AN ABSTRACT OF THE THESIS OF

DANIEL BRUCE KINGSLEY for the degree of MASTER OF SCIENCE

in Industrial and General Engineering presented on August 26, 1975

Title: AN ANALYSIS OF THE UNIT DOSE PHARMACY SYSTEM IN SMALL HOSPITALS

Abstract approved by Redacted for Privacy

Dr. James L. Riggs

The traditional and the unit dose pharmacy distribution system were compared to determine which one, in the opinion of hospital pharmacists and administrators, is best suited to the needs of hospitals of less than 200 beds.

The comparison was made by having the pharmacists rate the alternative distribution systems on five criteria at four hospital size categories. The hospital size categories were less than 50 beds, 50 to 100 beds, 100 to 150 beds and greater than 150 beds. The comparison criteria were cost, control of medication, pharmacist utilization, patient safety and loss and pilferage. Each criterion had a certain amount of weight in determining the final rating of each distribution system. This weight was determined by the administrators' and pharmacists' rating of the importance of each criteria in governing the type of distribution system used in a hospital. The final rating

given each distribution system at a given hospital size was the sum of the products of the rating of each criterion and its respective importance rating, for all the criteria.

The final results showed that the unit dose distribution system was felt to be substantially more suited to the needs of small hospitals. The unit dose system averaged at least 100 points better than the traditional system in all four hospital size categories.

An Analysis of the Unit Dose Pharmacy System in Small Hospitals

by

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A THESIS

submitted to

Oregon State University

in partial fulfillment of
the requirements for the
degree of

Master of Science

June 1976

APPROVED:

Redacted for Privacy

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Date thesis is presented August 26, 1975

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ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to Mr. Rodney Anderson, chief pharmacist at Lebanon Community Hospital, and to Mr. Paul Rassensperger, chief pharmacist at Good Samaritan Hospital in Corvallis, for their assistance in helping me better understand the functioning of a hospital pharmacy.

I would also like to thank Dr. James L. Riggs for his help and guidance during the course of this study.

Finally, I would like to thank my wife, Lynne, for her support and encouragement without which the completion of this task would have been much more difficult.

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CHAPTER I

INTRODUCTION

The hospital pharmacy department is one part of the total medication distribution system. This system includes ordering and receiving medications into the hospital, filling physicians' medication orders (prescriptions), administering medications to the patients and recording the results of the medication therapy. Traditionally the hospital pharmacy has been only responsible for ordering and receiving medications into the hospital and then dispensing these medications to the nursing units.

Over the past several years traditional medication distribution systems have been severely criticized. Hospital pharmacy literature published during this period has shown that traditional systems have resulted in a significant degree of medication errors (as great as one medication in error for every five medications administered), pharmacy staff inefficiencies and medication losses. For these reasons the technological improvements in pharmacy have emphasized the development of medication distribution systems that insure increased patient safety, improved medication control and better utilization of pharmacy and nursing personnel.

One alternative distribution system which can overcome some of the deficiencies of traditional systems is the unit dose distribution system. In the unit dose system, the hospital pharmacy provides a single dose of medication in ready-to-use form for administration to the patient, when required. The pharmacy also has the increased responsibility for controlling medications and in some cases administering medications to the patient.

A substantial amount of research has been conducted to determine the feasibility of the unit dose distribution system in large hospitals (usually much larger than 500 beds). In these studies the unit dose system generally does very well in meeting the hospitals' needs However, questions arise when looking at smaller hospitals: Are these study results at the large hospitals applicable to small hospitals, especially those with less than 200 beds? What will the hospital gain by changing from its present distribution system to the unit dose system? These are questions that a substantial number of small hospitals face and which up to now have been largely unanswered.

There are currently more than 7,060 hospitals in the continental United States,[1] of which 71 percent are hospitals of less than 200 beds. In Oregon the percentage is even greater: 82 percent of the hospitals (74 of the 90 hospitals) are of less than 200 beds. These are general hospitals which employ at least one full-

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[1] Statistics on numbers of hospitals and sizes are obtained from the American Hospital Association 1972 Hospital Statistics.

time pharmacist per 100 beds (usually more) and which need a thorough and complete drug distribution system (Wastchak, 1968). Dr. William E. Hassan in his text, Hospital Pharmacy, wrote, ". . . it is in the hospital of no more than 100 beds that we find the greatest challenge for providing adequate pharmaceutical services." The major part of this challenge is finding a medication distribution system that best suits the needs of hospitals of less than 200 beds.

It is, therefore, the intent of this study to compare the traditional and unit dose distribution systems in hospitals of less than 200 beds. The purpose being to determine which distribution system is best suited to the needs of hospitals of this size. This comparison is made by the hospital personnel very much involved in determining the type of distribution system used in a hospital: the chief pharmacists and administrators.

Chapter II consists of a general description of traditional distribution systems and of the unit dose distribution system. Chapter III consists of the highlights of previous research on the feasibility of the unit dose system and an initial survey of Oregon hospital pharmacists to test the applicability of the previous research to hospitals in this area. Chapter IV describes the methodology used: the method of analysis; the development of the criteria used for comparing the traditional and unit dose systems; and the second survey rating the importance of the criteria and comparing the two distribution systems at four hospital size categories. In Chapter V the results of the second survey are detailed and the final results of the comparison of the alternative distribution systems are calculated. The material in Chapter VI consists of a summary of the results and recommendations for future studies.

CHAPTER II

MEDICATION DISTRIBUTION SYSTEMS

Traditional Distribution System

The traditional pharmacy medication distribution system is used by a majority of the hospitals in the United States today. There are several variations of this system in use; the three most common will be described in the following paragraphs.

In the first variation a complete stock of all medications is kept on the nursing floor. When the physician orders medications for a patient the nurse gets the medication from the floor stock, prepares and administers the medication to the patient, and records the results of the medication therapy. The pharmacy's job is essentially supplying the nursing unit with bulk packages of all medications. These supplies are replenished either by requisition from the nursing unit or on a routine replacement basis.

In the second variation the nurse sends a requisition or a copy of the physician's order for each patient to the pharmacy to be filled. The pharmacy provides the nursing unit with a supply of medications for each patient. When it is time for the medication to be given to the patient, the nurse readies the medication for administration, administers it to the patient and charts the results. When the patient's supply is depleted, a refill order must be sent to the pharmacy by the nurse.

The third variation, the most widely used traditional distribution systems in hospitals today, is a combination of the two previous methods. The most frequently used medications are stocked on each nursing floor. The less commonly used items are ordered from the pharmacy when prescribed by a physician. In this case too, the nurse is in charge of preparing the administering the medications and recording the results of the medication therapy.

A simplified diagram of the flow of information and materials (medications, requisitions, etc.) in the traditional system is given in Figure 2.1.

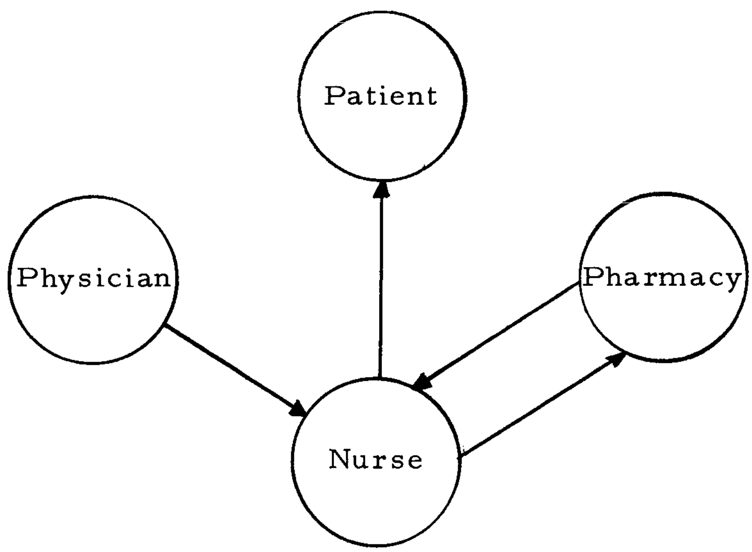

Figure 2.1. Information and material flow in the traditional system.

As can be seen from Figure 1, in the traditional system the nurse has the essential role of coordinating all activity concerned with medications in the patient area. The nurse is responsible for:

(1) Receiving and transcribing physician's orders for medications,

(2) Insuring that the correct medications are available in the nursing area,

(3) Determining when medications are to be administered,

(4) Readying and administering medications to the patients,

(5) Recording and evaluating patients' reactions to medications.

The pharmacy's primary responsibilities are the procurement of medications from outside the hospital and the distribution of medications to the patient areas. Figure 2.2 gives a diagram of the work flow of the most common traditional distribution system. The diagram shows the areas of responsibilities for both nursing and pharmacy personnel. (The dotted lines denote transactions made to the patient charts.)

Unit Dose Distribution System

Development

In the early 1960's an investigation of drug distribution systems was conducted by Barker and Heller (Nov., 1963) at the University of Arkansas Medical Center (U.A.M.C.). Their interdisciplinary

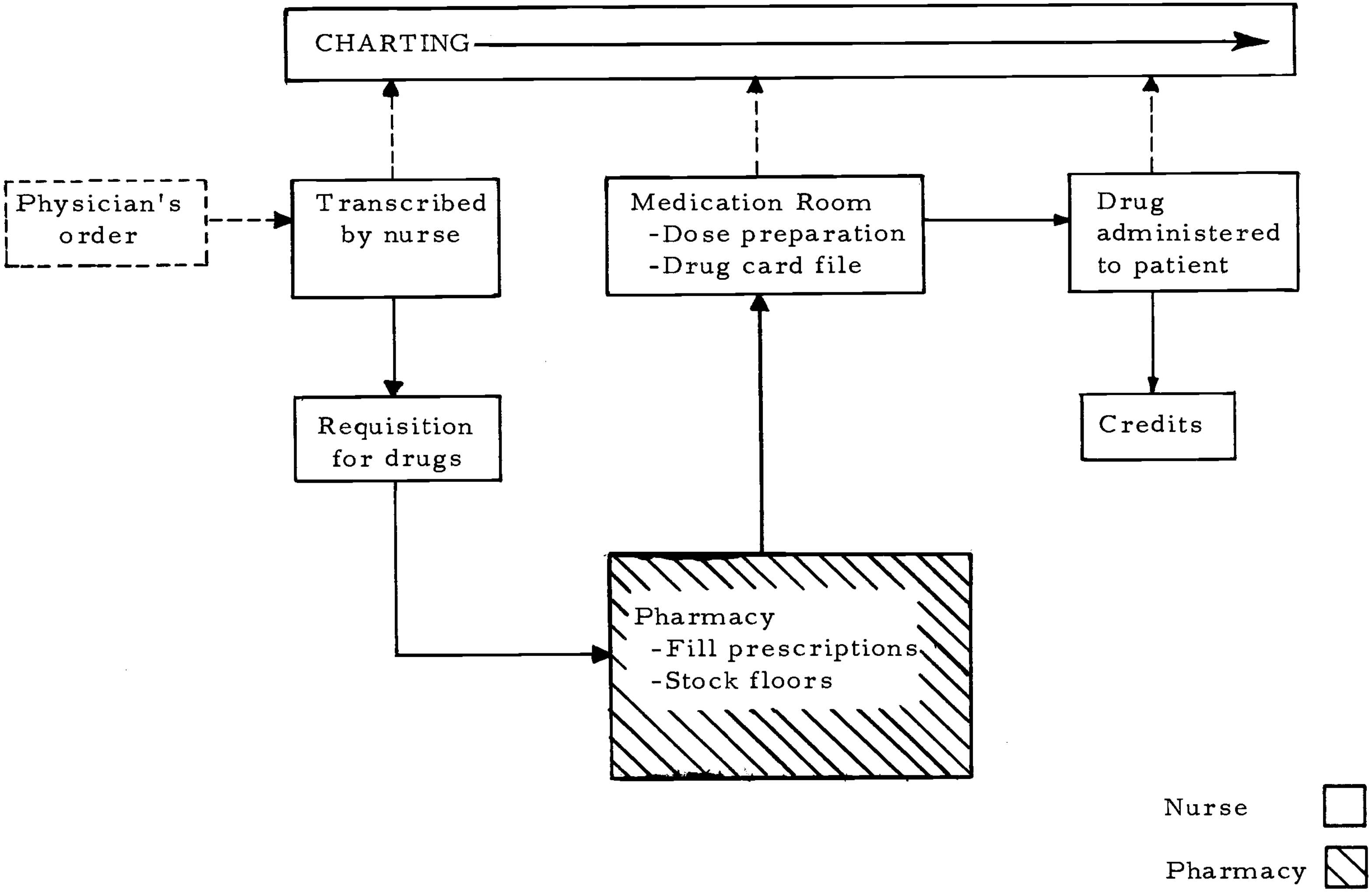

Figure 2.2. Work flow of the traditional distribution system.

research team concluded that existing medication distribution systems in hospitals were:

> Wasteful of economic and human resources, inequitable in their distribution of the cost of patient care and becoming an increasing danger to the health of every person whose health they were supposedly designed to improve--the patient.

