance of theater war reserve stock to peacetime operating medical treatment facilities (MTFs).

Shelf-life. The period of time beginning with the date of manufacture/cure/assembly and terminated by a date by which the item must be used or subjected to inspection/test/ restorative disposal action. For medical commodities, the term shelf-life refers only to expiration dated (potency) items.

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I. INTRODUCTION

A. BACKGROUND

The Medical Logistics Company (Medlog) maintains and manages the Authorized Medical/Dental Allowance List (AMAL/ADAL). The AMAL/ADAL lists the items needed to provide medical support for a Marine Expeditionary Force (MEF) for 60 days in the event of war. The AMAL[1] contains the pharmaceuticals required to treat a number of casualties or perform a specified number of treatment procedures. Since the AMAL is maintained ready for combat support, all pharmaceuticals allocated to the MEF are classified as prepositioned war reserved (PWR) material. The PWR pharmaceuticals are distributed within different AMALs (Appendices A and B).

The major problem with pharmaceuticals is expiration due to degradation in potency and sterility. Readiness requires stockage even though there is a recurring financial loss due to outdating. Loss also occurs because of deficient inventory controls and inadequate tracking and distribution methods. Further losses occur due to the lack of training for Medlog personnel. There is a high turnover of personnel because of

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[1]AMAL/ADAL will be referred to as AMAL for the purpose of brevity.

short tour rotation. Currently, the sole means by which Medlog can reduce financial loss is by requesting shelf-life extension from the Food and Drug Administration (FDA) via the Naval Medical Logistics Command (NAVMEDLOGCOM).

The shelf-life constraint of pharmaceuticals has seriously complicated combat medical logistics planning by increasing mobilization costs in an era of shrinking Department of Defense (DoD) budget. If DoD does not procure the required pharmaceuticals, combat readiness is reduced; on the other hand, if required levels are stock-piled, high dollar values of pharmaceuticals are disposed of each year as their shelf-life expires (Petroski, 1987).

B. STATEMENT OF THE PROBLEM

An analysis of the supply procedures, methods, and supporting documents of Medlog was conducted in January 1991 by the Field Supply and Maintenance Analysis Office Two at Marine Corps Base, Camp Pendleton. Similar analyses are conducted periodically to determine compliance with applicable regulations and to report readiness conditions. The analysis found that AMAL blocks were issued to Fleet Marine Force (FMF) units deployed to the Persian Gulf between August and November 1990 without conducting pre-deployment inventories. Asset Locator Reports (ALRs), which list AMAL block contents, were not provided due to the short-fused mobilization. FMF units were advised to contact Medlog if blocks contained expired

pharmaceuticals (USMC Field Supply Office Two, 1991). A review of the ALRs during the analysis revealed that many pharmaceuticals in the AMAL blocks had expired.

The report further indicated that 411 (91%) of 449 National Stock Numbers (NSN) in the Bulk Warehouse had discrepancies, such as excesses, shortages and inaccurate locations. An inventory review of 92 NSNs packed in AMAL blocks scheduled for deployment noted 55 (60%) disparities between quantities listed on ALRs and the warehouse locator cards within the containers. Two AMAL blocks were opened, which revealed two types of discrepancies: (1) on hand items were not in the ALR, and (2) the blocks contained expired items. In one block, 15 (28%) out of 53 items showed disparities. In the other block, disparities were noted in 15 (33%) of 46 items.

A review of the Medlog Database System revealed that stocks of 151 drugs had expired prior to July 1989, without documentation for FDA extension requests or FDA approved extensions. The total value of the expired pharmaceuticals was $587,656.97. Furthermore, there were no records to substantiate that annual inventories had been conducted in 1990, as required. It was noted in the analysis that adjustments were made to rectify discrepancies such as: inventory gain of $1,875,640; inventory loss of $145,355; administrative gain of $802,892; administrative loss of $57,355; and miscellaneous loss of $354,573. This indicates

that current files and records lack a viable inventory control program (USMC Field Supply Office Two, 1991.) Finally, proper storage procedures to protect against damage and deterioration of material were disregarded (USMC Field Supply Office Two, 1991). The report concluded:

> The current operating procedures within the unit's supply account reflect significant deficiencies. Of specific note were the findings in the areas of Inventory Control and Deployed Unit Support. It is of paramount importance for any supply operation to effectively control all assets assigned to their account and ensure timely identification, requisition and receipt of asset shortages. Failure to properly accomplish these primary supply functions obscures the asset picture and creates an atmosphere conducive to mismanagement and misappropriation. Further, the lack of effective supply procedures could have a devastating effect on the unit's ability to conduct its assigned mission.

C. OBJECTIVE OF THE RESEARCH

This research will analyze Medlog's inventory problems involving critical pharmaceuticals that are expensive, subject to deterioration, and require special storage. The research will focus on shelf-life and drug stability in planning and managing PWR pharmaceuticals. In addition, the thesis will analyze the cost of using a bar coding system to more accurately track expiration dates and location of pharmaceuticals in AMAL blocks.

Many techniques are used to compare alternative solutions. One of these is tradeoff analysis. Like any business entity, cost containment is a major objective. In a constrained resource environment, especially in a period of budget

reduction and increased oversight by both in-house and congressional agencies, the optimal allocation of funding resources is a major goal of Medlog. The results of this study will indicate the strengths and weaknesses of the current pharmaceutical inventory management policies and suggest future policy alternatives.

D. RESEARCH QUESTIONS

The primary question is "How can the inventory cost of PWR pharmaceuticals be minimized?"

Subsidiary questions are as follows:

1. What are the strengths and weaknesses of the current system?

2. What are alternative ways to effectively manage pharmaceuticals?

E. SCOPE

The thesis examines the problems in achieving inventory readiness for pharmaceuticals and analyzes alternative inventory management policies to resolve existing problems. It also examines shelf-life extension, drug stability, and inventory actions to better track expiration dates. All of the measures will help reduce disposal costs. Alternatives will be analyzed to optimize the distribution of pharmaceuticals, to increase accuracy of records, and eventually to minimize annual operating costs. The study is limited to

pharmaceuticals prepositioned with the Medlog. Specific methods to reduce inventory costs and to improve the efficiency of inventory management will be addressed.

F. ORGANIZATION OF THE THESIS

The remainder of the thesis is organized as follows: In Chapter II, background literature provides an overview of the role and operations of Medlog and the problems with pharmaceuticals. Chapter III investigates current programs to manage the shelf-life of pharmaceuticals and analyzes alternative actions. Chapter IV discusses the tradeoffs, cost-benefit and sensitivity analyses of alternative methods. The final chapter offers conclusions and recommendations for better managing pharmaceutical inventories in the FMF.

II. BACKGROUND OF PWR PHARMACEUTICALS

A. OVERVIEW

PWR pharmaceuticals are part of AMALs required to accomplish the war time health care mission from D-day to D+60. This means that each MEF will hold enough AMAL consumables, including deteriorative medicines, to support a MEF requirement of 60 days. D-day pharmaceuticals are designated by the military as critical during initial mobilization or deployment of Navy and Marine Corps forces. The quantities in the AMAL are set for the initial 60 days, before normal replenishment shipments arrive.

B. MEDICAL SUPPORT OF THE FMF

The AMAL allowances are capable of treating 20,000 casualties in 60 days. The AMAL is reviewed every six years for adequacy to meet support needs. The Navy Medical and Dental Material Bulletin provides current information on drug stability, safety, suspensions, extensions and other pharmaceutical information. Medlog, in conjunction with MEF units, is responsible for maintaining adequate AMAL inventories to ensure that the appropriate level of medical support can be delivered when required.

AMALs are inventoried annually. At this periodic review, pharmaceuticals which expire prior to the next review are

highlighted and are checked for candidacy in the FDA Shelf-life Extension Program. Items that are not listed under the extension program may be redistributed to other military treatment facilities as a no cost transfer or in an item-for-item trade for newer stocks (Marine Corps Order 6700.2D, 1991).

C. MISSION AND TASKS OF MEDLOG

Medlog provides the organizational structure for centralizing AMAL maintenance and management within the Force Service Support Group (FSSG). The Commanding Officer, Supply Battalion, FSSG is responsible for directing and guiding the operation of Medlog. Figure II-A provides the organizational chart of Medlog. The mission is to provide for the receipt, storage, management, and issue of medical supplies and equipment to support the AMALs assigned to medical and dental elements of the force. Medlog manages the AMAL inventory before it is issued to using units.

One of the major tasks is to maintain PWR pharmaceuticals for combat support. Maintenance of pharmaceuticals includes inventory management, building required blocks for training and operations, maintaining 60 days of supply (DOS) for pharmaceuticals and pursuing disposal through authorized disposal sites for expired drugs. Disposal goes through Pine Bluff Arsenal or Defense Reutilization and Marketing Office (DRMO). Unexpired drugs are redistributed to other users.

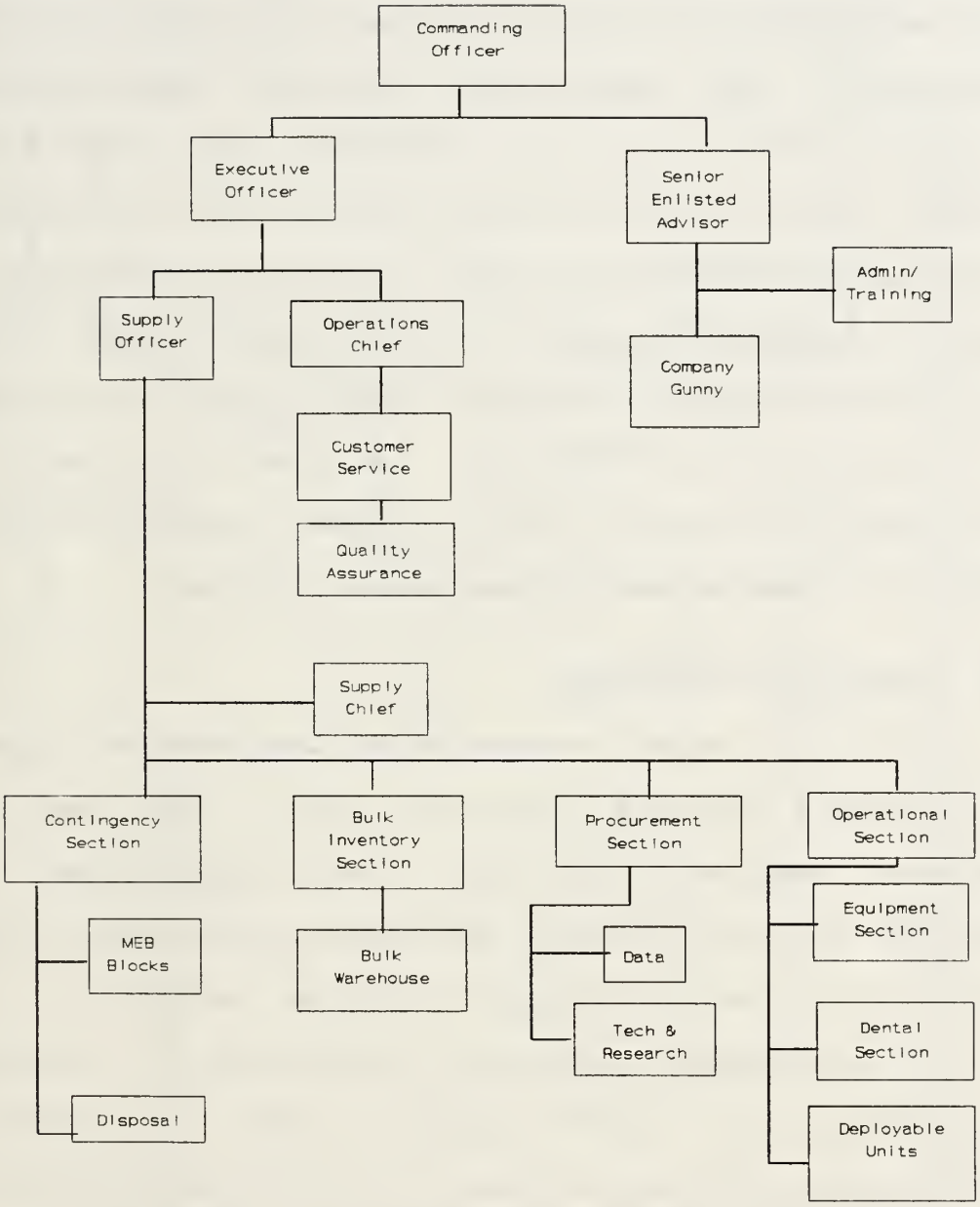


Figure II-A Medical Logistics Co. Organizational Chart

Medlog has five sections for AMAL management: Contingency, Data, Procurement, Bulk Warehouse, and Deployable Units. The Contingency section maintains the AMAL blocks for pharmaceutical stockpiling. Data maintains ALRs and forecasts information for shelf-life tracking. Deployable Units maintains AMAL blocks for training. They track inventory before and after each training exercise. Both Contingency and Deployable Units use the ALR to update deficiencies. Data section updates the database and forwards a "picking ticket" to the Procurement section for replenishment. If the item is in stock at the Bulk Warehouse, the item is restocked. If not in stock, a purchase order is placed. Figure II-B shows the flow of inventory and replenishment of items.