They reported that in the face of hospital and health care trends of increased use and numbers of drugs, increased use of health facilities, expanding population, the great rise in the number of people who can pay for health care and the greater rise in prepayment plans to pay for those that can't, it did not appear that existing systems would be able to maintain even barely satisfactory levels of performance and their potential for improvement seemed unencouraging.

As an alternative to existing systems they established a centralized unit dose drug distribution system and after a thorough investigation found that it was feasible and could solve many of the problems of traditional systems.

University of Arkansas Medical Center System

In the unit dose system individual dosages of medication are prepared and dispensed for administration. A unit dose is defined as, ". . . any physical quantity of a drug specified by a physician to be administered to a patient at one time, and not requiring any significant physical or chemical alterations before being administered"

(Barker and Heller, Nov. 1963). Generally, the central pharmacy prepares all medications thus eliminating the nurse's function of ordering, inventorying floor stock drugs and preparing medications for administration.

In the system developed by Barker and Heller at the University of Arkansas Medical Center, when it is time for medications to be administered, the pharmacy delivers a medication cart containing the individual patient medication in unit dose form to the nursing unit. The medication cart remains at the nursing unit for a specified period of time. At the end of the period the cart is replaced by a new cart containing medications for the next period. The replaced cart is returned to the pharmacy and refilled. The time the cart remains at the nursing unit is approximately two hours. Medication orders are initiated upon the receipt of a copy of the physician's order. This system also provides 24-hour-a-day coverage by the pharmacist.

General System Description

There are three general classifications of unit dose distribution systems. They are centralized, decentralized and various combinations of the two. In the centralized system each individual dose is prepared for administration in a centrally located pharmacy. In the decentralized system each individual dose is prepared for administration in a subsidiary (or satellite) pharmacy on the nursing floor.

A simplified diagram of the flow of information and materials (medications, physician's orders, etc.) in the unit dose system is given in Figure 2.3.

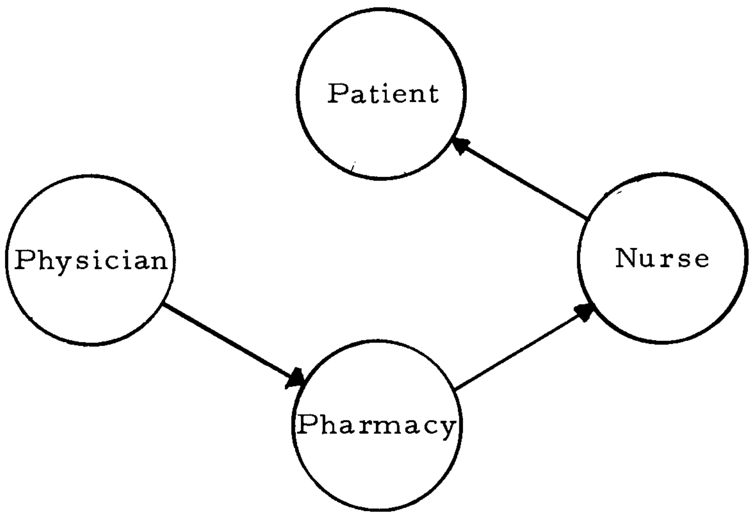

Figure 2.3. Information and material flow in the unit dose system.

There are several variations of the unit dose distribution system used today. The systems vary primarily in the degree to which the pharmacy department becomes involved in administering medications to the patients. Beste (1968) developed a unit dose system in which certain nurses were assigned to drug administration fulltime and were budgeted and scheduled by the pharmacy. Latiolais et al. (1970) developed a system in which trained technicians are employed by the pharmacy to administer the medications.

The systems also vary in the amount of coverage by the pharmacist and the length of time the medication carts remain at the nursing unit. In the smaller hospitals there is coverage by a pharmacist usually only eight to 12 hours a day. Thus because the pharmacist is not at the hospital 24 hours a day the length of time the cart remains at the nursing unit varies. Usually the carts are exchanged at four-, eight- or 12-hour intervals.

The distinguishing features of the unit dose distribution systems are that the pharmacy personnel are responsible for:

(1) Recordkeeping associated with dispensing and controlling medications,

(2) Interpreting physicians' orders,

(3) Maintaining patient medication records,

(4) Providing unit dose packages of medications at the time the medications are to be administered.

(5) In certain instances administering medications to patients.

Figure 2.4 gives a diagram of the work flow of the unit dose distribution system. Dotted lines represent information transferred to the patient's chart.

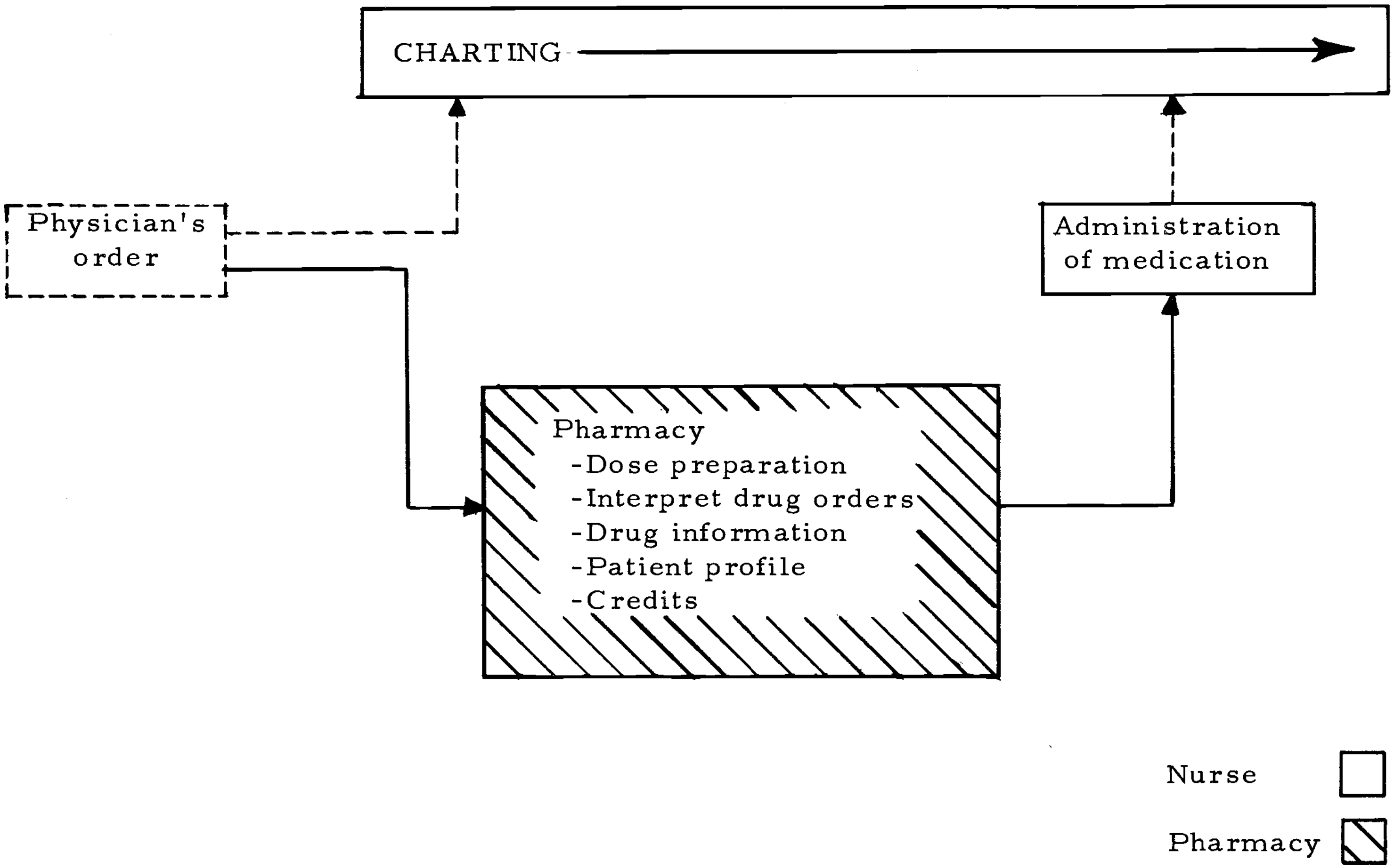

Figure 2.4. Work flow of the unit dose distribution system.

CHAPTER III

COSTS AND BENEFITS OF THE UNIT DOSE DISTRIBUTION SYSTEM

A tremendous amount of literature has been published extolling the benefits of the unit dose distribution system since its inception in the early 1960's. In a majority of this literature some type of analysis is made comparing the unit dose system to the distribution system that was previously used. This analysis is usually a modified version of the benefit to cost analysis.

The following paragraphs are a brief description of the benefits and costs of the unit dose distribution system, as presented in the current pharmacy literature.

Costs

In the unit dose distribution system increased costs occur mainly in three areas: (1) labor costs; (2) equipment costs; (3) more inventory space is required.

Increased labor costs occur because a larger pharmacy staff is required. The unit dose system requires significantly more pharmacists and pharmacy technicians to handle the greater work load. The major reasons for the larger staff are that the pharmacy has increased responsibilities and increased paper work. More labor is needed to package medications that do not come in the unit dose form and the pharmacy must provide service over longer periods of time per day. Several studies (Smith-Mackewicz, 1970; Yario et al., 1972; Mueller, 1972) have shown that pharmacy costs increased by between $.30/patient/day and $.65/patient/day in the unit dose system.

Equipment costs increase because more equipment is needed to distribute medications to the patient areas in the unit dose system. The additional equipment are medication carts and drug packaging machines to package medications that are not available in the unit dose form. The hospital may also want to package medications in unit dose form, rather than purchase prepackaged medications.

More inventory space is needed in the pharmacy in the unit dose system because the individually packaged doses require more space than bulk packages. Osterberger (1971) in his study of the layout and design of a unit dose pharmacy said, "unit dose packages present a problem. . . . packages are far from being uniform." In a lot of pharmacies it is not economically feasible to expand their facilities any significant amount. This is usually the case in the older hospitals where the pharmacy was designed for smaller inventories of drugs.

Another area in which costs are higher in the unit dose system is the cost per dose of medication. The cost difference of unit dose is approximately $.15 - $.30 per 100 doses more than bulk costs (Zilz, 1972). However, because nursing unit inventories are discontinued and because of increased pharmacy control, the overall cost of medications decreases. Also there seems to be a definite trend appearing in the pharmaceutical industry to reduce the unit dose costs (Zilz, 1972).

Benefits

In the unit dose system the benefits listed most often are increased control over medications, better utilization of nursing staff and pharmacy, and reduced medication errors.

Increased control over medications results because of the increased control of drug distribution by the pharmacy in the unit dose system. There is less waste and pilferage of medications. A study made by Mathieson and Rawlings (1971) showed that discarded medications may account for as much as 16.9% of a nursing home patient's drug bill. This waste resulted from (1) discontinued orders, (2) transfer of patients, and (3) death of the patient. How applicable these results are to the hospital may be questioned. In the unit dose system much of this waste is eliminated because the patient is only given the medication needed. Increased accuracy in charting medications on the inpatient medical record (done in the pharmacy) reduces the loss due to missed charges. Pilferage is often mentioned but is rarely evaluated because of the difficulty in gaining accurate information regarding this problem. The discontinuation of the floor stocks in the unit dose system reduces the chances for pilferage to occur.

Better utilization of the nursing staff and pharmacy occurs in the unit dose system because most of the medication administration duties that were performed by the nurses in the traditional system are now being done by the pharmacy. Better use is made of the pharmacy and the nurses are able to spend more time in "nursing" functions. Studies have shown that in the unit dose system the decrease in nursing hours spent in medication related activities in a typical nursing unit ranged from 40% to 60% of original time spent on medication duties in the traditional system (Martin, 1970; Jacobsen, 1972). In many cases this savings in nursing time was translated into dollar savings to offset the increased pharmacy personnel costs. Better use is made of the pharmacy because the unit dose system allows the pharmacist to have more input in drugs a patient receives; thus reducing the chance that the patient would receive drugs to which he would have a harmful reaction.

The major benefit listed in all of the studies of unit dose systems is the reduction of medication errors. A study of four hospitals, three using traditional distribution systems and one using the unit dose distribution system, by Hynniman _et al_. (1970) showed that a significant amount of medication errors, between 10% and 20%, were committed in the traditional system. (The Hynniman study is the major study dealing with medication errors that is quoted in current pharmacy literature.) In the unit dose system the error level was below four percent. The errors were broken down into two categories, omission errors and commission errors. Omission errors occur when the patient does not receive the medication. In the traditional systems omission errors occurred three to nine percent of the time and in the unit dose system less than three percent of the time. Commission errors occur when the patient receives the wrong medication. Usually commission errors are of the following types: the wrong dosage is given, dosage is in the wrong form, an extra dose is given (beyond physicians' orders), an unordered medication. The most common error found was that the medication was administered at the wrong time. In the traditional systems commission errors occurred two to eleven percent of the time and less than one percent of the time in the unit dose system.

Once the studies of medication errors determine the levels of errors for the two systems they stop. Nowhere is it stated what the reduction in medication errors is worth to the hospital. Documentation of medication errors is very scarce. The problem was aptly put when someone said, ". . . neither has there been definitive information on medication errors simply because no hospital can depend on the willingness of personnel to report these when they occur" (Modern Hospitals, Nov. 1966, p. 103).

State of the Art

The "state of the art" in studies written about the unit dose distribution system was very well put by Richard Andriole (1972). In his study of the literature he concluded that:

> Primary themes of unit dose articles are those of patient safety and more meaningful roles of both the pharmacist and the nurse. In comparison to the total literature on the subject few articles deal with the financial considerations of the unit dose distribution systems.

He goes on to say that although it is fairly well documented that the unit dose distribution system is an effective system of getting the right drug to the right patient at the right time and that it will reduce medication errors, questions should be raised about its ability to provide a cost savings and a nurse labor saving that will increase at a constant rate over time.

After a thorough search of the available literature on unit dose, I agree with Andriole's statement. The documentation has not been strong and some of the study methods have been questionable, particularly in the financial aspects.

One other fact noticed in the literature is that the studies in which the unit dose system is considered most feasible are conducted at hospitals of at least 400 beds, usually larger. The studies at smaller hospitals, i.e. 250 to 400 beds, for the most part do not have good documentation of the results of their studies. Their conclusions usually consist of general comments about the savings that are possible. These savings are in many cases based on studies done at bigger hospitals. Studies done at hospitals of less than 200 beds have very little objective support for the savings they say are possible. In most cases the support is in the form of a subjective appraisal of the system.

Survey I

In order to determine if the hospital pharmacists in Oregon agree with the benefits and costs (disadvantages) of the unit dose system, as presented in the literature, a survey was developed. The survey requested information in two areas: (1) what sources introduced the participant to the unit dose concept; (2) rank the benefits or disbenefits of the unit dose system.

Information about what sources introduced the pharmacist to the unit dose distribution system was requested in order that the most influential sources could be determined. This was needed to answer the question as to whether or not the drug companies were the major source behind the unit dose movement. Information about the benefits and disadvantages was wanted for the reason stated above, to see if the material presented in the literature was representative of how

Oregon hospital pharmacists thought. A copy of the survey is given in Appendix A.

The survey was mailed to 56 pharmacists (to chief pharmacists in hospitals with more than 50 beds) around the state, of which 31 were filled out and returned. A breakdown of the returned surveys, by hospital size and type of distribution system used, is given in Table 3.1. The results of the survey are given in Tables 3.2 and 3.3.

Table 3.1. Breakdown of the surveys returned by hospital size and type of distribution system used.

Hospital Size, Number of Beds	Type of Pharmacy System Used		
	Traditional System	Unit Dose System	Changing to Unit Dose System
50 to 100 beds	5	4**	3*
100 to 200	3	3	
200 to 300	3		1
300 and above	1	5	1

* These hospitals are changing to modified unit dose systems (combination of traditional and unit dose systems).

** These hospitals are using a modified form of the unit dose system.

Generally, the results of the survey correlated well with the benefits and disadvantages (items that cause costs to increase)

Table 3.2. The results of the ranking of the unit dose distribution system benefits by the hospital pharmacists. The value in parenthesis is the average of the ranks given by the pharmacists.

Benefits	Rank
Decreased medication errors	1 (1.5)
Increased control of medications	2 (2.33)
Allows for more appropriate utilization of nursing skills	3 (3.33)
Better utilization of pharmacy personnel	4 (3.75)
Reduced loss and pilferage of medications	5 (4.5)

Table 3.3. Results of the ranking of the disadvantages of the unit dose system by the hospital pharmacists. The value in parenthesis is the average rank given to the disadvantage by the pharmacists.

Disadvantages	Rank
Requires a large pharmacy staff	1 (2.36)
Requires more inventory space than bulk packages	2 (3.09)
Results in increased equipment costs	3 (3.73)
Cost of unit dose medications is higher than bulk medications	4 (3.82)
Unavailability of drugs in unit dose form	5 (4.82)

presented in the unit dose literature. The major exception was that the pharmacists mentioned several times that there was a lack of support or a resistance to the unit dose system by the hospital administrator and nurses. The lack of support by the administration is something that is not mentioned in any of the studies. In fact they strongly imply, that is if they don't come out and say it, that the unit dose system is supported by their administrations. The resistance by nurses according to the literature is an initial response to the unit dose system. Whether this is the case here or not is unknown. The implications of this resistance will be discussed more fully later.

The survey results also showed that the drug companies were not, as was previously thought, the prime movers behind the unit dose distribution system. The pharmacists listed their professional societies and peer group as the most influential source behind the introduction of the unit dose system. The results of the survey on sources of information, listed in order of decreasing influence, are:

1. Professional society and peers (other pharmacists),
2. Pharmacy publications,
3. Drug companies.

CHAPTER IV

METHODOLOGY

As was stated in Chapter I, the purpose of this study is to determine which medication distribution system, the traditional or the unit dose, would best suit the needs of small hospitals (hospitals with 200 or fewer beds). To accomplish this, hospital personnel were given a survey in which they were asked to rate several criteria. These criteria govern the type of medication distribution system used in a hospital.

Survey Population

The hospital personnel surveyed were the administrators and the pharmacists. These two groups were chosen because they are the two groups most involved in determining the type of pharmacy system used. The administrators in the survey are in charge of hospitals of less than 200 beds. The pharmacists in the survey are the chief pharmacists in hospitals of 400 beds or less. Both hospitals using the traditional and unit dose distribution systems are in the survey. (All hospitals in the survey are in Oregon).

Method of Analysis

The criteria used to compare the unit dose and traditional systems are, for the most part, intangibles. The survey participants are asked to compare the two alternative distribution systems on the basis of their judgment of the attributes of those systems. To handle this, a method for measuring intangibles must be employed.

One of the best measurements of intangibles we can strive for is an interval rating. This type of scale provides a relative measure of preference in the same way a thermometer measures relative warmth (Riggs and Kalbaugh, 1974). An interval scale usually extends from zero to one, from least preferable to most preferable. The person doing the rating places each alternative on the scale where he feels it belongs. The alternatives are compared only over one criteria at a time. An example of an interval scale is shown in Figure 4.1.

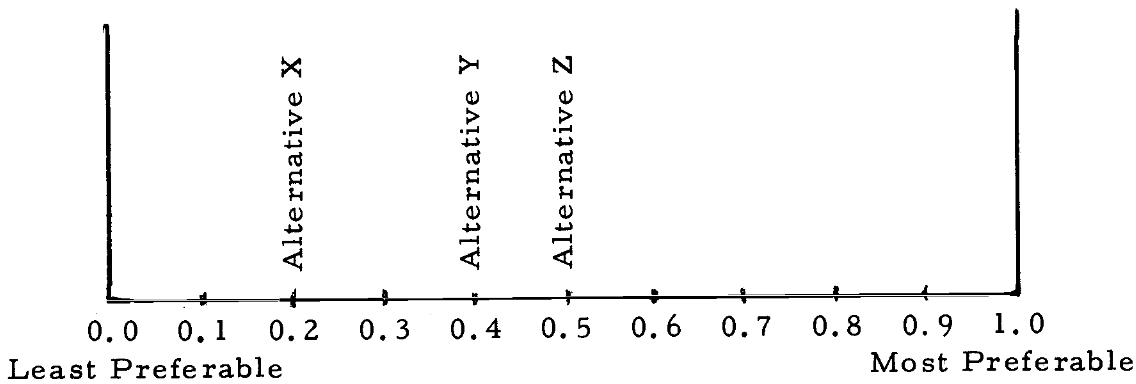

Figure 4.1. Interval scale assignments for three alternatives.

Since more than one criterion was being used to compare the two systems it was necessary to come up with a single value that represents each alternative. This was accomplished using the following procedure (Riggs and Kalbaugh, 1974):

Step 1. Select independent criteria by which to compare all alternatives. A quantitative value must be developed to measure how well each criterion is satisfied.

Step 2. Use rating procedures to determine the relative importance of each criterion (a scale of one to ten with the higher numbers indicating a greater importance was used).

Step 3. Identify the various outcomes. Rate all alternatives for one criterion before going to the next criterion.

Step 4. For all the alternatives, multiply each criterion rating by its respective importance number and add the products of all multiplications. The alternative with the highest total is the preferred solution.