D. OPERATING PROCEDURES

The total current assets of bulk and modular stock items on hand are recorded in the PWR report. This report is the primary management tool to track deficiencies. It is considered a best estimate. The report identifies both pending requisitions and FDA Extension Program nominations.

A procurement clerk is designated to monitor PWR pharmaceuticals. The PWR report is used to determine over stockage or shortages by NSNs. To avoid interruption of supply support, total current pharmaceuticals from the PWR report plus substitute items and FDA extension nomination drugs can be considered as good assets. Expired pharmaceuticals and the

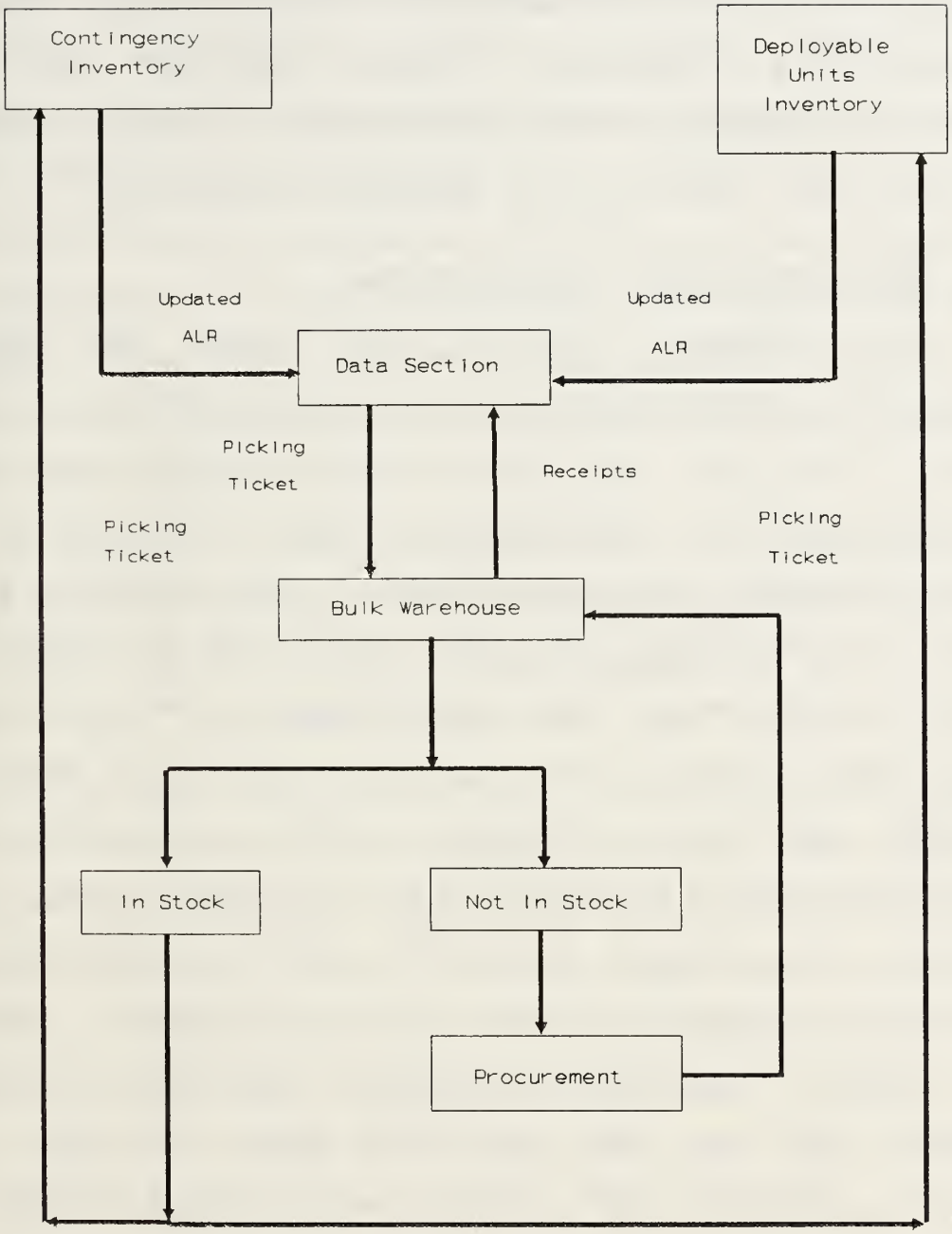


Figure II-B Inventory/Replenishment Flow Diagram

forecast report of expiring items are used to project stocks for the next 12 months. Pharmaceuticals must have at least 12 months shelf-life to be deployable. Items with less than this shelf-life are retained to support other FMF units. These drugs are highlighted and replenishment is ordered if the drug is not under FDA shelf-life extension nomination.

E. THE PROBLEM WITH PHARMACEUTICALS

The fundamental problem that burdens the inventory management of PWR pharmaceuticals is deterioration or limited shelf-life. D-day significant pharmaceuticals have varying expiration dates, which cause a complex inventory problem. Some pharmaceuticals are packaged in the same manner as used for civilian medical facilities. This poses storage problems for the DoD (Swope, Drill, and Chappell, 1982). The quick, convenient, ready to use drug forms expire or deteriorate quicker than drugs packaged in vials or in powder form. Although ready to use drugs are more efficient in the civilian sector, the shorter shelf-life inhibits stockpiling for mobilization purposes (Swope, Drill, and Chappell, 1982).

There are other types of medical consumables contained in AMALs which also have expiration dates, including: x-ray films, laboratory test reagents, and certain bandages. The current system of procuring AMAL quantities, storing and allocating them to AMALs, and disposing and replacing when

they expire is an expensive process (Swope, Drill, and Chappell, 1982).

The average shelf-life of pharmaceuticals is three years. Therefore, a significant amount of inventory value must be replaced annually to meet medical support readiness (Petroski, 1987). Medlog spends approximately 2.0 million dollars a year to replace outdated material. Contracting for pharmaceuticals is the responsibility of the Defense Logistics Agency (DLA) through the Defense Personnel Support Center (DPSC). DPSC specifies that dated assets be contracted for a shelf-life not less than 36 months.

A portion of PWR pharmaceuticals are categorized as military unique. Examples include Atropine and other nerve gas antidotes. These require unique packaging and storage requirements. Petroski stated that all military unique pharmaceuticals have a shelf-life less than three years. Taking into account procurement lead time, AMAL location placement and inventory, many will be near expiration prior to the next periodic review. Tracking these items is a labor intensive process and 2.0 million dollars worth of pharmaceuticals await disposition every year. If Medlog can not issue or redistribute the stock to other Military Treatment Facilities (MTFs) or Navy and Marine Corps units, there is a financial loss.

F. RELATED STUDIES

A literature survey was conducted to assess studies regarding the issue of dated pharmaceuticals. Previous research on the subject includes studies regarding stability for specific drugs, shelf-life characteristics, alternatives to extend shelf-life, quality assurance in inventory management, and logistics planning and policy making recommendations for mobilization. Most of the studies were directed towards either stability for specific drugs or overall pharmaceuticals management policy.

1. Logistics Planning and Mobilization

Petroski (1987) examined inventory readiness for drugs as a critical element of logistics support. He recommended that DPSC should seek exemption from the Small Business Act when procuring PWR material and should seek maximum dating. The Small Business Act fosters competition, but discourages larger drug manufacturers from conducting research to increase shelf-life of military unique drugs. Industry needs incentives to pursue research to technologically improve stability. Petroski recommended that DoD should also pursue the possibility of Allied assistance in maintaining PWR stocks.

A medical mobilization study on the management of dated drugs was conducted by Swope, Drill, and Chappell, (1982). The report noted different policies implemented by the different services. The authors recommended that coordination

in planning would make mobilization tasking more efficient and help to maintain readiness.

2. **Quality Assurance and Management of Pharmaceuticals**

Treece and Rosnick (1977) investigated existing regulations and policies on the management of dated pharmaceuticals to determine whether patients received adequate care. They concluded that regulation guidance is inadequate to properly ensure patient welfare. They found improper management of expiration-dated pharmaceuticals at the lowest level. The incidence of expired items at the activity level were higher than the acceptable levels mandated by higher authority. Treece and Rosnick recommended that Army regulations be amended to provide specific guidance for operating activities to ensure optimum quality in an Army health care activity.

This recommendation seems to pertain to Medlog, considering the number of expired items found during the recent deployment to the Persian Gulf. According to Treece and Rosnick, the acceptable level per standards is .005 or one expired item in every 200 lines of stock inspected. From the supply analysis conducted at Medlog, the average expired rate was approximately 0.31. The expired rate was determined by dividing the number of expired drugs by the total number of expiration-dated drugs in an inventory block.

Treece and Rosnick also recommended a semi-automated data entry system, similar to the system Medlog uses - key entry computer to store a data base that includes NSN, expiration date, and placement. They also recommended a periodic inventory of pharmaceuticals. This is currently the method used at Medlog.

T. Brown (1989) addressed the methodology for selecting and maintaining potency and dated drugs. He concluded that the current policy for PWR pharmaceuticals, involving extension, storage and mobilization, is fundamentally sound at the strategic level.

3. **Shelf-life and Procurement of Medical Items**

A method discussed by Baker and Jernigan (1989) uses the Medical Acquisition Shelf-life System (MASS) model to assist procurement analysts in evaluating alternative bids for stocked medical shelf-life material. The MASS is used by DPSC to evaluate bids and make recommendations for procurement. The decision aid uses historical data to calculate life cycle costs by considering purchase price and administrative costs, including transportation, handling, storage, disposal and replacement costs. The model balances shelf-life stability against higher purchase prices. They recommended updating the data used for evaluation annually.

4. Stability Studies

Stability studies conducted by Brown and Sleeman (1980) indicated that stability is dependent upon the active ingredient, temperature, and other factors such as pH, packaging and additives. They concluded that the shelf-life for nerve agent antidotes would be maximized when packaged in glass at pH 2.7 and stored at 5 degrees centigrade. In addition, adding propylene glycol improves the stability of the drug.

The above studies indicate that drug stability and general policies regarding the management of PWR pharmaceuticals have been conducted. This thesis will reflect on the conclusions and recommendations made by others and focus on improving inventory practices to manage expiration-dated pharmaceuticals in AMALs. This study will reemphasize how drug stability studies could be centrally implemented at the DoD level and use transactional methods of inventory control at the Medlog level. Cost and benefits of the proposed solutions will be compared with the current system. Based on this comparison, implementation of a bar code system to track expiration dates accurately will be introduced to improve the overall inventory management.

The next chapter will investigate the current system and the current programs that provide guidance on shelf-life management. Analysis of proposed alternatives will then be presented to relate how the existing practice can be improved

to fulfill the mission of Medlog and serve the FMF more effectively, efficiently, and responsibly.

III. RESEARCH AND CONCEPTUAL FRAMEWORK

This chapter will look into the current Medlog methodology for PWR pharmaceuticals management. The process encompasses procedures as mandated by directives from Marine Corps Orders (MCOs) and Navy Medicine manuals as well as practices handed down as a result of the organizational culture. The process is drawn from standard operating procedures (SOPs) written by previous Medlog commanders to be consistent with MCOs and manuals. The current practices will be assessed first. Then potential alternatives for dealing with the issue of shelf-life will be identified. Finally, the chapter will look into a transactional method for Medlog to monitor shelf-life, redistribution and disposition of pharmaceuticals.