An excellent analogy of this method of arriving at an answer was given by Kavanaugh (1974) when he stated, ". . . is similar to the way a winner in the Pentathlon of track is determined. In the Pentathlon, athletes compete in five events, which could be thought of as criteria. In each event, the athlete, the alternative, is given a certain amount of points depending on how well he did. Some events offer more points than others which would be analogous to the importance rating. At the completion of the five events, the points gained by the athlete are summed up and the one with the most points is the winner."

Criteria

There are three basic factors which govern the choice of the drug distribution system used:

(1) Patient care and safety,

(2) Efficiency,

(3) Economics

(Barker, 1962). These factors provided the basis from which all previous studies of the traditional and unit dose distribution systems were conducted. In this study too, these factors provided the base from which the criteria for comparison were determined.

The criteria over which the alternative distribution systems were compared are:

(1) Patient Safety,

(2) Cost,

(3) Control of Medication,

(4) Pharmacist Utilization,

(5) Loss and Pilferage.

In this study the criterion, Patient Safety, was defined in terms of ability of the distribution system to control medication errors. The criterion, Control of Medication, was defined as the ability to control what medications are given to the patient. Control of Medications differs from Patient Safety in that medication errors, as defined in Chapter III, is a much more general category, involved more with the administration of the medication to the patient. Control of Medication is more concerned with the ability of the pharmacy to know what medications are given to the patient (type of drug, strength, form and numbers). The criterion, Pharmacist Utilization, was defined in terms of the distribution system's ability to use the pharmacist's training and skills. The criterion, Loss and Pilferage, was concerned with waste of unused medications that cannot be given to another patient and with the stealing of drugs by hospital personnel. The final criteria, Cost, was comprised of several components. Two of the most common ones, used in previous studies, are personnel costs and medication costs. There are more components, but because each medication distribution system is different, especially at the small hospital level, in terms of what its actual duties are and how it is run, it was not possible to get a single cost model containing all the components which would accurately describe all hospitals. A simplified general cost model consisting of the two components listed above was used in this study because of its greater applicability to the hospital size being looked at.

The data for determining costs was obtained from two hospitals: one using the traditional distribution system (Lebanon Community Hospital); and one using the unit dose distribution system (Good Samaritan Hospital, Corvallis, Oregon).

The personnel costs for the two alternative systems were calculated as a function of patient days. The cost of medications was determined by calculating the average cost per dose, which in turn was calculated by averaging the cost of 29 of the most commonly used medications.

Analysis of Data

The five criteria were rated on (one to ten) scales for each of the criterion. Patient safety, control of medication, pharmacist utilization and loss and pilferage are interval scales, and cost is a ratio scale. Even so, they were treated the same.

On the one to ten scale of the criteria, ten was the best possible and one was the worst possible. An example scale is shown in Figure 4.2. Basically, the two alternative distribution systems were competing against one another in five categories (criteria).

In addition, the alternative systems were compared at four hospital size categories: Less than 50 beds, 50 to 100 beds, 100 to 150 beds and above 150 beds (up to 250 beds). The rating of the two

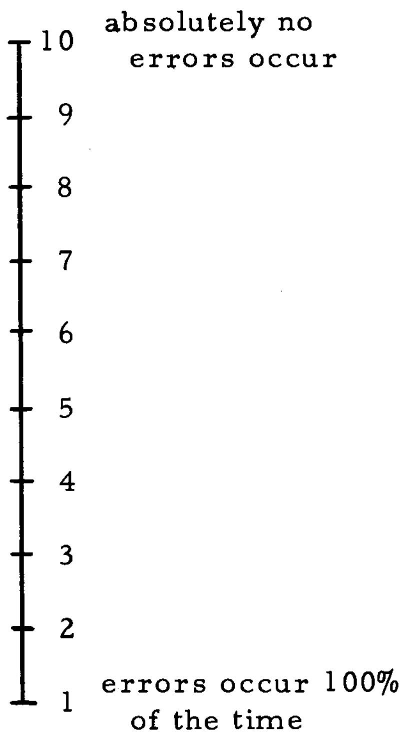

Figure 4.2. Rating scale for the criteria Patient Safety.

systems was done by the hospital pharmacists.

Importance Rating

Each criterion carried a certain amount of weight depending upon its importance. The importance of each criterion was determined by rating the criteria on a scale of one to ten, where one was that the criteria is of no importance in governing the type of distribution system used and ten was that the criteria is extremely important. The scale was similar to the one shown in Figure 4.2. The rating was done by both the hospital administrators and pharmacists.

The final value of a criterion (importance) was determined by calculating the average rating given to that criterion. The weight of a criterion was calculated as follows:

$$\text{Weight} = \frac{\text{Final Rating of a Criterion}}{\text{Final Ratings of All Criteria}}$$

Survey II

The survey was presented in two parts. The first part was an importance rating of the five criteria. The second part was concerned with a comparison of the traditional and unit dose distribution systems at the different hospital size categories. In addition to the ratings, the participants were asked to provide some information about the hospital, in particular the number of patient days last year (1974). A copy of the survey is given in Appendix B.

The hospital administrators were mailed their survey because it was difficult and time consuming to get individual appointments with them. Page one of the survey with a cover letter was sent to 18 administrators. A copy of the cover letter is given in Appendix C. The survey of the hospital pharmacists, because more time was necessary to complete their part (part II) of the survey, was done on an interview basis.

The ratings obtained from the completed surveys were used to calculate the final rating for each distribution system. The administrators' and pharmacists' importance ratings were used to determine the weight of each criteria. Multiplying the criteria weight (importance rating) of the alternative (type of distribution system for a given hospital size category) by its respective rating (done by the pharmacist) gives a numerical value. Summing these values for each alternative over all the criteria gives the alternative's final score. The higher the final score, the better the distribution system meets the needs of small hospitals or, to put it simpler, the distribution system with the higher score wins.

CHAPTER V

RESULTS OF DATA ANALYSIS

Survey Response

The importance ratings for the five criteria (Cost, Control of Medication, Pharmacist Utilization, Patient Safety and Loss and Pilferage) were completed by 23 people: 12 hospital administrators and 11 chief pharmacists. The administrators were in charge of hospitals of less than 200 beds. The chief pharmacists were in charge of the pharmacies of hospitals ranging in size from 50 to 450 beds. Seven of the pharmacists surveyed had used both types of distribution systems. A more complete breakdown of the administrators and pharmacists surveyed, according to hospital size and type of distribution system used, is given in Table 5.1.

Importance Rating

The results of the importance ratings are given in Tables 5.2 and 5.3. Table 5.2 contains the administrators' importance ratings of the five criteria. Table 5.3 contains the pharmacists' ratings.

There was a definite tendency to rate the criteria very high on the importance scale by both the administrators and the pharmacists (the average rating for each criterion being greater than six). This trend is especially noticeable when looking at the criterion Patient

Table 5.1. Breakdown of the administrators and pharmacists surveyed by hospital size and type of distribution system used.

Distribution System Used	Hospital Size (Number of Beds) 50 to 100	100 to 150	150 to 200	200 to 300	300 to 400	Greater than 400
Administrators						
Traditional system	2	3	2			
Unit Dose system	1	2	1			
Combination*		1				
Average Hospital Size	93	144	176			
Pharmacists						
Traditional system		2	1			
Unit Dose system	1	2	1	1	1	
Combination*	1					1
Average Hospital Size	84	116	160	270	390	450

* These hospitals use both types of distribution systems.

Table 5.2. The administrators' importance ratings of the five criteria.

Administrator	Cost	Control of Medication	Pharmacist Utilization	Patient Safety	Loss and Pilferage
1	7	7	9	9	2
2	6	8	5	9	4
3	9	9	8	9	9
4	9	8	9	10	8
5	8	9	9	10	7
6	3	10	5	10	7
7	10	5	8	10	7
8	7	8	5	8	6
9	8	7	6	9	5
10	8	9	9	10	9
11	8	9	6	10	7
12	10	10	8	10	8
N = 12	$\bar{X}$ = 7.75	$\bar{X}$ = 8.25	$\bar{X}$ = 7.17	$\bar{X}$ = 9.5	$\bar{X}$ = 6.25

Table 5.3. The chief pharmacists' importance ratings of the five criteria.

Pharmacist	Cost	Control of Medication	Pharmacist Utilization	Patient Safety	Loss and Pilferage
1	8	9	6	10	5
2	7	10	8	8	9
3	8	9	9	10	8
4	8	10	5	10	10
5	8	8	5	10	7
6	3	10	5	10	9
7	10	9	8	9	10
8	5	8	8	10	7
9	7	10	10	10	8
10	9	8	8	10	8
11	8	9	8	10	8
N = 11	$\overline{X}$ = 7.36	$\overline{X}$ = 9.09	$\overline{X}$ = 7.27	$\overline{X}$ = 9.73	$\overline{X}$ = 8.09

Safety and to a lesser extent the criterion Control of Medication. When rating Patient Safety, both groups rated the criterion as an eight or better, the average rating being 9.5 by the administrators and 9.73 by the pharmacists (on a ten-point scale, where a ten meant the criterion was of extreme importance). Sixteen (70%) of the 23 persons surveyed gave the criterion a rating of ten, five a rating of nine and two a rating of eight. Therefore instead of a ten-point scale measuring Patient Safety there is, in essence, only a three-point scale of varying degrees of extreme importance. The criterion Control of Medication was rated similarly to Patient Safety. The majority of the administrators and pharmacists (20 out of the 23) rated the criterion an eight or above. The average being 8.25 by the administrators and 9.09 by the pharmacists. For the rest of the criteria the range in rating was greater, but in all cases over half of the administrators and pharmacists rated the criteria eight or above. Also in all cases, save one, the pharmacists tended to rate the criteria higher (give more importance) than did the administrators. The only exception being the criterion Cost.

Two tests, a t-test to compare the average ratings and a chi-squared test to compare the variation in rating, were performed to see if there was a statistical difference in the way the two groups rated the criteria. Table 5.4 contains the results of the t-test and Table 5.5 contains the results of the chi-squared test. The t-test

Table 5.4. Results of the t-test comparing the importance ratings of the two groups.

	Cost	Control of Medication	Pharmacist Utilization	Patient Safety	Loss and Pilferage
Administrators, (N = 12) ($\bar{X}$ =)	7.75	8.25	7.17	9.5	6.25
Pharmacists, (N = 12) ($\bar{X}$ =)	7.36	9.09	7.27	9.73	8.09
t_{data}	0.489	1.73*	0.142	0.833	2.278*
α = 0.05	($t_{.95,21}$ = 1.721)				

* Significant at the α = 0.05 level.

Table 5.5. Results of the χ^2 test comparing the ratings of the two groups.

	Cost	Control of Medication	Pharmacist Utilization	Patient Safety	Loss and Pilferage
χ^2 data	1.74	2.947	2.405	2.01	6.836
$\chi^2_{9, 0.05}$	16.919	16.919	16.919	16.919	16.919
α = 0.05					

using $\alpha = 0.05$ showed that there was a significant difference between the way the administrators and pharmacists rated two criteria: Loss and Pilferage and Control of Medication. The pharmacists and administrators differed most strongly over the criterion Loss and Pilferage. The pharmacists, because loss and pilferage affected their costs and budget directly, were much more concerned with the control of it. The chi-squared test using $\alpha = 0.05$ showed that there was no significant difference between the variance in rating of the two groups. These results support what was said in the previous paragraph, that the two groups, the administrators and pharmacists, rated the criteria similarly (both groups rated the criteria high with the pharmacists tending to rate higher).