A. ANALYSIS OF THE CURRENT SYSTEM

Pharmaceuticals and medical supplies are classified as Class VIII Material. The collective allowance of medical and dental materiel forms the AMAL. Medical supplies are obtained from the Supported Activities Supply System (SASSY) management unit, referred to as SMU. SMU is responsible for Class VIII ordering. These orders are coordinated with the Marine Corps Standard Supply System (M3S), a supply subsection at the Medlog level.

Pharmaceutical stock levels are computed by the Procurement section. All bulk shelf-life items are stored in a separate and distinct area in a warehouse. Each item is separated and maintained by NSN and lot number in a bulk location. The pharmaceuticals and other dated items are identified by the Federal Stock Classification of 6505 and 6550. The expiration dates are closely monitored. Prior to moving pharmaceuticals from bulk to modular AMAL, shelf-life must be at least one year. Items with less than one year shelf-life are checked for FDA extendibility. Some pharmaceuticals are automatically extended by FDA. These items are published in the Navy Medical and Dental Bulletin (a NAVMEDLOGCOM Publication). Items that have expired are immediately moved to an expired location awaiting disposition.

Medlog does not have a fully automated tracking system. The Data section tracks pharmaceuticals based on lot number and expiration date. This section prints out a forecast of expiration by lot number. However, once pharmaceuticals move to AMAL blocks, tracking by ALR is labor intensive and oftentimes erroneous, as revealed in the Supply Analysis discussed in Chapter I.

The current inventory policy includes a periodic review of items when they are received, annually for AMAL, and pre- and post-training for deployable AMAL blocks. Inventory teams are organized within the Contingency and Deployable Unit sections. This practice involves physical counts and requires strict

validation of inventory counts. These counts are translated into reports and printouts. AMAL blocks are taken out of the warehouse location and counted item by item. The inventory involves two teams. Team A takes out items and counts them. Team B counts the items again and puts them back on warehouse block locations.

After each inventory, large boxes of pharmaceuticals with less than 12 months shelf-life are removed from AMAL blocks for disposition. Medlog has several options. Medlog may send them to the U.S. Army Depot, Pine Bluff, Arkansas for destruction or redistribution; send them to DRMO; or advertize them to other units for use other than originally intended. If shipment is determined to be too costly, Medlog is left with the burden of disposal.

Medlog's ability to manage mobilization quantities of pharmaceuticals needs to be addressed. The current system of forecasting expiration dates by lot number is a tremendous undertaking. Once each pharmaceutical unit is placed into AMAL blocks, the tracking system gets complicated. It requires periodically opening blocks and inspecting each pharmaceutical item by item. This requires extensive labor and paperwork and is subject to error.

Medlog inventory costs consist primarily of carrying, replenishment, and disposal costs. Carrying costs are incurred by AMAL storage requirements, costs of pharmaceuticals, and expenses incurred for expiring drugs. Replenishment costs are

incurred for routine replacement and priority, unanticipated requisitions. Personnel costs, while important, are funded from different appropriations: Military Pay, Navy and Marine Corps (MPN, MPMC).

The current system can be summarized as follows:

1. Personnel visually inspect each item for quantity, expiration and condition.

2. Personnel locate each item on an ALR and picking ticket, then annotate any adjustments i.e., lot number, quantity, and expiration.

3. Forms are sent to the Data section for key data entry adjustments to the Medlog Class VIII Requirements Database. Replenishments are ordered to fill shortages, and FDA extension requests are initiated.

4. Finally, picking tickets go to the Bulk warehouse for replenishment and/or procurement if the item is not-in-stock (NIS). Items to be removed from bulk are subtracted from the inventory list. Medlog does not have a reorder point (ROP) or safety stock policy.

5. Expired or expiring drugs are removed and placed outside storage blocks awaiting disposition.

One advantage of the current system is the manual process itself. It is easy to perform and does not require special training. Opening and inspecting AMAL blocks for required stocks is physical work which ensures no idle time. The inventory process maintains constant checks, which are

essential to the proper security for all assets. Another strength of the system is the organizational structure. The structure has well established lines of authority and communication. Medlog objectives are constantly incorporated in the daily taskings. They have SOPs for every specific tasks, including issue and receiving, requisitioning, and receipt control. Decisions are made based on reports, such as the PWR Asset Requirements report which determines excesses and shortages by NSN. To avoid interruption of supply, only total current assets on the reports plus substitute items and FDA shelf-life extension nominations are considered good assets. The forecast report is a good tool to project expiration dates for the succeeding 12-18 months. Items with less than 12 months shelf-life are retained for redistribution. Requisitions are coordinated through SASSY.

Another strength of Medlog's management structure is the voluminous guidance by various Marine Corps Orders, Naval Instructions and SOPs. Procedures are incorporated in all the training plans. Inventories are conducted on a periodic cycle and during pre- and post-deployment training. All bulk shelf-life items are stored in a separate and distinct area. The Medlog has established a supply management program to train personnel to perform their duties.

On the other hand, the system has problems and weaknesses, as evidenced by the error rate in inventories. Despite quality controls in maintaining PWR pharmaceuticals, Medlog spends

long manhours in taking inventories and still has $2.0 million worth of pharmaceuticals waiting to be extended, replaced or disposed of. This is due to the different lengths of potency and packing requirements of pharmaceuticals. The FDA is the only agency for the Navy for expiration date extension testing. Considering the lead time for testing, typically 270 to 365 days (T. Brown 1989), the FDA shelf-life extension program is of little help to Medlog. Furthermore, FDA is currently faced with problems of underfunding and impending management instability (Benac, 1991). The DoD needs to establish its own centralized program to improve the stability of those PWR pharmaceuticals that are stockpiled.

B. MANAGEMENT AND PROCUREMENT GUIDANCE

This section discusses the FDA shelf-life extension program and the general process by which pharmaceuticals are ordered.

1. FDA Shelf-Life Extension Program

The FDA Shelf-Life Extension Program was initiated by Commander, Naval Medical Command, now Bureau of Medicine and Surgery (BUMED), in conjunction with the FDA. This program retests certain pharmaceuticals to determine the feasibility of extending the shelf-life. Prior to August 1986, all expired pharmaceuticals would automatically be sent to the Disposal section. Pharmaceuticals within six months of expiration were advertized to MTFs for redistribution before being sent to

Disposal to await their expiration date (Medlog Shelf-life SOP, 1987). The Shelf-Life Extension Program potentially saves the government millions of dollars annually.

The SOP at Medlog directs that pharmaceuticals meeting requirements are nominated for potency testing every three to six months. Requirements are set by NAVMEDLOGCOM. The Defense Medical Standardization Board (DMSB) designates criteria for extension and identifies certain military unique dated material which may be considered for extension. Appendix C lists unique medical items that may be considered. Medlog verifies expiration dates, lot number, and quantity on hand for each item nominated. The Data section maintains a program to list all pharmaceuticals within 18 months of expiration which have a value of at least $5,000 per lot. Samples of pharmaceuticals by lot are packaged and shipped to FDA and items are placed in a suspension status. Once approved and extended, pharmaceuticals are relabeled for new extension. The program conducts laboratory testing on sample lots for PWR pharmaceuticals. If testing demonstrates that a lot is safe, and will remain safe for a determinable period, shelf-life extension is approved. Although the suspended assets are considered good assets, they will necessitate immediate replenishment if the request is disapproved.

2. Procurement Guidance

The DPSC conducts central inventory management and procurement for standardized medical supply for all the DoD services. External from DPSC is DMSB which consists of tri-service medical experts responsible for technical review and approval of medical items. DPSC, DMSB, FDA and the service field medical officers work closely to decide what pharmaceuticals will be standardized (Petroski, 1987).

The services submit requisitions to DPSC, which in turn immediately ships pharmaceuticals to the customer. Medical materials are stored in CONUS DLA depots. DPSC practices a first-in-first-out (FIFO) shipping policy (T. Brown, 1989). DPSC ensures that pharmaceuticals shipped to customer have at least 12 months of shelf-life remaining. This may pose problems when received by lower echelons such as Medlog.

C. ANALYSIS OF PROPOSED ALTERNATIVES

1. Drug Stability Studies

The Pharmaceutical field has conducted in-depth investigations on the stability of drugs. Of particular interest to logisticians is the formulation and production processes, the role of the container and the effect of storage and distribution of packaged pharmaceuticals on their stability or potency. A review conducted by Mollica, Ahuja, and Cohen (1978) identified the many factors affecting

stability and outlined what a stability program should include. They recognized the economic and competitive reasons for monitoring drug stability.

The subject of stability evaluation is a very broad and extensive process and is beyond the scope of this thesis. However, a description of the topic could provide an understanding of the process and how it relates to storage, expiration dates and packaging pharmaceuticals. The disciplines primarily involved with stability are pharmaceutical analysis and product development. However, physical and organic chemistry, mathematics, physics, microbiology, toxicology, production, packaging, engineering, quality control, and distribution are all included (Mollica et.al., 1978).

Results of stability evaluations are obtained from methods based on solvent extraction, gas chromatography and mass spectrometry to determine the level of degradation. Analysts are required to have knowledge of the physicochemical properties of a drug, degradation products, degradation mechanisms, and degradation reaction rates to perform stability evaluations. Studies on drug stability and temperature exposure show a direct relationship. Identical sets of drugs are usually compared to analyze the effects of exposure to light and heat. One sample is subjected to environmental conditions while the other is kept under a controlled environment and used as a reference sample. Drugs

subject to temperature as high as 40 degrees centigrade can degrade to the point where patients will not respond to normal drug doses (Valenzuela et.al., 1989). Newton and Miller (1987) stated that for every 10 degrees centigrade increase in temperature, chemical reaction rates increase twofold, which cause drug degradation. The stability evaluation also determines effects of environmental conditions on the product. Other factors commonly tested include humidity, light and air. They accelerate, catalyze, or mediate hydrolytic (addition of water), photolytic (action of light) and oxidative (combination with oxygen) reactions.

Extrinsic to the stabilization of the drug form is the stability of the drug-container combination. The container is an integral part of the pharmaceutical, as with topicals and injectibles. A specific study on the effect of containers on stability is shown in Appendix D. Additional studies in the choice of container are necessary to obtain total drug stability. Pharmaceutical packages are designed to provide not only a means of transport and brand identification but to serve more significant functions: to provide adequate protection and to ensure the stability of the product while in distribution and storage.

All of the above factors and packing conditions form the basis for shelf-life determination. Expiration dates have a real significance under specific storage conditions. DPSC has an "Accelerated Aging Test" program to determine the

stability of a pharmaceutical under anticipated storage conditions in the field, assuming limited exposure to stress conditions. The objective of stability testing is to determine the time period and conditions for which the product is satisfactory. The expiration date limits the time during which the drug may be used, provided it is stored under the prescribed storage conditions.

Once results of the studies are obtained, they must be validated by the drug stability program, as pointed out by Trissel and Flora (1988). Validation is an essential step in the analytical process. The stability-enhancing results of the analysis must be verified.

Expiration dating is the ultimate practical result of determining stability. Short shelf-life generates wastage and high disposal costs. Stability is the inverse of degradation. All materials undergo degradation at a rate defined by chemistry and physics. The basic technique to measure the degradation rate at different environmental conditions is to extrapolate to the anticipated storage temperature and convert this extrapolated rate constant into months of shelf-life (Zakowski, 1991).

The drug stability processes described above could be centrally managed by the government to standardize the shelf-life methodology for military unique as well as generic combat support. A network between laboratories, drug industry, and the government could be established to address the issue of

shelf-life on DoD pharmaceuticals, including those prepositioned with the combat units.

2. Bar Coding for a Transactional Inventory Review

The inventory practice Medlog employs may not be the most effective process. Manually checking for expired drugs is subject to errors, in both tracking quantities and in generating timely requests for replenishment and extension. The use of a bar code system may provide timely replenishment decisions, decrease time and labor resources, and provide effective decisions in redistribution and disposal.

Chester and Zilz (1989) describe a bar code as a specific arrangement of rectangular bars and spaces that represent data characters (letters, numbers, and symbols). The code is read by a light source (scanner) which generates an electrical signal. The signal is translated by a terminal (also known as bar-code reader, device, or transaction manager) to a usable form. Bar code technology has enhanced labor efficiency through time savings and increased record accuracy (Chester and Zilz, 1989).

Since one of DoD's objectives is to reduce manpower, implementing bar code technology is a means to achieve this objective. Bar codes for PWR pharmaceuticals can be added to the packages and to the AMAL blocks. Bar codes will provide up-to-date data, such as expiration dates, for an automated database with a high degree of accuracy. Medlog can use bar

codes to track drug expiration data, monitor inventories, control narcotics and coordinate replenishment. It could replace the item by item counting by inventory teams.