The final importance rating of a criterion (the one used in the determination of the best distribution system) was the average of the ratings given that criterion by the administrators and pharmacists. The importance rating of each criterion is:

Cost	7.56
Control of Medication	8.67
Pharmacist Utilization	7.22
Patient Safety	9.26
Loss and Pilferage	7.17

Criteria Weight

As was stated in Chapter IV the weight given each criteria is a function of its importance compared to the importance of the other criteria. Therefore, using the formula that was given the weight of each criterion expressed as a percentage is:

$$\text{Cost} = \frac{7.56}{7.56 + 8.67 + 7.22 + 9.62 + 7.17} = 18.8\%$$

$$\text{Control of Medication} = \frac{8.67}{40.24} = 21.5\%$$

$$\text{Pharmacist Utilization} = \frac{7.22}{40.24} = 17.9\%$$

$$\text{Patient Safety} = \frac{9.62}{40.24} = 23.9\%$$

$$\text{Loss and Pilferage} = \frac{7.17}{40.24} = \underline{17.8\%}$$

$$99.9\%$$

Comparison of the Alternate Systems

Ten of the 11 pharmacists who did the importance rating also rated the traditional and unit dose distribution systems at the four hospital size categories (less than 50 beds, 50 to 100 beds, 100 to 150 beds and greater than 150 beds). The comparison was done using four of the criteria: Control of Medication, Pharmacist Utilization, Patient Safety and Loss and Pilferage. The following paragraphs contain the results of the rating.

Control of Medication

Control of Medication, as defined previously, is the ability of the pharmacy to know what medication the patient receives. When rating the two distribution systems for this criterion the pharmacists rated the traditional system low and the unit dose system high. The results of the ratings are in Table 5.6.

The larger the hospital the worse the traditional system did. The system went from a rating of 4.8 for a hospital of less than 50 beds to a 3.5 for a hospital larger than 150 beds. The unit dose system did better as hospital size increased. The system went from a rating of 8.4 for a hospital of less than 50 beds to 9.0 for one of greater than 150 beds. However, not all pharmacists rated the criterion that way, several felt that as hospital size increased beyond a certain point (in this case 150 beds) the unit dose system lost some of its ability to know what medications are given to the patient. The most common reason for this was that as more people became involved in the system, the harder it was for the pharmacist to know everything that happens. This is especially true if the pharmacy has to be open 24 hours a day and there are three shifts of pharmacists. A similar reason was given for rating the unit dose system lower on

Table 5.6. The ratings given the different hospital size categories, for the alternative distribution systems for the criterion: Control of Medication.

Pharmacist	Traditional Distribution System, Hospital Size (Number of Beds)				Unit Dose Distribution System, Hospital Size (Number of Beds)			
	Less than 50	50 to 100	100 to 150	Greater than 150	Less than 50	50 to 100	100 to 150	Greater than 150
1	4	4	4	4	7	9	9	10
2	2	2	2	2	9	9	9	9
3	6	6	6	5	10	10	10	10
4	5	4	3	2	9	8	8	8
5	8	7	7	6	9	9	8	8
6	4	4	4	4	6	8	9	10
7	5	4	3	1	9	9	9	8
8	5	5	5	5	9	9	9	10
9	5	5	4	4	9	9	9	9
10	4	4	4	2	7	8	8	8
N = 10	$\bar{X} = 4.8$	$\bar{X} = 4.5$	$\bar{X} = 4.2$	$\bar{X} = 3.5$	$\bar{X} = 8.4$	$\bar{X} = 8.8$	$\bar{X} = 8.8$	$\bar{X} = 9.0$

the small hospitals. In this case the pharmacist was there only part of the time and if a special medication order was needed and he wasn't there, the nurse would have to get it.

The ratings given the alternate distribution systems at the different hospital sizes are shown in Figure 5.1.

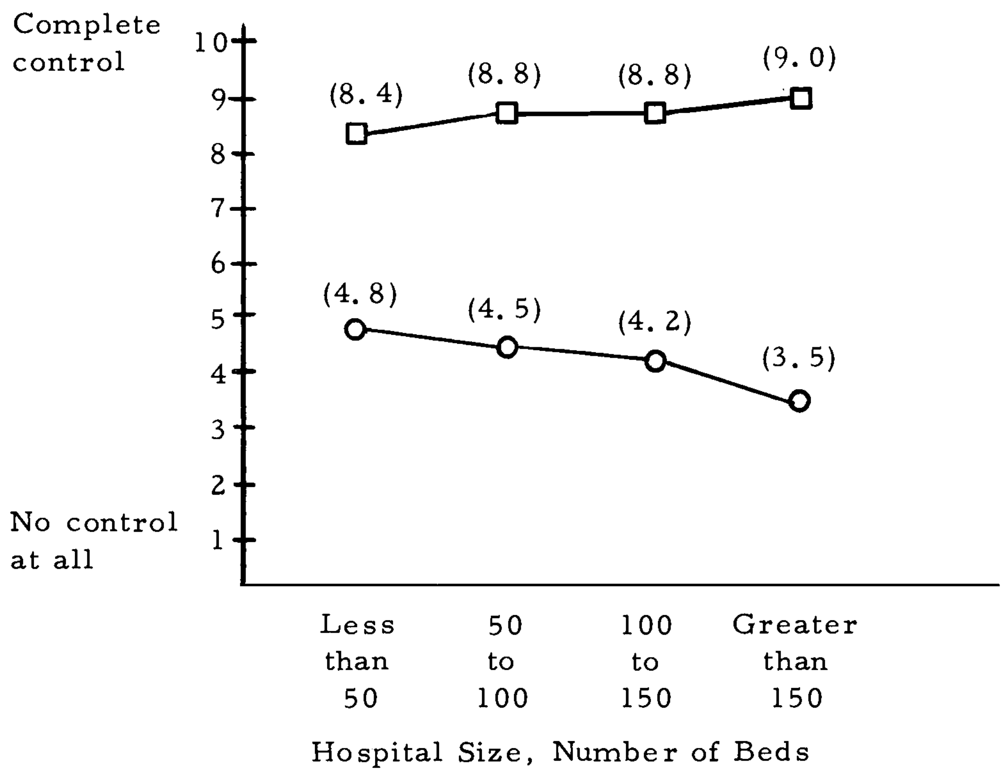

Figure 5.1. The ratings given the traditional (O) and unit dose (□) distribution systems for the criterion: Control of Medication.

Pharmacist Utilization

Pharmacist Utilization, as defined previously, refers to the use of the pharmacists' training and skill. When rating the two distribution systems for this criterion, the pharmacists rated the traditional system higher overall than for any of the other criteria and gave the unit dose system the lowest overall rating of any criteria. The results of the pharmacists' ratings are given in Table 5.7.

In rating Pharmacist Utilization for the traditional system the pharmacists felt that the best utilization occurred in the small hospitals (less than 50 beds). In the intermediate hospital sizes the utilization decreased. Then in the larger hospitals (greater than 150 beds) the utilization increased again. In rating the unit dose system for this criterion the pharmacists rated utilization in the upper quarter of the ten-point scale for all hospital sizes with the rating increasing with increasing hospital size.

Several of the pharmacists commented on the utilization criterion saying that the way it was defined neither of the distribution systems were that good. However, this feeling does not show up in the way the pharmacists rated the criteria especially for the unit dose system.

The trends in rating of the different distribution systems at the different hospital sizes are shown in Figure 5.2.

Patient Safety

Patient Safety, as defined previously, concerns the ability of a

Table 5.7. The ratings given the different hospital size categories, for the alternative distribution systems, for the criterion: Pharmacist Utilization.

Pharmacist	Traditional Distribution System — Hospital Size (Number of Beds): Less than 50	50 to 100	100 to 150	Greater than 150	Unit Dose Distribution System — Hospital Size (Number of Beds): Less than 50	50 to 100	100 to 150	Greater than 150
1	3	3	3	3	9	9	9	9
2	9	9	8	8	9	9	8	7
3	7	5	5	5	9	8	8	9
4	6	6	6	7	8	8	8	9
5	5	5	5	5	7	7	7	7
6	3	3	3	4	6	8	9	9
7	6	6	6	6	9	9	9	9
8	7	6	5	5	8	8	8	8
9	5	5	5	5	9	9	9	9
10	5	5	5	6	7	8	8	8
N = 10	$\bar{X} = 5.6$	$\bar{X} = 5.3$	$\bar{X} = 5.1$	$\bar{X} = 5.4$	$\bar{X} = 8.1$	$\bar{X} = 8.3$	$\bar{X} = 8.3$	$\bar{X} = 8.4$

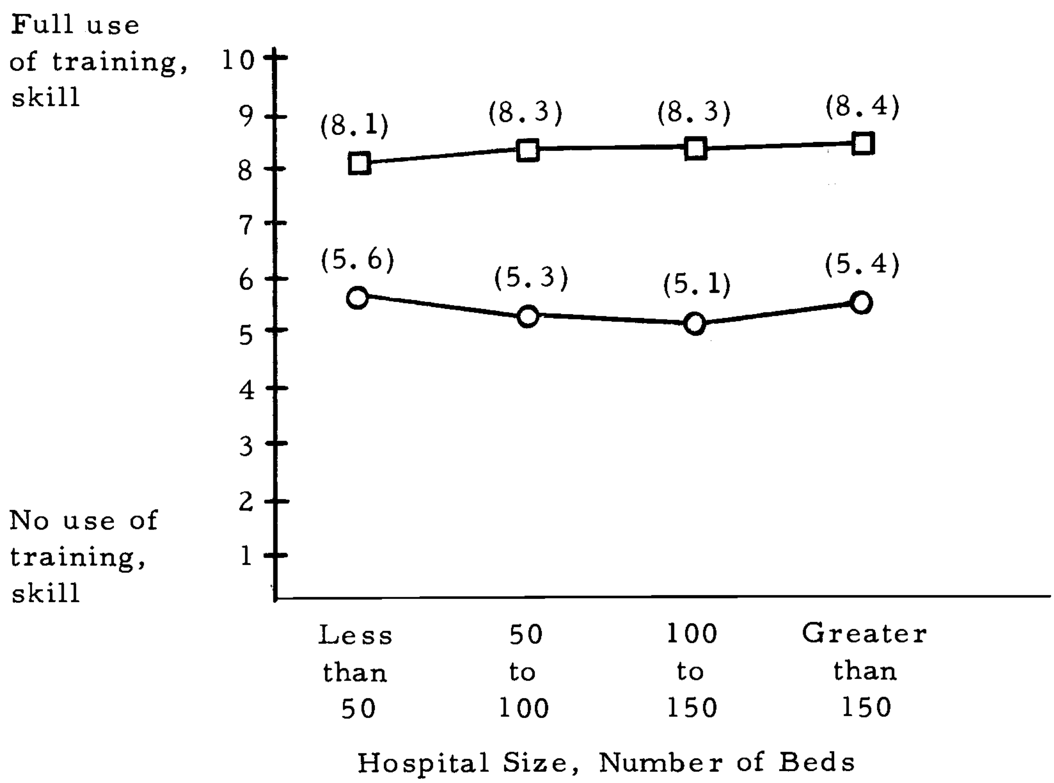

Figure 5.2. The ratings given the traditional (O) and unit dose (□) distribution systems for the criterion: Pharmacist Utilization.

distribution system to control medication errors. In rating the alternative distribution systems for this criterion the pharmacists rated the traditional system in the middle range of the ten-point scale and the unit dose system in the upper quarter. The traditional system again got lower ratings as the size of the hospital increased, although the total decrease was not great (it went from a rating of 5.3 to a rating of 4.9 as the hospital went from less than 50 beds to greater than 150 beds). In rating the unit dose system the pharmacists thought that in the small to intermediate hospital size (up to 150 beds) the system was better able to control medication errors (the rating going from 8.25 to 8.55). At hospitals larger than 150 beds the unit dose system was less able to control the errors (the rating dropping to 8.35). The major reason given for this downward trend was that the most frequent type of errors, commission errors, take place outside of the pharmacists' sphere of control. These types of errors are more likely to occur when there are more people involved with the dispensing and administration of medications.