Standardized bar coding within the health care industry is accomplished through the Health Industry Bar Code Council (HIBCC). The HIBCC develops and publishes standards for implementing bar codes in health care and provides labeler identification codes to manufacturers, distributors, and customers. They also disseminate information on bar codes to the above users as well as to manufacturers for bar code software and hardware and health care providers (McGee, 1989).

The implementation of a bar code system can serve as a local solution to the shelf-life inventory management problem at Medlog. This system is to be built around automated data-collection technology. Bar code labels and scanners provide an accurate, fast way of data entry for data management. The system can save personnel time in recording ALRs. Manually, this is a cumbersome and unreliable task. Bar code systems have typically had an investment payback period of 12 to 18 months (Betts, 1991).

The system can improve the accuracy and timeliness of the inventory data. It can track the expiration dates of each drug and flag those that need to be FDA extended or disposed of. Drugs that require disposition could be redistributed in a more timely manner for use by other government agencies. Bar coding improves data accuracy by a factor of 10,000. According

to Betts, where manual data entry has one error per 300 entries, bar code scanners have an error rate of one in every three million entries.

The use of bar codes is consistent with the transactional review method of inventories that suggest having a real-time inventory tracking capability. The system would eliminate the need for key-driven data entry. This is known as source data automation and will reduce if not totally eliminate the existence of input errors. Inventory personnel need only pass bar code labels of the drug items over a laser scanner and information is updated. For bulk items, portable data entry devices, such as hand-held wand scanners, expedite data input at the point of origin. The wand scanner also reads package labels for shipping and receiving. The Contingency and Deployable Units sections, who are tasked with counting blocks of AMAL, could use a scanner to read labels on the blocks.

D. SUMMARY

The current inventory practices at Medlog involve physical counts and checks of AMAL blocks. This review monitors the expiration of pharmaceuticals. Pharmaceuticals are extended by requests or by extension notices from the Navy Medical and Dental Materiel Bulletin. Non-extendible and expired drugs are redistributed and disposed of respectively. The periodic review causes error and expired item rates higher than the industry average or acceptable levels. A drug stability

program and a transactional method of tracking inventory could help solve the problem. The proposed alternatives present viable solutions to institute bar coding technology to assist Medlog managers in making accurate inventory decisions. The benefits of increased shelf-life and accuracy allow Medlog to carry out its mission more effectively.

The next chapter discusses tradeoffs and cost-benefit analysis of proposed alternatives. A summary of the issues proposed by the recommendations will be presented and other qualitative benefits.

IV. DISCUSSION AND ANALYSIS

The current Medlog inventory practices and shelf-life management were presented in Chapter III. Alternative management tools, drug stability program and bar coding for inventory management, were suggested to show how the present process may be improved. The level of readiness will definitely increase with a stability program and a fully automated on-site inventory tool to manage pharmaceuticals. This chapter will discuss further details on Medlog pharmaceutical inventory policies and the applications of alternative management methods.

A. CENTRALIZED DRUG STABILITY PROGRAM

1. Cost-Benefit Analysis

A DoD stability program for PWR pharmaceuticals helps to solve the shelf-life problem. Physicochemical properties of drugs may be the focus of programs to develop packages for military unique items. Issues that the program could address are selection of containers, package stability, storage requirements, expiration dating and regulatory considerations. The cost of the shelf-life improvement program is traded-off with inventory, replenishment and disposal costs. With a longer shelf-life, manpower needed for periodic inventories

can be diverted to other peacetime training while readiness for medical support is maintained.

The types of pharmaceuticals required by peacetime MTFs and those place in AMALs are different. For example, atropine may be required in large amounts in a possible chemical warfare. The drug is used to counteract chemical agents anticipated on the battlefield. Studies described by various researchers show that temperature is a major contributing factor to the instability of atropine sulfate. The stability program may help predict the optimal temperature for storage. Cost-benefit analyses can be used to justify whether to invest in capital to prolong storage life.

A centralized stability program within the DoD will require initial outlays for facilities and equipment. In addition, research and development (R & D) increases start-up costs. Investment in the short run is costly but potential benefits may outweigh the costs in the long run. The problem with PWR pharmaceuticals is the short shelf-life which results in high annual replacement cost to maintain readiness. To demonstrate the potential savings, it is assumed that a 10% increase in shelf-life will save Medlog approximately 10% of operating costs, as shown in Figure IV-A-1. Increasing the shelf-life by 33 1/3% and 50% yield similar potential savings. Based on stability studies, ultra low refrigeration may be sufficient to increase shelf-life by 10%. Refrigeration units cost $30,000 each. One refrigeration unit is needed per 150

NSNs of consumables or pharmaceuticals, as described in Figure IV-D. Thus, Medlog would require nine units. The total start-up cost for a 10% shelf-life extension using refrigeration is $270,000.

Figure IV-A-1 shows the annual savings in disposal, replenishment and inventory costs as shelf-lives are extended by different amounts. An increase of 10% will provide annual savings of $249,189. Based on an average shelf-life of three years, the new shelf-life is 3.3 years. As shown in Figure IV-A-2, the net present value (NPV) of the savings over a five-year period is $944,625 at a discount rate of 10%. Deducting the $270,000 start-up costs yields a discounted net savings of

Potential Annual Operating Cost Savings	Shelf-Life % Increase		
	10%	33 1/3%	50%
Disposal	29,533	98,346	147,666
Replenishment	200,000	666,000	1,000,000
Inventory	19,656	65,454	98,280
Total	$249,189	$829,800	$1,245,946

Note: Potential savings are based on operating costs provided in Figures IV-B and IV-C.

Figure IV-A-1 Cost Savings of Increased Shelf-Life

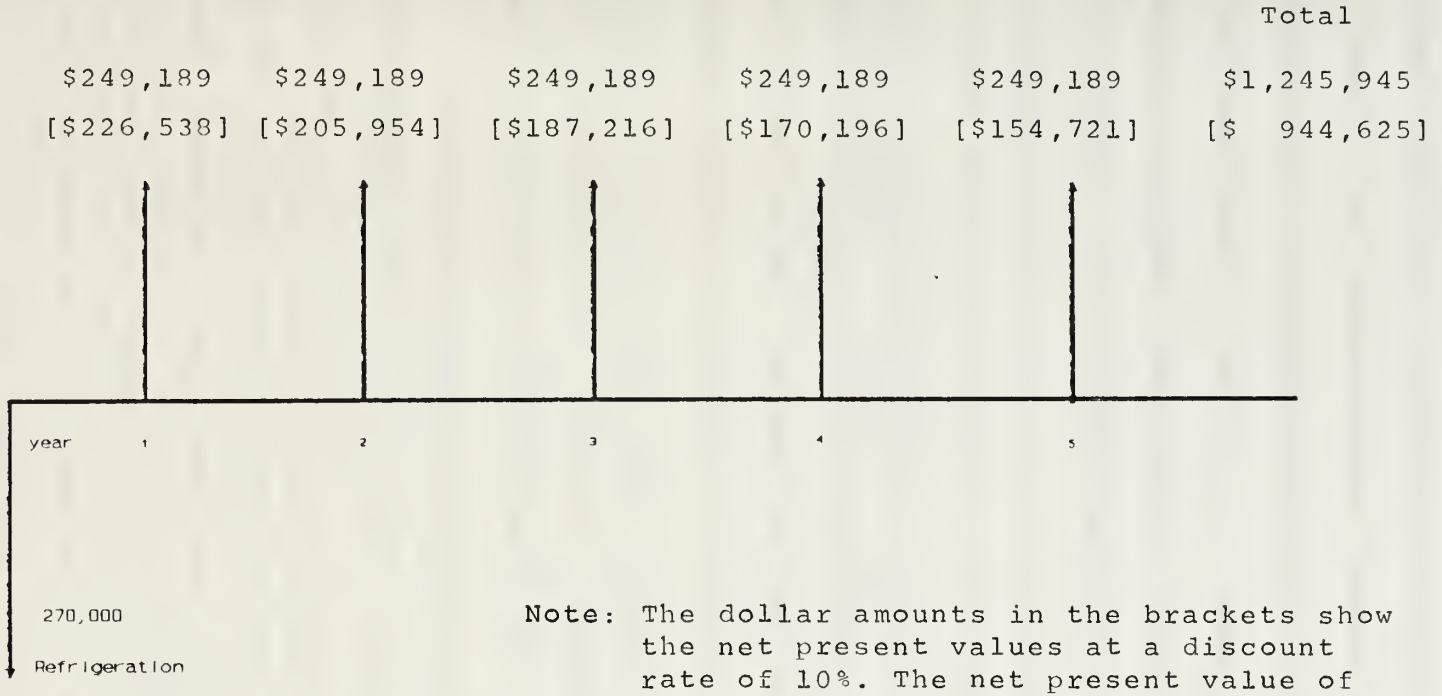


Figure IV-A-2 Cost Flow Diagram

Note: The dollar amounts in the brackets show the net present values at a discount rate of 10%. The net present value of the savings over a five-year period is $944,625.

$674,625. Increasing the shelf-life by 33 1/3% or more may provide even greater net discounted benefits.

Investment in stability methods to increase shelf-life, as shown in Figure IV-A-3, looks attractive for DoD. Increasing shelf-life by 10% may only require temperature control methods. Increasing shelf-life to 33 1/3% may require both temperature control and R & D into packaging and other physicochemical properties of drugs. From Figure IV-A-3, the potential annual savings for a 33 1/3% shelf-life extension is $829,800. Over five years, the discounted total savings is $3,145,606. Thus, the marginal net savings as shelf-life is extended from 10% to 33 1/3% is $2,200,981. Total additional R & D costs to extend shelf-life from 10% to 33 1/3% should not exceed this incremental savings. If it costs $270,000 to extend shelf-life by 10%, then the total R & D costs to extend shelf-life to 33 1/3% should not exceed $2,470,981.

Extending shelf-life to 50% will require additional R & D, possibly into additives and other drug forms. From Figure IV-A-3, the total potential annual savings from a 50% shelf-life extension is $1,245,946. The total discounted five-year savings are $4,723,132. This represent an increase of $1,577,526 over the 33 1/3% shelf-life extension. Thus, the incremental R & D costs to increase shelf-life from 33 1/3% to 50% should not exceed $1,577,526.

To determine the optimal shelf-life extension program, the incremental R & D costs to increase shelf-life is

compared with the incremental discounted savings. As the incremental net savings exceed the incremental R & D costs, DoD may continue to extend the shelf-life. As the shelf-life is extended, the R & D costs to obtain further extensions are likely to increase. When the incremental R & D costs exceed the incremental discounted savings, DoD may stop extending the shelf-life.

Shelf-Life % Increase	Potential Annual Benefits	Five-Year Discounted Benefits	Marginal Benefits	Stablity R&D Parameters
10%	249,189	944,625	--	Refrigeration and Environmental Factors
33 1/3%	829,800	3,145,606	2,200,981	Drug Packaging
50%	1,245,946	4,723,132	1,577,526	Additives and Drug Form

33 1/3% R&D Not-to-exceed (NTE) $2,470,981

Figure IV-A-3 Marginal Benefit - Marginal Cost Analysis

The cost analysis and tradeoff described in Figures IV-A-1 through IV-A-3 provide a model for demonstrating potential benefits of a stability program. To determine the actual start-up cost of a drug stability program (i.e., R & D and equipment) would require a more intensive life-cycle approach. R & D costs other than refrigeration costs are not available.

2. Benefits of a Drug Stability Program

There are cost tradeoffs between the factors contributing to shelf-life extensions. A decrease in storage temperature increases refrigeration costs. However, with longer drug shelf-life, disposal and replenishment costs decrease. Another benefit of a drug stability program is determining the best drug form for stockpiling. Powdered antibiotic products often expire several years after their production. However, once the pharmaceutical is reconstituted in a diluent, the rate of degradation increases dramatically (Newton and Miller, 1987).

A drug stability program under DoD control decreases the lead time for extension requests since retesting will be conducted within the agency. The program also invests in research and development to enhance the sterility and potency of pharmaceuticals. This is conducted through stability evaluations described in Chapter III. Initial outlays for special storage equipment and packaging materials will outweigh the costs in the long run. An increase of the shelf-life by 10% shows potential savings in operating costs i.e., disposal, replenishment and inventory. Equally important is the effectiveness of Medlog in terms of readiness.