Figure 5.3 shows the ratings for the alternate distribution systems at the different hospital sizes. Table 5.8 contains the results of the pharmacists' ratings.

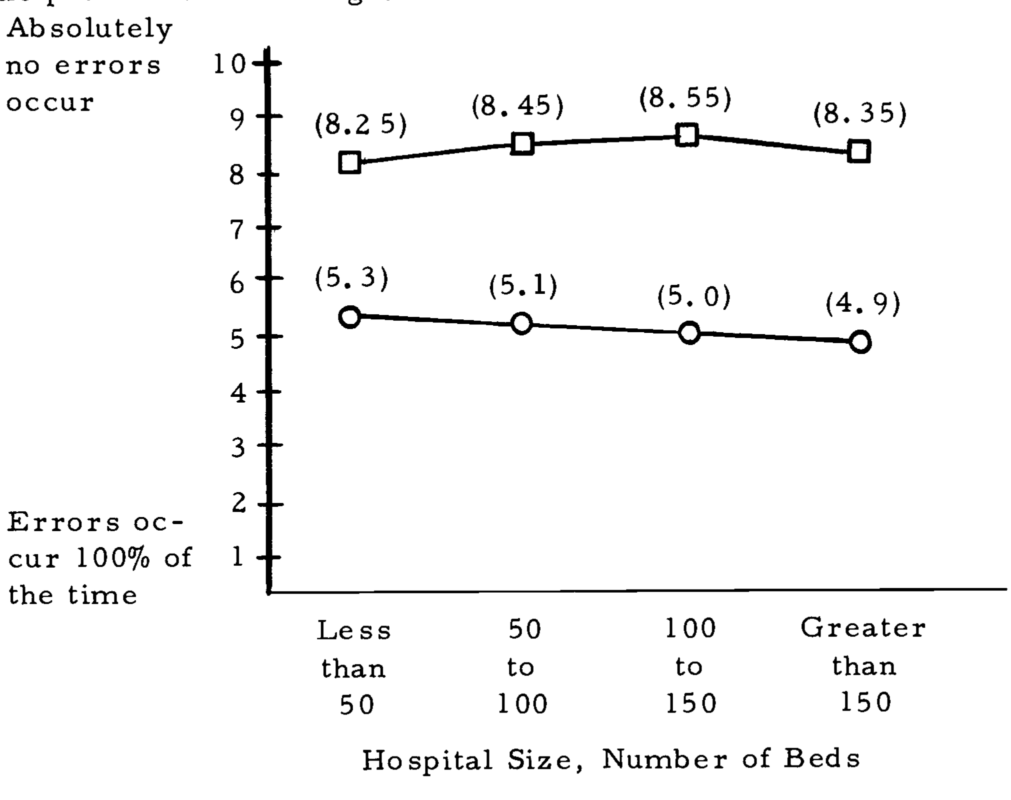

Figure 5.3. The ratings given the traditional (O) and unit dose (□) distribution systems for the criterion: **Patient Safety.**

Table 5.8. The ratings given the different hospital size categories, for the alternative distribution systems, for the criterion: Patient Safety.

Pharmacist	Traditional Distribution System — Hospital Size (Number of Beds)				Unit Dose Distribution System — Hospital Size (Number of Beds)			
	Less than 50	50 to 100	100 to 150	Greater than 150	Less than 50	50 to 100	100 to 150	Greater than 150
1	4	4	4	4	8.5	8.5	8.5	8.5
2	3	3	3	4	6	7	8	8
3	8	7	6	5	8	8	8	8
4	6	6	6	6	9	9	9	9
5	2	2	2	2	8	9	9	9
6	8	8	8	7	9	9	9	8
7	6	6	6	6	9	9	9	8
8	6	6	6	6	9	9	9	8
9	5	5	5	5	8	8	8	9
10	5	4	4	4	8	8	8	8
N = 10	$\bar{X} = 5.3$	$\bar{X} = 5.1$	$\bar{X} = 5.0$	$\bar{X} = 4.9$	$\bar{X} = 8.25$	$\bar{X} = 8.45$	$\bar{X} = 8.55$	$\bar{X} = 8.35$

Loss and Pilferage

The criterion Loss and Pilferage, as defined previously, concerns a distribution system's ability to control waste and stealing. The results of the ratings of both distribution systems are given in Table 5.9. When rating the traditional system the pharmacists gave it the lowest overall of any of the criteria. The pharmacists, for the most part, thought that control of waste and pilferage was very hard to achieve in the traditional system. Mr. Robert Brooks, chief pharmacist for the Memorial Unit of Salem General Hospital (Salem, Oregon), wanted to rate the traditional system off the scale. He felt that it was impossible using the traditional system to achieve an adequate level of control.

In rating the unit dose system for this criterion, the pharmacists felt that the possibility of controlling waste and pilferage was very good (all of the ratings for the different hospital sizes being above 8.5). However, as the size of the hospital increased the ability of the system to control loss and pilferage decreased. The major reason given for this downward trend was that as the hospital becomes larger more people become involved, thus more chances for loss and pilferage exist. Also Mr. Robert Tefft, chief pharmacist at Sacred Heart Hospital (Eugene, Oregon), pointed out that it would be easy for a nurse to give the patient an aspirin and pocket the original medication and nobody would know it happened because

Table 5.9. The ratings given the different hospital size categories, for the alternative distribution systems, for the criterion: Loss and Pilferage.

Pharmacist	Traditional Distribution System				Unit Dose Distribution System			
	Hospital Size (Number of Beds)				Hospital Size (Number of Beds)			
	Less than 50	50 to 100	100 to 150	Greater than 150	Less than 50	50 to 100	100 to 150	Greater than 150
1	1	1	1	1	9	9	9	9
2	4	4	6	7	8	8	9	9
3	8	7	6	5	9	9	8	8
4	3	4	4	5	8	9	9	9
5	1	2	2	1	8	9	9	9
6	7	7	7	6	10	10	9	9
7	2	2	2	2	9	9	8	7
8	5	5	5	4	8	9	9	9
9	2	3	3	4	9	9	9	9
10	4	4	4	4	9	9	8	8
N = 10	$\bar{X} = 3.7$	$\bar{X} = 3.9$	$\bar{X} = 4.0$	$\bar{X} = 3.9$	$\bar{X} = 8.7$	$\bar{X} = 9.0$	$\bar{X} = 8.7$	$\bar{X} = 8.6$

the patient in most cases wouldn't know the difference.

The ratings for the alternate distribution systems at the different hospital sizes are given in Figure 5.4.

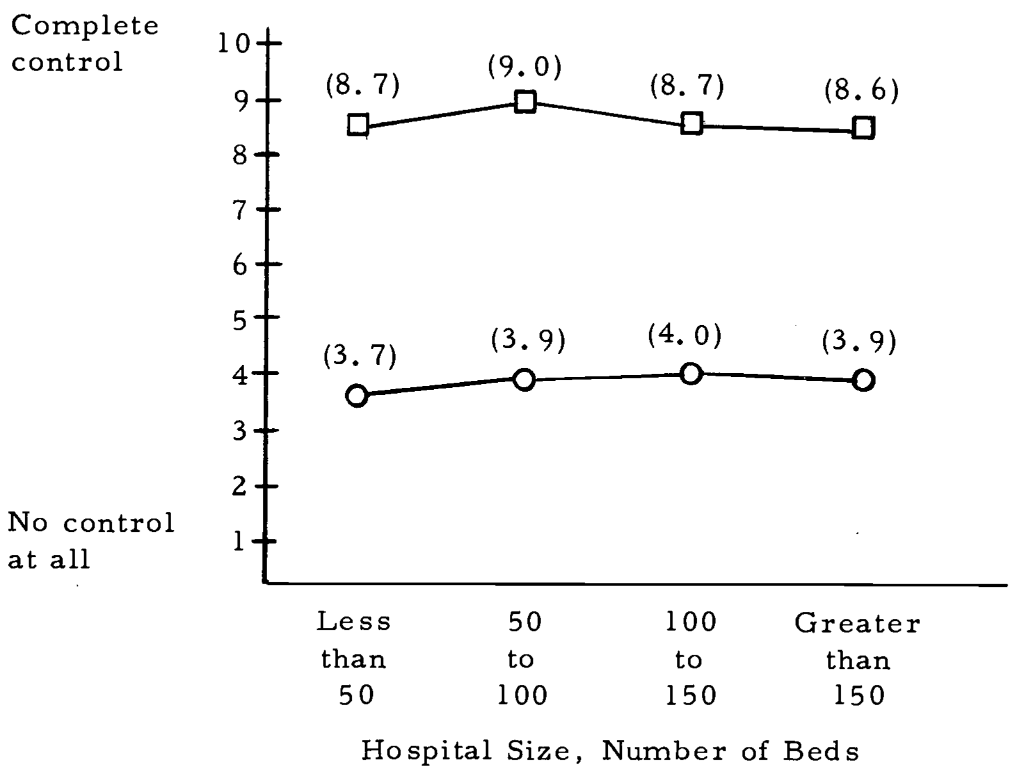

Figure 5.4. The ratings given the traditional (O) and unit dose (□) distribution systems for the criterion: Loss and Pilferage.

Cost

The criterion Cost for this study, as defined in the previous chapter, is comprised of two components: medication costs and personnel costs. Medication costs for the alternate distribution systems are the averaged costs of frequently used medications. Personnel costs are made up of the wages paid the pharmacists and the pharmacy technicians.

Medication Costs

Twenty-nine of the most commonly prescribed medications and the cost per dose of each for the two distribution systems are listed in Table 5.10. The costs listed are what the hospital pays for the medications. The first column of Table 5.10 lists the bulk medication costs of the traditional system. The bulk costs were obtained as cost per 100 doses, from which the cost per dose was calculated. The second column lists the costs of unit dose system medications. The third column lists the difference in costs between bulk and unit dose medications. A + sign means that the unit dose medication costs more and a - sign means the bulk medication costs more.

The medications listed are split into two groups: capsules or tablets and injectables or liquids (taken orally). The reason for this separation is that the injectables or liquids are not prescribed (ordered) as often as the capsules or tablets. It was estimated (by pharmacists) that 80 to 90 percent of the medications ordered are capsules or tablets. For this study a figure of 85 percent was used. Therefore, the average cost per dose is calculated as 0.85 times the average cost per dose of the capsules or tablets plus 0.15 times the

Table 5.10. Twenty-nine commonly prescribed medications and the cost/dose of each in bulk and unit dose form.