The program also conducts special studies in new methods of maintaining pharmaceuticals. An example is the use of reconstituted or unreconstituted drugs. While the use of pre-mixed forms results in efficiency for MTFs in peacetime,

the ready to use form is not appropriate for PWR pharmaceuticals. If there is a high demand for the drug, pre-mixed doses could be cost effective for MTFs, because technicians can devote more time to other labor intensive pharmaceutical duties. However, in the case of stockpiling pharmaceuticals, it is best to store them in their most stable form and reconstitute them only prior to mobilization or training exercises. Stockpiling pharmaceuticals in the most stable form (unreconstituted), with the appropriate container (glass with minimal air content), and the proper storage environment leads to longer expiration dating and personnel time savings, which translates to less inventory and disposal costs.

In case of a mobilization or training exercise, reconstitution may either be done by batch method (advanced preparation) or by extemporaneous method (prepared at the field on a daily basis). Part of training could be the amount of time and labor involved in reconstitution of pharmaceuticals in the field. To determine the preferred field method would involve time-and-motion studies. Reconstitution includes time to retrieve and assemble materials, prepare lot number/expiration date labels, and repackage prepared doses for the field.

In summary, investing in a drug stability program would increase costs in research, packaging, drug forms, and storage facilities (temperature and humidity control

equipment). The benefits would include longer shelf-life, decrease in ordering and disposal costs, increased readiness, and reduced labor costs.

B. MEDLOG BAR CODE APPLICATION

1. Tradeoff Studies and Cost-Benefit Analysis

Medlog can be characterized as having a labor intensive inventory system. There are huge inventories of drugs expiring annually and awaiting disposition. In addition, inventory records on expired drugs are inaccurate and there are deficient quantities in AMALs (surpluses or shortages).

Experience in the food industry indicates that today's grocery stores, retail and manufacturing industries have used bar codes as a critical part of inventory management. The health care industry is now starting to use the bar code system to improve health management systems. In light of DoD attempts to reduce funds and decrease manpower requirements, a bar code system could help alleviate Medlog's shelf-life problems. Investment in a flexible, automated field system could provide a solution to pharmaceuticals in the AMAL stockpile.

The need to seek an alternative inventory review to provide the required medical readiness for the MEF is a strategic issue in view of the plans to downsize DoD. This section provides a cost-benefit analysis and tradeoff study of a bar code system to provide a transactional inventory

control. Costs associated with acquisition, installation, training, and maintenance are explored. The estimated costs and benefits are traded-off to provide a breakeven analysis for recoupment of the capital investment.

The proposed system is evaluated for a five-year period. The five-year period is used for analysis to exemplify the average useful life of bar code technology. It is usually the period which computer hardware and software changes occur. The bar code system is analyzed in terms of cost savings and benefits from increased accuracy, decreased time and labor resources (includes disposal), and improved redistribution. The increased accuracy is a result of information stored from scanned codes vice manual counting and shelf-life verification. Concerns over inaccuracies and deficiencies mandates audits and review analyses similar to the investigation conducted by Field Supply Office Two. As described below, Figures IV-B through IV-F provide the cost analysis of the proposed system. The figures are based on realistic assumptions using available data and are provided for demonstration purposes only. Calculations are presented with the figures. Appendix E provides additional cost data.

COST DATA
(Computations are based on Annual Cost Structure)

Medlog Data	
Annual Inventory	$23,973,704
Number of line items	3318 NSNs (9% are dated and deteriorative material)
Operating Costs	$2.5 million
Replenishment Costs	$2.0 million
Cost of Expiration Dated Items	$2,157,633 (9% of Annual Inventory)
Percentage of Consumables	40%
Disposal Costs	$295,333
Inventory Time	60-90 days, 8 hours per day
Number of Personnel	39 (Full-time-equivalents)
Personnel Labor Costs	$546,151/yr
Redistribution Savings	2% or $43,152 (Expiration dated items)
Industry Data on Bar Code System	
Payback Time	12 to 18 months
Bar code scanner error rate	1 per 3,000,000 entries*
Training Costs	90 minutes per trainee at $200-250/hour
Reported Accuracy	1% of Total Annual Costs
Reported Time Savings	1-2 hours per day per technician
*Manual Data Error Rate	1 per 300 entries
Oakland Naval Hospital (uses Bar coding for Central Processing Department (CPD))	
Reported Accuracy of Bar Code System	1-5%
Time Savings	2 hours per day per technician

Figure IV-B Cost Analysis Extrapolation

INVENTORY TEAMS

Total Personnel: 39 (USN & USMC)

Composition: E2-9, E3-16, E4-11, E5-2, E6-1

Total Annual Personnel Costs based on Base Pay, BAQ (Partial and BAS from FY91 pay chart without dependent) = $546,151

Time Required to Inventory (periodic)

a. Hours per day: 8
b. No. of days: 90

Annual Cost ÷ 250 ÷ 8 = Cost per hour

546,151 ÷ 250 ÷ 8 = $273.00

No. of hours to inventory X cost/hr = Inventory Labor Costs

90 days X 8 hours X $273.00 = $196,560

No. of hours saved X Cost per hour X No. of Days to Inventory = Annual Savings

2 X $273.00 X 90 = $49,140 (savings)

Note: The inventory cost per hour is calculated using total annual personnel costs divided by 250 work days in a year and by eight work hours in a day.

Figure IV-C Inventory Labor Cost Calculation

COST OF EQUIPMENT, INSTALLATION, TRAINING AND MAINTENANCE

Item	Cost	Unit	Total Cost	Inflation Estimate
Bar Code Reader (Transaction Manager)	$2,415	9*	$21,735	$25,160
Scanners	$1,099	9	$ 9,891	$11,450
Printer	$6,000		$ 6,000	$ 6,945
Manuals, Cables, Storage Disk	$ 193		$ 193	$ 224
Installation and Software Requirements				$22,057
Trainees (90 minutes)	$ 200 per/hr	12	$ 3,600	$ 3,600
TOTAL SYSTEM REQUIREMENTS				$69,436

Operating Costs	$1,500/yr (average)
Maintenance Costs	$4,738/yr (10% of Total System Requirements excluding installation and software)

* Number of units needed to inventory 40 % of total line items. Based on Oakland Naval Hospital Central Processing Dept. which uses 1 scanner per 150 NSNs: 40% of 3318 = 1327; 1327 ÷ 150 = 8.8 ≈ 9 units.

Figure IV-D Bar Code System Cost Data

Source: Naval Hospital Oakland Materials Management
Date acquired: 1988
Inflation Rate Used: 5%

		BENEFITS					COSTS				
10% Discount Factor	Year	Labor(1) Savings	Disposal(2) Cost Savings	Redistribution(3) Cost Savings	Total	NPV	Capital Investment	Maintenance Cost	Operating Cost	Total	NPV
1	0						69436			69436	69436
0.9091	1	49140	2953	21576	73669	66972		4738	1500	6238	5671
0.8264	2	49140	2953	21576	73669	60880		4738	1500	6238	5155
0.7513	3	49140	2953	21576	73669	55348		4738	1500	6238	4687
0.683	4	49140	2953	21576	73669	50316		4738	1500	6238	4260
0.6205	5	49140	2953	21576	73669	45712		4738	1500	6238	3871
Total						279228					93080

Difference: 186148

Break even Analysis (undiscounted)

Year	Benefits	Costs	B E Balance
0	0	69436	-69436
1	73669	6238	-2005
2	73669	6238	65426
3	73669	6238	132857
4	73669	6238	200288
5	73669	6238	267719

Break even Analysis (discounted)

Year	Benefits	Costs	B E Balance
0	0	69436	-69436
1	66972	5671	-8135
2	60880	5155	47590
3	55348	4687	98251
4	50316	4260	144307
5	45712	3871	186148

Notes
1. Labor See Figure IV-C
2. Disposal 1% of disposal Costs
3. Redistribution 1% of Expiration Dated Item Cost's

Figure IV-E Cost Benefit Analysis

	Manual or Periodic Review	Bar Code System or Transactional Review	Cost Savings
Equipment	0	69,436	-69,436
Labor Costs (1)	982,800	737,100	+245,700
Disposal Costs (2)	1,476,665	1,461,900	+14,765
Redistribution Savings (3)	215,760	323,640	+107,880
Maintenance and Operating Costs (4)	0	31,190	-31,190
Five-year total	2,243,705	1,975,986	+267,719

1. 196,560 (Fig. IV-C) X 5 = 982,800; 49,140 X 5 = 245,700 (savings)

2. 295,332 X 5 = 1,476,665 (Bar Code System is assumed to save 1% of disposal cost: 1% savings = $14,765)

3. 43,152 (Fig. IV-B) X 5 = 215,760; 21,576 X 5 = 107,880 (savings)

4. 6,238 X 5 = 31,190

Figure IV-F Tradeoff Study Over Five Years (Undiscounted Costs)

The average annual inventory of Medlog totals $23,973,704. Other cost data are presented in Figures IV-B and IV-C. Operating costs, not including personnel pay, are funded under Operations and Maintenance, Marine Corps (O&M, MC). Figure IV-B lists operating costs and bar code savings data.

Figure IV-C shows the composition of Medlog's inventory team and a calculation of the inventory costs used in the analysis. A periodic review is assumed to require 90 days for inventory. Total system cost is presented in Figure IV-D. The total system requirement is $69,436. Operating costs were estimated from the average cost incurred by the Central Processing Department at Naval Hospital Oakland. Maintenance cost is 10% of system requirements excluding installation and software. The cost effectiveness measures the cost savings which the bar code system could provide. From industry data, bar code use indicates a 1% savings on total annual costs excluding capital investment (Krause, 1991). For our discussion, it is assumed that industry results represent a good measure of the overall savings for Medlog. In the analysis, savings are based on the percentage of average inventory, replenishment cost, disposal cost, and redistribution savings. Calculations are presented as footnotes in the figures. For all calculations, it is assumed that total yearly costs for the five-year outlay are constant and are affected by inflation. The discount factor used is 10%. The overall discounted net savings is $186,148 for five years, as shown in Figure IV-E. The total annual potential savings from labor, disposal and redistribution is $73,669. The NPV of the total potential savings after five years is $279,228. Capital investment costs $69,436. Adding

annual operations and maintenance costs of $6,238 yields a total NPV cost of $93,080. The difference in NPV values provides the overall net savings. The payback period is 1.03 years. In Figure IV-F, the tradeoff study indicates that the total expected (undiscounted) savings from the bar code system is $267,719 for five years. The analysis quantifies the potential benefits of a bar code system investment. Figure IV-F shows that the total benefit is greater than the total cost in the period compared.

The use of bar codes initially has capital and start-up costs, but the benefits will outweigh the costs. The benefits include improved expiration tracking, reduced inventory time (which may justify personnel reduction), and better decision-making in redistribution and replenishment. Managers can better make decisions as to ordering frequency, reducing stockouts, and making timely FDA extension requests. The level of combat support readiness may be jeopardized by the inaccurate inventory of pharmaceuticals under the periodic review. As the required PWR pharmaceuticals are correctly managed, Medlog's combat support readiness is maintained.

2. **Sensitivity Analysis**

The effectiveness of the system is based on the savings provided by increased accuracy in tracking. Therefore, timely decisions are made as to extension requests,

redistribution, replenishment and disposal. The analysis shown in Figure IV-E used a discount rate of 10% and accuracy savings of 1%. It showed a NPV of $186,148 for five years. Four sensitivity analyses provided in Figure IV-G illustrate the robustness of the bar code investment. The analyses use discount rates of 12% and 8%, respectively, and potential savings of 2% and 5% from increased accuracy. These percentages are not accuracy rates but the potential savings from bar code inventory management. The sensitivity analyses illustrate that the higher accuracy from bar codes results in increased savings. The payback period is computed by dividing the initial investment by the net annual savings from bar code use.

Scenario	Discount Factor	Accuracy Rate (Savings)	Labor Costs	NPV (Savings)	Payback (Years)
1	10%	1%	Constant	186,148	1.03
2	12%	1%	Constant	173,641	1.03
3	8%	1%	Constant	199,787	1.03
4	10%	2%	Constant	279,128	.75
5	10%	5%	Constant	558,090	.42

Figure IV-G Sensitivity Analysis
to Illustrate Robustness of the Bar Code System

In conclusion, this section provides the costs associated with the introduction of a bar code system for Medlog. Monetary and quality benefits demonstrate the attractiveness of investing in the system. Considering the worst case scenario, the system can be expected to return its original investment in 12-13 months. By investing in the system, productivity and efficiency will improve. At the same time, readiness increases as time spent in inventory is used for training and other duties. Above all, the highest quality of PWR pharmaceuticals in AMALs is maintained.

3. Medlog Shelf-Life Management Model

The model being proposed for the PWR pharmaceuticals inventory management is outlined in Figure IV-H. A drug stability program is centrally coordinated by DPSC in conjunction with the FDA, DMSB, DoD drug laboratories, and drug manufacturers. Other key organizations are SASSY, Naval Hospitals, and Naval Supply Centers or Depots. Once pharmaceuticals are procured and received by Medlog, they are labeled with bar codes prior to prepositioning to AMAL blocks or storing them in the bulk warehouse. Required information is taken from the product or drug manufacturers may directly label the shipment.

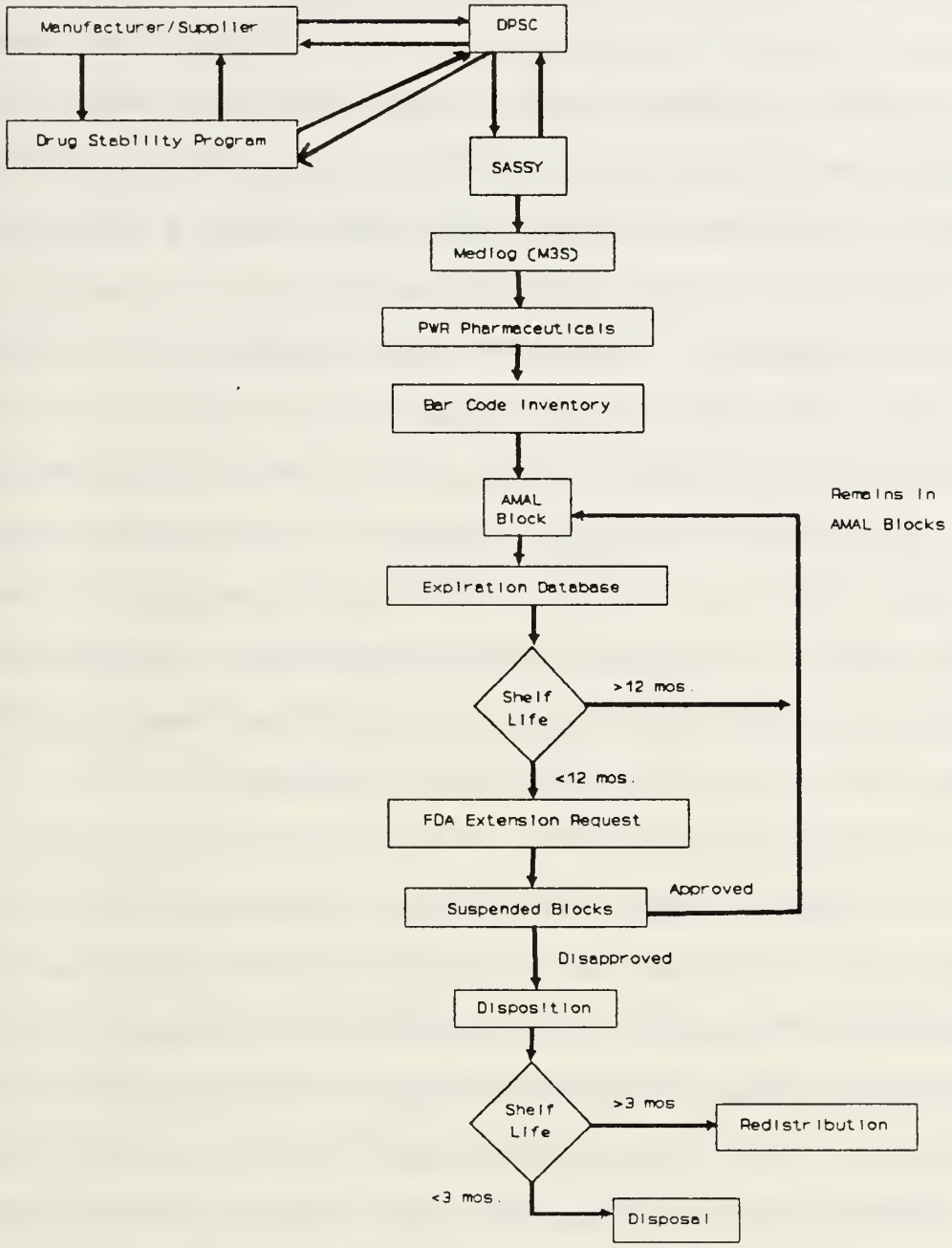


Figure IV-H Inventory Flow Model (Using Bar Code System)

Pharmaceuticals placed in AMALs and in the bulk warehouse are ensured of proper storage requirements. Items placed in AMALs are scanned and data is stored into the Medlog inventory database. On-line inquiries could determine the shelf-life of pharmaceuticals and their location. Reports could be generated to list all items within a certain period of expiration for exception reporting. This will provide timely extension requests and redistribution for non-extendible items. A final step in the process is a Quality Assurance program for the evaluation of the system. Results of the review would then be compared to the manual system to validate the cost analysis. The review process could also be conducted in relation to the philosophy of Total Quality Leadership (TQL) for continual improvement employing control charts to ensure standards are maintained.

4. Application

Based on the cost analysis presented in the preceding sections, bar code technology provides monetary as well as qualitative benefits. The system will eliminate item-by-item entries on ALRs and picking tickets. Personnel still have to determine items, quantities, AMAL composition and warehouse location, but once these are set for AMAL blocks, bar code labels are attached with all the required information. Information on labels would include pharmaceutical name, lot

number, expiration date, AMAL block, warehouse location or bulk location. Personnel scan the label with a bar code device.

After inventory, the bar code reader is taken to the Data section where it is attached to the Medlog computer. Inventory data is electronically transferred to the database. After the data is entered, exception reports may be produced to identify item deficiencies and shelf-life forecasts. From this, a picking ticket may be generated for Bulk and Procurement to replenish expired pharmaceuticals. The transactional inventory review permits continuous updating of inventory balances when items are received and distributed to the AMAL blocks. Furthermore, real time data provides better planning for redistribution of non-extendible pharmaceuticals.

One requirement to consider is that bar code labels must have a high resolution to compress multi-character bar codes to a compact level. A high-volume laser printer could be used. Such a printer can print up to 70 pages a minute and can print continuously with few interruptions. The printout on durable labels should be virtually indelible (Bar Code System, P & IM Review, 1990). The capability of a printer to produce high resolution labels is essential in maintaining the integrity of the labels, especially when the AMAL blocks are deployed.

5. Benefits of a Bar Coding System

A return-on-investment analysis would follow a pilot study to measure the ability to track all pharmaceuticals, their expiration dates and proper disposition (i.e., extension requests, redistribution, or disposal). Equally important are the time savings, increased shelf-life and maintained level of readiness.

The use of bar code data entry provides fast and accurate collection of information in receipt control, AMAL block assembly, bulk locations, replenishment and disposal of pharmaceuticals. One of the obvious benefits of using bar code entry and collection is the reduction by a factor of 10,000 of the error rate from manual counting and keying in of information. Adoption of bar code asset locator labels gathers information instantly and accurately. The long hours of detailed counting and ALR adjusting is reduced.

For every incoming item, receipt control generates a bar coded label that channels items to AMALs and bulk storage locations as appropriate. The NSN identifies the particular drug being inventoried and will indicate required data. The amount and volume of pharmaceuticals along with the need for traceability for expiration makes the bar code application relevant.

With bar codes, all information needed can be extracted from AMAL labels that identify each drug. As the bulk warehouse transfers items and releases them for AMALs, bar code labeling identifies each item and feeds the data back to the Medlog database. The system permits a number of management reports. The reports could provide a detailed analysis of total assets, locations, shortages, excesses and expired items. The item placement report would help expose the magnitude of any loss problem on a timely basis. Currently, it is not possible to ascertain any loss until the next physical inventory.

In summary, these are computerized solutions that incorporate bar code data collection techniques and allow Medlog to provide assistance in complying with MCOs and directives and increase the efficiency in maintaining readiness. In addition, this technology will assist Medlog planners in making decisions for redistribution of non-extendible pharmaceuticals.

The cost-benefit analyses for the drug stability program and bar code system have been conducted independently. The total benefits of both proposals can not be determined by adding the total from each individual programs. If both programs are undertaken, the total benefits are likely to be less than the sum of the individual programs. As inventory

management improves with bar coding, savings from drug stability may decrease, and vice versa. However, both investments appear attractive enough that it is unlikely to change the decision for either program.

V. CONCLUSION AND RECOMMENDATION

A. CONCLUSION

Maintaining PWR pharmaceuticals is costly because critical drugs are expensive, storage requires special conditions, and stockpile necessitates continuous replacement due to limited shelf-life. DoD should pursue a centralized Drug Stability program to assist or relieve the FDA in extension studies. DPSC and the medical services through the centralized program should further examine the possibility of increasing shelf-life through research to improve packaging, formulate stabilizers and use special containers for temperature control. To encourage larger drug manufacturers to participate in the program, DPSC should seek exemption from maximizing competition when procuring PWR pharmaceuticals. It is the large companies that generally conduct original research on military unique items and can maintain the capacity to produce low profit items.

At Medlog, the bar code technology as described in Chapters III and IV, provides financial and qualitative inventory management benefits. The system reduces labor and increases inventory accuracy. Bar coding can eliminate hours worth of administrative work and almost all counting errors.

Time savings can be reallocated to quality assurance procedures and to peacetime training with the FMF units. This overall analysis improves the operating efficiency of Medlog and could be applied to the other Medlogs.

B. RECOMMENDATIONS FOR IMPLEMENTATION

There are two possible ways to implement the bar code technology. One is to obtain the expertise of an outside integrator to convert all of the databases into bar codes. The other is to handle the integration locally by requesting conversion to bar coding from the MIS department of the local command, such as Naval Hospital San Diego. At the implementation phase, the following key points may aid in the successful implementation of the system: (1) work flows, such as procurement, receipt, AMAL placement, warehousing, and disposition, must be well defined; (2) involve end users at the start of the development process; and (3) lay out the system for flexibility so that bar code formats, devices, and printers can be easily connected for application. Information systems people as well as people at the Supply Battalion headquarters should be involved. The MIS and Data sections should oversee the installation schedule and anticipate problems before the system goes into full operation.

Meyer (1991) presents a successful eight-step program in approaching inventory accuracy. He states that people management is the key to executing an inventory program such as the bar code system.

- First, managers must be aware of the problem and its magnitude. The problem with Medlog is the high rate of inventory discrepancies and the financial loss from shelf-life expiration. Both factors equate to a decreased support readiness.
- Second, the key decision makers must get involved.
- Third, a review of how and what must be done should be documented. The SOPs must be reviewed and updated to show a step-by-step process with the expected outcomes described. Additionally, the SOPs should be simple enough for inventory teams to follow.
- Fourth, goals and control procedures must be communicated to personnel concerned. Training is essential since inventory accuracy starts with the workers.
- Fifth, a test area or pilot area should be established consisting of a number of AMAL locations to introduce the system. The test area is necessary to identify strengths and weaknesses of the system to correct problem areas and/or reinforce training. Beginning with a test area should help to minimize the pain involved in learning from mistakes.
- Sixth, once the system is proven effective, integrate the rest of the Medlog inventory.
- Seventh, once the system is implemented, quality controls should be employed to assure the system is performing as expected and to identify areas for improvement.
- Lastly, supply audits, such as the one performed by Field Analysis Supply Office Two should continue to promote efficiency.

Bar coding may also be implemented using the cutover method (Ferravanti, 1990). Inventory teams perform the task in parallel. The teams simultaneously enter data using the current system as well as the bar code system until they are convinced of the accuracy provided by the replacement system. The advantage of running in parallel is security against major failure in the new system.

Another approach is the data process design methodology. An example is the traditional life cycle approach as described in Chapter IV. The sequence is as follows: systems requirements are defined; output and input formats are designed; from these formats the system's internal processing is defined; the system is coded and tested; procedures are written; the users are trained and finally data is converted as the bar code system is brought on-line (Ferravanti, 1990). The successful implementation of the system also requires a champion as the motivating force or leader. Top management as well as operational personnel must be committed in keeping the project at a high level of visibility during the entire implementation phase.