Medications	Bulk Cost Dose	Unit Dose Cost Dose	Difference
Capsule or Tablet			
Ampicillin 250mg	$0.0742	$0.05	-0.0242
Ampicillin 500mg	0.098	0.10	+0.0020
Colace 100mg	0.0696	0.07	+0.0004
Dolmane 30mg	0.0562	0.06	+0.0038
Darvocet-N 100mg	0.0832	0.08	-0.0032
Doxidan	0.056	0.06	+0.0040
Emprin #3	0.067	0.07	+0.0030
Hydroxiuril 50mg	0.0485	0.06	+0.0115
Inderal 10mg	0.0321	0.04	+0.0079
K-LOR 20mEq	0.1166	0.09	-0.0266
Keflex 250mg	0.3052	0.30	-0.0052
Lanoxin 0.25mg	0.079	0.10	+0.0021
Lasix 40mg	0.0832	0.08	-0.0032
Tetracycline 250mg	0.0181	0.03	+0.0119
Tylenol #3	0.0795	0.08	+0.0005
Valium 5mg	0.07	0.08	+0.0100
Valium 10mg	0.087	0.11	+0.0230
	1.4234	1.4603	+0.0077
Average cost/dose =	0.0838	0.0859	+0.00045
Injectable or Liquids			
Ampicillin 500mg	$0.98	$1.25	+0.27
Cefazalin 500mg	2.42	2.60	+0.18
Demerol 50mg	0.24	0.24	--
Demerol 100mg	0.25	0.30	+0.05
Keflin 1 gm	2.60	3.00	+0.40
Lanoxin 0.5mg/2cc	0.18	0.15	-0.03
Lasix 20mg/2cc	1.10	1.00	-0.10
Maalox 6oz.	0.20	0.20	--
Phenergan 25mg	0.50	0.55	+0.05
Phenergan 50mg	0.61	1.10	+0.49
Talwin 30mg	0.25	0.35	+0.10
Valium 10mg/2cc	0.61	0.75	+0.14
	9.94	11.49	+1.55
Average cost/dose =	0.83	0.96	+0.1292

average cost per dose of the injectables or liquids. Thus, the medication costs are:

Traditional distribution system	\$0.196/dose.
Unit Dose distribution system	\$0.217/dose.

On the average unit dose medications cost 2.1 cents more per dose than medications in bulk form. This value compares very favorably to what was found in other studies (1.5 to 3 cents being the range stated by Zilz, 1972).

Since all costs are to be in the form of cost per patient day, it was necessary to multiply the cost per dose times the average number of doses per patient day. Three doses per patient day was the value used in this study. Performing this calculation results in the following costs per patient day:

Traditional distribution system	\$0.59/patient day.
Unit Dose distribution system	\$0.65/patient day.

Personnel Costs

As stated previously there are two categories of personnel working in the pharmacy. These are the pharmacists and pharmacy technicians. The technicians are much more prevalent in pharmacies using the unit dose system than in those using the traditional system.

Labor costs (wages) of pharmacists vary immensely between hospitals because they depend upon such things as the experience of the pharmacist, the type of pharmacy system used and what the hospital feels it can afford to pay. The wages of a pharmacy technician vary in the same way for similar reasons.

The cost data were obtained from three hospitals: one of 100 beds using the traditional distribution system; one of 100 beds using the unit dose distribution system; and one of 150 beds that is now using the unit dose system. The 100-bed hospital using the traditional system employs two full-time pharmacists. The 100-bed hospital using the unit dose system employs two full-time pharmacists and one pharmacy technician. The 150-bed hospital when it used the traditional system employed two pharmacists full-time and one part-time (2.5 pharmacists) and one pharmacy technician full-time and one part-time (1.4 technicians). When the hospital switched to the unit dose system the pharmacy staff increased to three full-time pharmacists and 1.5 pharmacy technicians.

Estimates of the average wage for a pharmacist at these hospitals varied from a low of $14,900/ year to a high of $16,500/year with the average being $15,700/year. Estimates of the average wage for a pharmacy technician varied from $8,900/year to $9,300/year with the average being $9,100/year. The values $15,700/year for a pharmacist and $9,100/year for a pharmacy technician were used in this study. Multiplying these values times the appropriate number of pharmacists and pharmacy technicians for each hospital size category and distribution system used results in the following annual labor costs:

100-bed hospital using the traditional distribution system:

Labor cost = \$31,400.

100-bed hospital using the unit dose distribution system:

Labor cost = \$40,500.

150-bed hospital using the traditional distribution system:

Labor cost = \$51,990.

150-bed hospital using the unit dose distribution system:

Labor cost = \$60,750.

In order that the labor costs be compatible with the medication costs, it is necessary that they also be in terms of cost per patient day. To make this change the labor costs of each hospital size were divided by the average number of patient days for that hospital size. The average number of patient days for the 100-bed hospitals was 21,982 and for the 150-bed hospital was 40,471. The results of dividing the labor costs by the respective number of patient days is given in Table 5.11. The costs per patient day used in this study are the averages of the costs of 100-bed and 150-bed hospitals. Thus the labor costs per patient day are:

Traditional distribution system:	\$1.36/patient day.
Unit Dose distribution system:	\$1.67/patient day.

Table 5.11. Cost per patient day of the traditional and unit dose systems. Also listed is the average cost per patient day for the alternate systems.

	Hospital Size		
	100 beds (21,982)*	150 beds (40,471)*	Average
Traditional System	$1.43	$1.28	$1.36
Unit Dose System	$1.84	$1.50	$1.67

* Average number of patient days.

These values compare favorably with the $1.32/patient day for the traditional system and $1.62/patient day for the unit dose system calculated by Yorio _et al._ (1972) in their study of a 600-bed community hospital.

Total Cost

The total cost is simply the medication cost plus the labor cost. Thus the total cost for each distribution system is:

Traditional distribution system: $0.59/patient day + $1.36/patient day = $1.95/patient day,

Unit Dose distribution system: $0.65/patient day + $1.67/patient day = $2.32/patient day,

Patient Days Per Hospital Size Category

Since the costs are in terms of patient days it was necessary to convert the four hospital size categories into an average number of patient days per size category. To determine the number of patient days two data sources were utilized. The first source was the hospitals surveyed. As part of some biographical data requested the hospital personnel were asked to give the approximate number of patient days last year (1974). Since it was not possible to get the number of patient days for all hospitals sizes because the hospitals surveyed were not of that particular size a second data source was used. This source was the American Hospital Associations' 1972 Hospital Statistics.

The average number of patient days per hospital size category are listed in the third column of Table 5.12. Multiplying the average number of patient days of each hospital size category times the cost per patient day of the alternative distribution systems gives the average annual cost of each system for each size category. The results of the calculation are listed in Table 5.13.

Cost Ratio Scale

The cost scale, as was stated previously, is a ratio scale. Rating on a ratio scale is done by dividing the cost of each alternative into the smallest cost alternative. Thus the alternative with the smallest cost will get the highest rating. Using the cost data from Table 5.13 the ratings of the alternative distribution systems for

Table 5.12. Patient days per hospital size category.

Hospital Size, Number of Beds	Average Hospital Size	Number of Patient Days		
		High	Low	Average**
Less than 50	41			8,340*
50 to 100	81	27,000	16,050*	21,683
100 to 150	123	33,690	19,874	26,370
150 to 200	176	48,163	40,471	44,317

* American Hospital Association values for Oregon hospitals.
** Values used to calculate total cost.

Table 5.13. The annual cost of the traditional and unit dose distribution systems for the four hospital size categories.

	Less than 50	50 to 100	100 to 150	Greater than 150
Traditional system	$16,263	$42,282	$51,421	$ 86,418
Unit Dose system	19,349	50,305	61,178	102,815

each size category are:

Less than 50 beds:

Traditional distribution system: $\frac{16,263}{16,263} = 1.0$

Unit Dose distribution system: $\frac{16,263}{19,349} = 0.85$

50 to 100 beds:

Traditional distribution system: $\frac{42,282}{42,282} = 1.0$

Unit Dose distribution system: $\frac{42,282}{50,305} = 0.84$

100 to 150 beds:

Traditional distribution system: $\frac{51,421}{51,421} = 1.0$

Unit Dose distribution system: $\frac{51,421}{61,178} = 0.84$

Greater than 150 beds:

Traditional distribution system: $\frac{86,418}{86,418} = 1.0$

Unit Dose distribution system: $\frac{86,418}{102,815} = 0.84$.

These ratings are then multiplied by ten to make them comparable to the ratings of the other criteria. The revised ratings for the alternate distribution systems at the different hospital size categories are given in Figure 5.5.

Final Solution

Now that both alternative distribution systems for each hospital size category have been rated for all the criteria, it is possible to

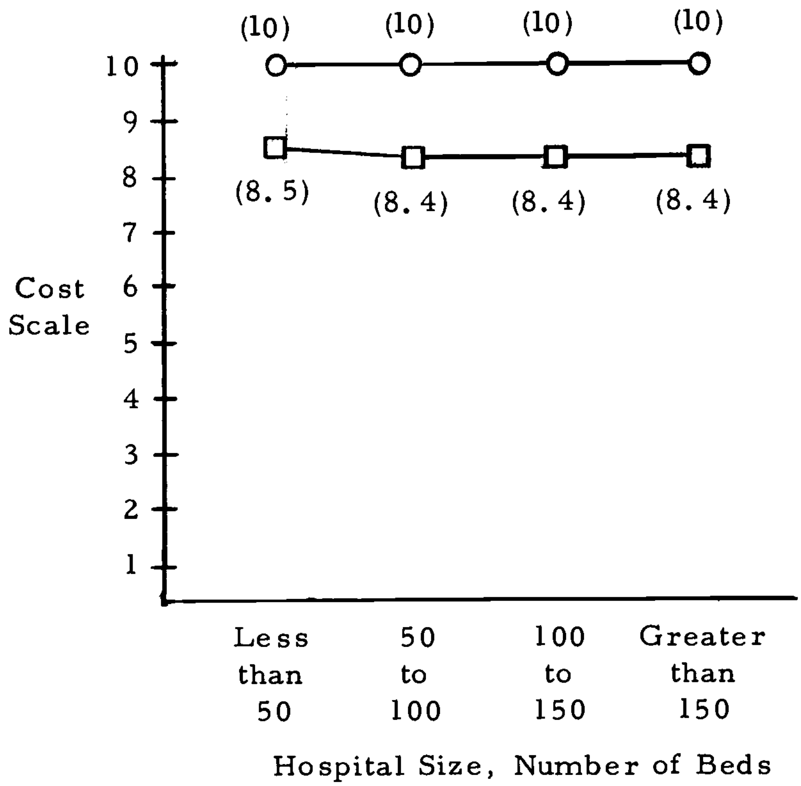

Figure 5.5. The ratings given the traditional (O) and unit dose (□) distribution systems for the criterion: Cost.

generate a solution. Multiplying each criteria rating by its respective importance rating and then summing these numbers will result in a numerical value for each alternative. This value will be the alternatives final score. Table 5.14 summarizes the ratings obtained for each alternative.

Thus for the hospital size category of less than 50 beds the final scores, rounded to the nearest whole number, for each distribution system are:

Table 5.14. Summary of the criteria ratings.