C. CAVEATS TO IMPLEMENTATION

1. Data overload is a potential drawback to detailed and timely information. Medlog has to enlist MIS support to make

best use of the huge amount of data that bar code technology can obtain. To avoid information paralysis, the Data section must establish specific guidelines about the structure of reports and how data should be placed in AMAL blocks to be analyzed. The reports must also conform to the requirements mandated by MCOs and BUMED instructions.

2. User anxiety is a possible barrier to implementation. There is oftentimes a "resistance to change" reaction of users at the start. They have to invest time in training and have to accept the change in procedures they are accustomed to. In the face of impending change, personnel may become nervous and anxious. They may worry about the ability to meet new demands and expectations. The commanders will have to manage the resistance through training, communication and facilitation by introducing the new system gradually. Although it may be different for the Marines having a strong military discipline.

3. Top management could be a barrier to the proposed system, especially if there are different conflicting priorities for the FMF structure. Even middle management sometimes views proposed solutions as just another bureaucratic administrative reaction to a management problem. A proposal could be buried in a in-basket or may end up in the shelf to collect dust. This attitude prevails because sometimes the status quo is preferred to change. The job of

middle managers is to convince key decision makers that a shift of capital investment through Other Procurement Navy (OPN) funds today would save annual Operations and Maintenance, Navy or Marine Corps (O&M,N and O&M,MC) funds in the outyears.

D. RECOMMENDATIONS FOR FURTHER STUDY

1. A pilot study should be conducted at Medlog to further determine the feasibility of bar code technology. Integration of the system could either be performed by in-house information systems personnel or by outside consultants, usually a vendor. A complete comparison can then be conducted between the manual process and the bar code system. The sequence from initial AMAL placement until replenishment can be compared across the two methods to determine differences in time and errors from actual data.

2. The Defense Priorities and Allocation System (DPAS) helps to keep current national defense programs on schedule and provides an operating system that can be expanded in a national emergency. Using this system, pharmaceuticals of certain designated war supplies may be included in the Federal Central Management (FEMA). Special instructions for normal peacetime requirements could be maintained with an operating mechanism that can be expanded during national emergency. A

segment of DPAS is the Special Priorities Assistance which allows the services to expedite deliveries, place priority rated orders, locate suppliers, and to coordinate information between customers and vendors. In Medlog, the flow of pharmaceuticals could be coordinated as follows: FEMA and DPSC establish policies with the drug industry using the DPAS concept of rated orders for D-day significant PWR pharmaceuticals; pharmaceuticals are delivered to Medlog where they are assembled into AMAL blocks as indicated by the AMAL using ALRs; assembled AMALs are distributed to FMF units for deployment and usage for D+60 days until normal replenishment is maintained. DPSC, DMSB, and FEMA should coordinate mobilization and national emergency planning for pharmaceuticals.

3. Currently, most bar code users use the hard-wired data collection method. The added task of relocating data collection devices and readers for tracking inventory still adds considerable time. There are now bar code producers who offer wireless data collection for real time transactions. This would provide more flexibility to easily move bar code collection points anywhere in the warehouse or even out in the field (FMF training deployments). Wireless data collection saves wiring costs and increases productivity by eliminating cables for hard-wired readers.

4. Lastly, the consolidation of Medlog assets from the three MEFs could be stored in a single location. There is a tradeoff between inventory costs and transportation costs. Other factors to consider include facility location, operating costs that include overhead, manpower costs, material handling costs, and mobilization. If we consolidate all assets into a single warehouse, benefits could include lower overhead and inventory. The disadvantage would be the lead time to mobilize and added costs of transportation. With the geopolitical arena perceived as decreasing in threat, perhaps consolidation would help justify budget reductions and manpower downsizing.

APPENDIX A

Current Authorized Medical/Dental Allowance List

FMF AMAL/ADALs are arranged in a modular concept. The equipment module contains equipment and reusable material required to establish the basic function of the module (e.g., AMAL 639 - Operating Room Equipment). The supply module contains consumable material designed to support the function in the treatment of a designated number of casualties or to perform a specific task. For readiness purposes, an equipment module may be stored in combination with its corresponding supply module. The material listed in each AMAL/ADAL is the minimum amount to be maintained. For a complete description of each AMAL/ADAL, refer to FMFM 4-50, Health Service Support, MC06700.2D dated 2 January 1991. It is the current primary source for the policies and procedures for procurement of AMAL/ADALs to meet the required capability of the FMF. The MEF consumables, which include pharmaceuticals, are listed below. The supply quantity held by Medlog is equal to the total line items expressed as numbers of modules.

MEDICAL BATTALION

Function	H&S Co X1	S/S Co X2	C&C Co X4	GAS X1	MWSS Tot#	Medlog X1	MEF TOTAL
Laboratory (AMAL 619)	-	6	3	9	12	155	200
Blood Bank (AMAL 624)	-	15	5	-	-	150	200
Pharmacy (AMAL 630)	_	4	2	3	4	77	100
Shock/Surgical (AMAL 632)	_	12	18	_	_	204	300
Acute Care Ward (AMAL 634)	_	45	18	_	_	270	432
Aid Station (AMAL 636)	One per division, wing, aid Station and Engineer Battalion T/O Medical Officer/Flight Surgeon (82)					218	300
Preventive Medicine (AMAL 638)	3	_	_	_	_	_	3
Operating Room (AMAL 640)	_	29	12	_	_	154	260
X-ray (AMAL 649)	_	6	3	9	12	155	200
Medlog Mission Geographic Related Supplement (AMAL 684)	_	_	_	_	_	1	1
Medlog Test& Repair Consumables (AMAL 692)	_	_	_	_	_	1	1
Sick CAll (AMAL 699)	(DivBas20)			5	4	31	60

Notes: H&S Co -- Headquarters and Service Company
S/S Co -- Surgical Support Company
C&C Co -- Collecting and Clearing Company
T/O -- Table of Organization

Source: FMFM 4-50 Health Service Support Manual

APPENDIX B
Sample Pharmaceuticals with NSN, AMAL Block and MEF Allowances

Pharmaceutical	NSN	AMAL Blk	MEF Allowance
Atropine Diphenoxylate	6505-00-074-4702	630	100
	6505-00-118-1914	636	300
Atropine Sulfate Injection	6505-00-299-9673	632	300
		634	432
		684	1
Morphine Injection	6505-00-129-5518	636	300
Morphine Sulfate	6505-00-812-2596	632	300
		634	432
		636	300
		640	260
Cupric Sulfate	6505-00-116-1495	640	260
		699	60
Chloroquine Phosphate	6505-00-117-6450	684	1
Sodium Bicarbonate Powder	6505-00-141-5000	638	3
Povidine-Iodine Ointment	6505-00-148-7096	634	432
Tripolodine Pseudo-Ephedrine	6505-00-142-9206	698	74
Glycerin USP	6505-00-153-8220	638	3
Globulin Immune USP	6505-00-153-8278	684	1
Aspirin Tablets	6505-00-153-8750	630	100
		698	74
Bacitracin Ointment	6505-00-159-6625	600	2
		647	1
		699	60

Source: Class VIII PWR Asset Requirements Report

APPENDIX C

Unique Pharmaceuticals That Maybe Requested for Shelf-life Extension

Atropine Injection

Atropine Sulfate Tablets

Calamine Lotion

Morphine Injection

Antidote, Nerve Agents

Albumin, Normal Human Serum

Atropine Sulfate Injection

Sodium Chloride - Sodium Bicarbonate Mixture

Kaolin and Pectin Mixture, Dehydrated

Chloroquine and Primaquine Phosphates Tablets

Water Purification Tablet, Iodine

Cupric Sulfate

APPENDIX D

Stability Studies

Mean anhydrous morphine content of kaolin and morphine mixture BP when stored in different containers of different sizes and materials.

Container Type	Time 0 (mfg. date)	3 mos Storage	6 mos Storage	12 mos Storage	24 mos Storage
a. 100 ml of mixture into a 100 ml amber glass, sloping shoulder, medicinal flat	.0071	.0071	.0071	.0070	.0067
b. 100 ml of mixture into a 100 ml white flint glass, sloping shoulder, medicinal flat	.0071	.0071	.0071	.0067	.0064
c. 2000 ml of mixture into a two liter amber glass winchester	.0071	.0071	.0070	.0065	.0062
d. 2000 ml of mixture into a two liter rectangular plain natural high density polyethylene container	.0071	.0068	.0066	.0059	.0051
e. 2000 ml of mixture into two liter rectangular plain amber high density polyethylene container	.0071	.0069	.0065	.0054	.0039

Proposed limits: 0.0061 - 0.0078% w/v

Discussion: All containers were stored undisturbed in normal light conditions at ambient temperatures. Results showed that a time related oxidative degradation of morphine is dependent upon the volume-fill of the container. Well-filled containers demonstrated virtually no loss of morphine over a six-month period. The morphine content demonstrated a much lower rate of degradation when stored in glass than when stored in high density polyethylene. The difference in rate of morphine degradation between two amber glass containers can be explained in terms of headspace air above the level of mixture. The study concluded that the shelf-life of kaolin and morphine mixture BP is longer when stored in well-filled glass containers.

Source: Helliwell, K., and Jennings, P., "Kaolin and morphine mixture BP: effects of containers on the stability of morphine," The Pharmaceutical Journal, p. 682, June 2, 1984.

APPENDIX E
Cost Data Sources and Computations

1. Class VIII PWR Asset Requirements Report (16 July 1991)

   - Operating costs/yr: $2.5 mil (excludes personnel cost)
   - Replenishment costs/yr: $2.0 mil
   - Consumables: 40% of Total Assets
   - 100% MEF Requirement Avg. Inventory: $23,973,704
   - Excess/Overstock: $2,094,836 (8.7%)
   - Equal Requirements: $1,265,255 (5.3%)
   - Shortages: $11,247,118 (46.9%)
   - Number of line items: 3318 NSNs

2. Supply Analysis Report - 21012

   - Disposal Costs = $223,320.72 ÷ 276 days X 356 days = $295,333.56 (1990)
   - From Julian Date: 0128 to 0007 (1991) = 276 days
   - Error Rate = 0.6
   - Expired Pharmaceuticals Rate = .31

3. (Betts, 1991)

   - Industry Data:

     a. Payback Time = 12 to 18 months
     b. Manual Data Entry Error Rate = one per 300 entries
     c. Bar Code Scanner Error Rate = one per 3,000,000 entries

4. (Chester and Zilz, 1989)

• Ave. Bar Code Device Cost:	$1,200 each
• Technician Training:	90-minute orientation to the principles of bar code system and basic operation of the device.
• Total inventory time:	342.1 hours/yr
• Annual time savings:	104.0 hours/yr
• % decrease:	30.4%

5. (Schultz et.al., 1990)

   - Industry Time savings per technician for inventory: 1 hour/day

6. (Krause, 1991)

   - Industry Training Costs: $200-250 per hour
   - Increased in reporting accuracy: 1% of the total annual costs
   - Labor Cost in Time: 14 hours/week or 2 hours/day

APPENDIX F

Pharmaceutical Inventory Reports and Documents Used for AMAL

1. Class VIII PWR Assets Requirement Report
2. Expiration Forecast Report
3. Asset Location Report
4. Warehouse Picking Ticket and Location Receipt

CLASS VIII PWR ASSET REQUIREMENTS REPORT

EXPIREO REJECTEO 9108

PART A: AMAL / ADAL (TRL) STOCK NUMBERS - OETAIL SECTION

OIC	NAT-STOCK-NUMBER	AML NUM	MEF AML ALLOW	MEB AML ALLOW	TRL U-I	TRL QUANTITY	MEF QUANTITY	BULK QUANTITY	MEB QUANTITY	AUTHORITY FOR ITEM IN AMAL / ADAL
TRL	6505-00-864-6298	684	1	0	VI	20.000	20.000	0.000	0.000	
TEC: QUINIDINE GLUCONATE INJ 80MG/ML 10ML					CONSUMABLE ITEM		ITEM DAMAGED IF FROZEN		UI: VI	UPQ: 100 STD-UP: $ 9.70
TOTAL MEF QTY:	20.0	COST:	194.00		TOTAL CURRENT AST:	367.0		BULK ASSET:	367.0	
BUL QTY:	0.0		0.00		EXPIREO AST:	0.0		MEB QTY SHORT:	0.0	VALUE: $ 0.00
MOO QTY:	20.0		194.00		ASSETS SUMMARY:	367.0		MEF QTY (+/-):	347.0	VALUE: $ 3,365.90
MEB QTY:	0.0		0.00							
TRL	6505-00-865-2401	640	260	24	PG	1.000	260.000	160.000	24.000	
TEC: CALCIUM CHLORIDE INJ 0.1GM/ML 10ML				25	D-DAY SIGNIFICANT		ITEM DAMAGED IF FROZEN		UI: PG	UPQ: 25 STD-UP: $ 9.86
TOTAL MEF QTY:	260.0	COST:	2,563.60		TOTAL CURRENT AST:	17.0		BULK ASSET:	0.0	
BUL QTY:	160.0		1,577.60		EXPIRED AST:	0.0		MEB QTY SHORT:	7.0	VALUE: $ 69.02
MOO QTY:	100.0		986.00		ASSETS SUMMARY:	17.0		MEF QTY (+/-):	243.0-	VALUE: $ 2,395.98-
MEB QTY:	24.0		236.64							
TRL	6505-00-889-9034	600	2	1	BT	6.000	12.000	0.000	6.000	
TRL	6505-00-889-9034	699	60	31	BT	1.000	60.000	0.000	31.000	
TEC: BISACODYL TABS USP 5MG 1000'S ENTERIC					CONSUMABLE ITEM		POTENCY OR EXPIRATION		UI: BT	UPQ: 1 STD-UP: $ 4.92
TOTAL MEF QTY:	72.0	COST:	354.24		TOTAL CURRENT AST:	18.0		BULK ASSET:	5.0	
BUL QTY:	0.0		0.00		EXPIREO AST:	0.0		MEB QTY SHORT:	19.0	VALUE: $ 93.48
MOO QTY:	72.0		354.24		ASSETS SUMMARY:	18.0		MEF QTY (+/-):	54.0-	VALUE: $ 265.68-
MEB QTY:	37.0		182.04							
TRL	6505-00-890-1657	600	2	1	BT	60.000	120.000	0.000	60.000	
TRL	6505-00-890-1657	699	60	31	BT	10.000	600.000	0.000	310.000	
TEC: KAOLIN/PECTIN MIXTURE DEHYDRATED 53GM					D-DAY SIGNIFICANT		POTENCY OR EXPIRATION		UI: BT	UPQ: 1 STD-UP: $ 1.24
TOTAL MEF QTY:	720.0	COST:	892.80		TOTAL CURRENT AST:	1,673.0		BULK ASSET:	1,104.0	
BUL QTY:	0.0		0.00		EXPIRED AST:	0.0		MEB QTY SHORT:	0.0	VALUE: $ 0.00
MOO QTY:	720.0		892.80		ASSETS SUMMARY:	1,673.0		MEF QTY (+/-):	953.0	VALUE: $ 1,181.72
MEB QTY:	370.0		458.80							
TRL	6505-00-890-1840	630	100	5	BT	2.000	200.000	150.000	10.000	
TRL	6505-00-890-1840	634	432	36	BT	1.000	432.000	270.000	36.000	
TRL	6505-00-890-1840	684	1	0	BT	801.000	801.000	0.000	0.000	1990CMC LIST
TEC: METRONIDAZOLE TAB'S 250MG 250'S					D-DAY SIGNIFICANT		POTENCY OR EXPIRATION		UI: BT	UPQ: 1 STD-UP: $ 3.28
TOTAL MEF QTY:	1,433.0	COST:	4,700.24		TOTAL CURRENT AST:	58.0		BULK ASSET:	14.0	
BUL QTY:	420.0		1,377.60		EXPIRED AST:	0.0		MEB QTY SHORT:	0.0	VALUE: $ 0.00
MOO QTY:	1,013.0		3,322.64		ASSETS SUMMARY:	58.0		MEF QTY (+/-):	1,375.0-	VALUE: $ 4,510.00-
MEB QTY:	46.0		150.88							

E X P I R A T I O N F O R E C A S T R E P O R T - A L L A S S E T S
F O R P E R I O D : 0000 T O 9701

NAT STOCK NUMBER	LOCATION	BOX	WHOLE QTY	PART QTY	LOT NUMBER	MFG CODE	MFG DATE	NEXT INSP	XPIR DATE	LIFE LEFT	KEY ID NUMBER
6505-00-582-4737	SDUXPIR03		1		2KEE				8905	28-	90266
	SDUXPIR03		1		2KNU				8912	21-	319006
	SD0001604		8		2-M1DC				9108	1-	8612
	SD1410130		60		2-M1DC				9108	1-	8610
	SD2019518		36		2-M1DC				9108	1-	8615
	SD2839630		60		2-M1DC				9108	1-	8614
	SLIQXP001		1		2-KEE				8905	28-	284406
	SLIQXP001		7		2KEE				8905	28-	638962
	SLIQXP001		8		FDA-STRG-2LKCW				8909	24-	405259
	SLIQXP001		1		2KU				8912	21-	147010
	SLIQXP001		696		2KNU				8912	21-	638963
	SLIQXP001		3		2-MHCA				9107	2-	774773
	SLIQXP001		7		2MHCA				9107	2-	368915
	SLIQXP001		7		2-M1DC				9108	1-	279475
	SLIQXP003		1						8912	21-	367349
	SMCSXP005		1		2-M1DC				9108	1-	705394
	SPILXP003		1		2-M1DC				9108	1-	728374
	SWCM010AA		1		Z6NU				8912	21-	118472
	SWCM010AA		25		2KNU				8912	21-	263040
	S600ML000		24		2-M1DC				9108	1-	396011
	W140325DA		2		4016-1				8406	87-	658846
	W140507AA		1,128						9107	2-	658847
	W140750AA		4		2MHCA				9107	2-	657570
	W140750BA		1		2KNU				8912	21-	689719
	W140750BA		2		2MHCA				9107	2-	688320
	W140750BA		2		2-MHCA				9107	2-	711791
	W140750BA		3		2MIDB				9108	1-	684457
	W140750BA		12		2-M1DC				9108	1-	684458
	W140760CA		1		2-M1DC				9108	1-	703670
	600002028		24		2-M1DC				9108	1-	3971
	632002007		1		1B17				9302	17	757276
	632003007		1		1B17				9302	17	759804
	632005007		1		1B17				9302	17	757278
	632006007	DEPL	1		2-MHCA				9107	2-	139485
	632008007		1		2-M1DC				9108	1-	338019
	632012007		1		1B17				9302	17	716789
	632013007		1		1B17				9302	17	716790
	632014007		1		2-MIDB				9108	1-	706744
	632015007		1		1B17				9302	17	718496
	632016007		1		1B17				9302	17	716788
	632019007		1		2-MIDB				9108	1-	706745
	632020007		1		1B17				9302	17	718494
	632022007		1		2MHCA				9107	2-	106042
	632023007		1		2MHCA				9107	2-	196717
	632027007		1		2KEE				8905	28-	296857
	632028007		1		2-M1DC				9108	1-	134440
	632029007		1		2-M1DC				9108	1-	134441
	632035007		1		1B17				9302	17	757280

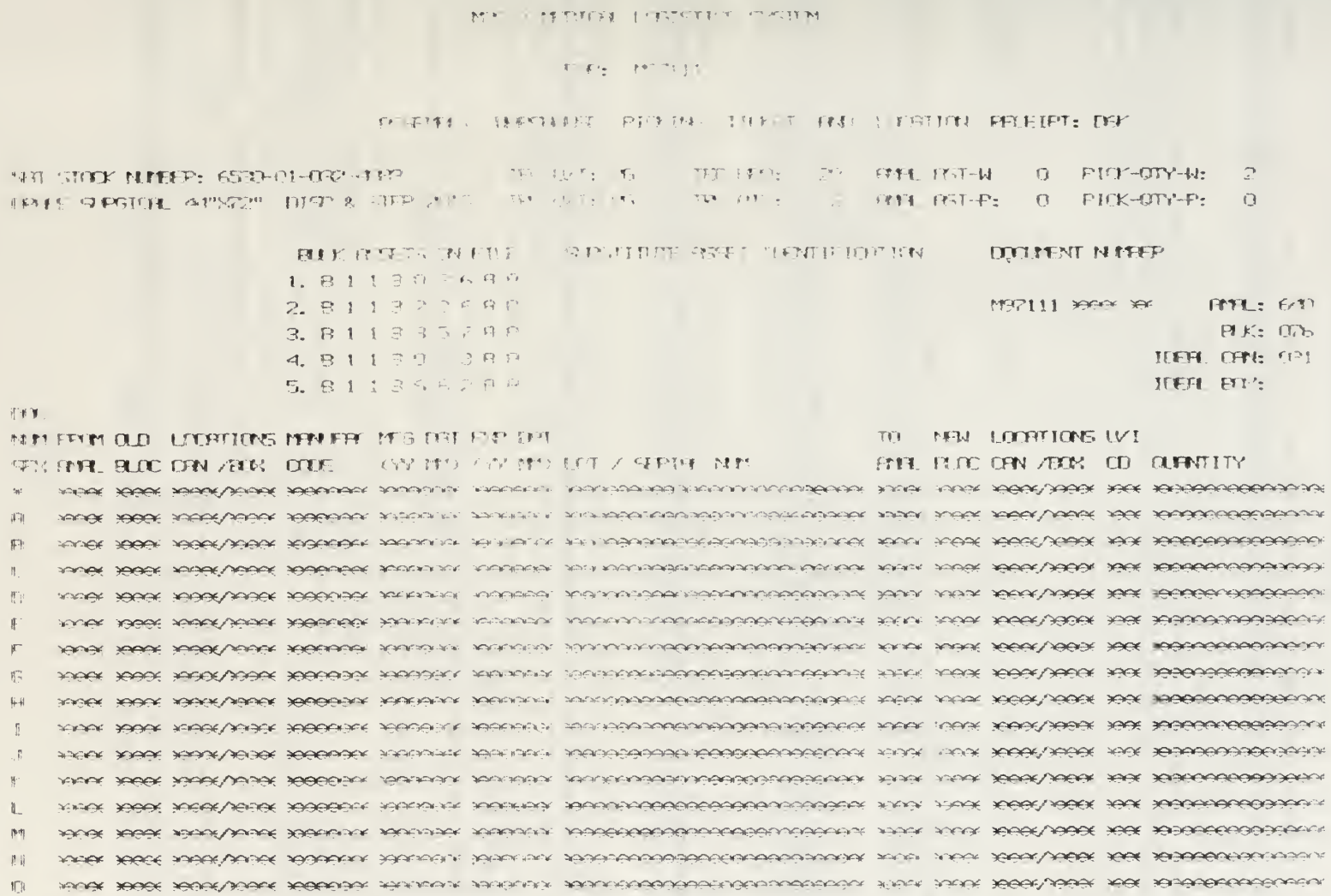
M S MEDICAL LOGISTICS DATA SYSTEM

[illegible]

ASSET LOCATOR REPORT FOR: AMAL 635 AID STATION EQUIPMENT BLOCK: 057

SECTION A: LOCATION SEQUENCE

LOCATION CAN	BOX	NAT STOCK NUMBER	N O M E N C L A T U R E (A29)	TRAILER U/I AND PKG-QTY	MFG. CODE	MFG. DATE	INSP DATE	EXP. DATE	LOT/SERIAL NUM	WHOLE ASSET QTY	PART. ASSET ISS	SHELF LIFE LEFT	KEY ID NUMBER
010		6515-0-299-8719	STRAP LEG TRACTION ADJUSTABLE	EA 6					OLA1207910E908	6		0	46480
010		6515-0-372-5125	LITTER BAR LEG SPLINT SUPPORT	EA 4		8008	9908			1		0	53895
010		6515-00-754-2660	SPLINT SUPPORT FOOT REST LEG	EA 4		8308	9908			2		0	56750
010		6515-01-071-6645	SPLINT LEG THOMAS HALF-RING	EA 4		9308	9908			2		0	61823
010		6530-00-784-4335	STRAP WEBB LITTER SECURING FE	EA 96						15		0	117741
010		6530-00-788-4010	RESTRAINT SET, WRIST AND ANKL	SE 2		8502				2		0	159986
010		6530-00-792-6000	I.V. SUPPORT POLE LITTER ONE-	EA 6		8308	9906			8		0	64081



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