Criteria	Importance Rating	Hospital Size, Number of Beds: Less than 50		50 to 100		100 to 150		Greater than 150	
		T	UD	T	UD	T	UD	T	UD
Control of Medication	8.67	4.8	8.4	4.5	8.8	4.2	8.8	3.5	9.0
Pharmacist Utilization	7.22	5.6	8.1	5.3	8.3	5.1	8.3	5.4	8.4
Patient Safety	9.62	5.3	8.25	5.1	8.45	5.0	8.55	4.9	8.35
Loss and Pilferage	7.17	3.7	8.7	3.9	9.0	4.0	8.7	3.9	8.6
Cost	7.56	10	8.5	10	8.4	10	8.4	10	8.4

T = Traditional distribution system
UD = Unit Dose distribution system

Traditional distribution system:

$$8.67(4.8) + 7.22(5.6) + 9.62(5.3) + 7.17(3.7) + 7.56(10) = 235$$

Unit Dose distribution system:

$$8.67(8.4) + 7.22(8.1) + 9.62(8.25) + 7.17(8.7) + 7.56(8.5) = 337$$

For the 50 to 100 bed category the final scores are:

Traditional distribution system:

$$8.67(4.5) + 7.22(5.3) + 9.62(5.1) + 7.17(3.9) + 7.56(10) = 230$$

Unit Dose distribution system:

$$8.67(8.8) + 7.22(8.3) + 9.62(8.45) + 7.17(9.0) + 7.56(8.4) = 346$$

For the 100 to 150 bed category the final scores are:

Traditional distribution system:

$$8.67(4.2) + 7.22(5.1) + 9.62(5.0) + 7.17(4.0) + 7.56(10) = 226$$

Unit Dose distribution system:

$$8.67(8.8) + 7.22(8.3) + 9.62(8.55) + 7.17(8.7) + 7.56(8.4) = 344$$

For the greater than 150 beds category the final scores are:

Traditional distribution system:

$$8.67(3.5) + 7.22(5.4) + 9.62(4.9) + 7.17(3.9) + 7.56(10) = 215$$

Unit Dose distribution system:

$$8.67(9.0) + 7.22(8.4) + 9.62(8.35) + 7.17(8.6) + 7.56\ (8.4) = 344$$

It should be remembered that these final scores are dimensionless numbers and only having meaning when compared to one another.

In all four hospital size categories the unit dose distribution system did substantially better than the traditional system. In all cases the unit dose system averaged 100 points or more better. The scores for the unit dose system were constant for the upper three size categories, the variation being only two points, 344 to 346. On the other hand, the scores of the traditional system, as would be expected from the criteria ratings, got smaller with increasing hospital size going from a score of 235 for the less than 50 bed category to a score of 215 for the greater than 150 bed category.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

The objective of this study was to determine which medication distribution system, traditional or unit dose, the hospital administrator and chief pharmacist felt best suited the needs of small hospitals. This was accomplished by first determining the criteria used in governing the type of distribution system used in a hospital. Once the criteria were chosen the administrators and pharmacists rated the importance of each. In addition, the pharmacists rated the traditional and unit dose systems for each of the criteria. This rating was done at four hospital size categories: less than 50 beds, 50 to 100 beds, 100 to 150 beds and greater than 150 beds. The final score given each alternative (type of distribution system for a given hospital size category) was the result of a calculation involving the importance rating of each criterion and the rating of the distribution system for that criterion, summed over all the criteria.

The results of this study showed that the unit dose distribution system was substantially better suited to the needs of a small hospital than was the traditional distribution system.

Study Limitations

Since the unit dose system was rated so much better than the traditional system the question arises then, if the unit dose system is so superior why aren't all hospitals using the system? Based on the returns of the first survey, only approximately half of the hospitals in Oregon are presently using the unit dose distribution system. Why aren't the other half using the unit dose system? The answer is that there must be other factors that influence the type of distribution system used in a hospital, than the ones looked at in this study.

One factor that was alluded to earlier was the resistance of the nurses and administrators. These people play such an important role that without their support and help, no distribution system is going to function properly and if they do not want to change to another type of distribution system, no matter how good the system is, the change can not take place.

Closely related to this resistance by the administrators, if not a partial cause of it, is the increased cost involved with implementing and running a unit dose distribution system. Two of the main cost factors were included in this study, but there are others that can be just as important as these, such as remodeling or expansion costs and equipment costs. Construction costs for hospitals today are in the vicinity of $50 per square foot. In some cases where extensive remodeling is needed this cost can be very large. Also in the older hospitals expansion of the pharmacy necessary for the unit dose system is not possible.

Several previous studies have stated that by changing to the unit dose system a savings will occur because of decreased nursing time spent in medication activities. However, a majority of the pharmacists felt that a real savings was not possible. As one put it, "you're spending real dollars to save imaginary dollars." Thus the general consensus of the people surveyed was that implementing and running a unit dose system costs money. Which then raises the question, what is improved patient care and safety worth to the hospital? The hospital is going to have to decide how much it is willing to pay.

An additional limitation that is specific to this study and that should be kept in mind when looking at the results is that a definite bias in favor of the unit dose distribution system exists. The desire to survey people who had been exposed to both types of distribution systems clouded the fact that by doing so a definite bias would enter the results. By surveying pharmacists who had used both types of systems it was hoped that the ratings would be based upon past experiences. However, it should have been apparent that the pharmacists would tend to favor the system presently used over the system used in the past, especially if they were involved in the change. This trend did show up in that the pharmacists who were using traditional systems rated that system higher than did the pharmacists using unit dose systems.

Future Research

Based upon the limitations of the present study, the recommendations for further study are:

1. A study of how other areas of the total medication distribution system, in particular the nurses, are affected by and how they react to changes in the distribution system.
2. Also, a study of how the medical staff feels about the type of distribution system used and their reactions to the unit dose system.
3. A much more thorough study of the total costs involved with implementing and running the unit dose distribution system.
4. A study of the costs involved in patient safety; the cost to the hospital. Determine what a medication error costs the hospital.

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APPENDICES

APPENDIX A

The following is a copy of Survey I. The survey was mailed to 56 pharmacists. The respondents were asked to rank the listed benefits of the unit dose system if they were using that distribution system. If not, they were asked to rank the disadvantages of the unit dose system.

Unit Dose Cost Benefit Questionnaire

My name is Dan Kingsley. I am a graduate student in Industrial Engineering at Oregon State University, working towards a masters degree. For my masters thesis I'm doing a cost benefit analysis of the unit dose pharmacy system.

I am sending out this questionnaire to find out what you, as a pharmacist, feel are the benefits derived from using the unit dose pharmacy system. Even if your hospital is not presently using the unit dose system, I would appreciate answers to the following questions. When you have completed the questionnaire please refold it, staple it and place it in the mail. Thank you for your time.

1. When did you first hear about the concept of a unit dose pharmacy system?
   Approximate Date:________________

2. What sources introduced you to the unit dose concept? Please list them in order of influence, e.g. #1 was the most influencial, etc..
   1. ________________
   2. ________________
   3. ________________

3. Has the unit dose concept been implemented in your hospital?

☐ Yes

a) If yes, what benefits have been derived from using the unit dose concept?

___ ☐ Decreased medication errors

___ ☐ Increased control of medications

___ ☐ Better utilization of pharmacy personnel

___ ☐ Reduced loss and pilferage of medications

___ ☐ Allows for more appropriate utilization of nursing skills

___ ☐ Other ________________

b) Now please rank the benefits you have checked giving the most important benefit a rank of 1, the next important benefit a rank of 2, and so on. It is important that no two benefits are given the same rank.

c) What reservations about having implemented a unit dose system do you now have, if any?

☐ No

a) If no, what are your reasons for not implementing the unit dose concept?

___ ☐ Requires a large pharmacy staff

___ ☐ Requires more inventory space than bulk packages

___ ☐ Results in increased equipment costs

___ ☐ Cost of unit dose medications is higher than bulk medications

___ ☐ Unavailability of drugs in unit dose form

___ ☐ Other ________________

b) Now please rank the reasons you have checked giving the most important reason a rank of 1, the next important reason a rank of 2, and so on. It is important that no two reasons are given the same rank.

c) What new developments or conditions, if any, might induce you to switch to the unit dose method?

APPENDIX B

The following is a complete copy of Survey II. This was the copy given to all the chief pharmacists surveyed.

ADMIMISTRATOR ☐ PHARMACIST ☐

HOSPITAL: ______________________________

NUMBER OF BEDS: ________

NUMBER OF PATIENT DAYS LAST YEAR (APPROX.): ________

TYPE OF PHARMACY SYSTEM PRESENTLY USED: TRADITIONAL ☐

UNIT-DOSE ☐

This survey is presented in two parts. The first part is an importance rating of five criteria used in determinig the type of pharmacy system in a hospital. The second part is concerned with a comparison of the traditional and unit-dose pharmacy systems at various hospital sizes.

PART I.

The purpose of this part of the survey is to determine the importance of five criteria: cost, control of medication, pharmacist utilization, patient safety, and loss and pilferage; in determining the type of pharmacy system used in a hospital. Rate each of the criteria on a scale of 1 to 10, where 1 is that the criteria is not important in determining the type of system used and 10 is that the criteria is extremely important.

SCALE	Criteria	Rating
10 extremely important		
9	Cost	______
8		
7	Control of Medication	______
6		
5	Pharmacist Utilization	______
4		
3	Patient Safety	______
2		
1 not important	Loss and Pilferage	______

PART II.

The purpose of this part of the survey is to compare the traditional pharmacy system to the unit-dose pharmacy system. The two systems are compared using four criteria: control of medications, pharmacist utilization, patient safety, and loss and pilferage. For each of the criteria the two systems are compared at different hospital sizes: less than 50 beds, 50 to 100 beds, 100 to 150 beds and greater than 150 beds. The rating will be done the same as in part I.

CONTROL OF MEDICATIONS: Rate the two distribution systems on their ability to control medications that are given to the patient. Use a scale of 1 to 10 where 1 is no control at all and 10 is complete control.

SCALE

10 complete control
9
8
7
6
5
4
3
2
1 no control at all

Traditional System	____	____	____	____
Unit-Dose System	____	____	____	____
Hospital Size, number of beds	less than 50	50 to 100	100 to 150	greater than 150

PHARMACIST UTILIZATION: Rate the two pharmacy distribution systems on their utilization of a pharmacist's training and skills. Use a scale of 1 to 10, where 1 is no use of training and skills and 10 is full use of training and skills.

SCALE

10 full use of training, skill
9
8
7
6
5
4
3
2
1 no use of training, skill

Traditional System	____	____	____	____
Unit-Dose System	____	____	____	____
Hospital Size, number of beds	less than 50	50 to 100	100 to 150	greater than 150

PATIENT SAFETY (medication errors): Rate the two pharmacy distribtuion systems as to their ability to control medication errors. Use a scale of 1 to 10, where 1 errors occur 100% of the time and 10 is absolutely no errors occur.

- 10 absolutely no errors occur
- 9
- 8
- 7
- 6
- 5
- 4
- 3
- 2
- 1 errors occur 100% of the time

SCALE

Traditional System	____	____	____	____
Unit-Dose System	____	____	____	____
Hospital Size, number of beds	less than 50	50 to 100	100 to 150	greater than 150

LOSS AND PILFERAGE: Rate the two pharmacy systems as to their ability to control loss and pilferage of medications. Use a scale of 1 to 10, where 1 is no control at all and 10 is complete control.

- 10 complete control
- 9
- 8
- 7
- 6
- 5
- 4
- 3
- 2
- 1 no control at all

SCALE

Traditional System	____	____	____	____
Unit-Dose System	____	____	____	____
Hospital Size, number of beds	less than 50	50 to 100	100 to 150	greater than 150

APPENDIX C

The following is the cover letter for the survey mailed to the hospital administrators.

Daniel B. Kingsley
Dept. of Industrial and
General Engineering
210 Covell Hall
Oregon State University
Corvallis, Oregon 97331

My name is Dan Kingsley. I am a graduate student in Industrial Engineering at Oregon State University working towards a masters degree. For my masters thesis I'm doing an analysis of the unit-dose pharmacy system in small hospitals (hospitals of 100 to 150 beds).

I am sending out this survey to find out how you, as a hospital administrator, would rate five criteria used in determining the type of pharmacy system in a hospital. The five criteria are: cost, control of medication (control of what medications the patient receives), pharmacist utilization, patient safety and loss and pilferage.

I would appreciate your spending 5 minutes of your time to supply the requested data and rate the five criteria. Once you have completed the survey please refold it, staple it and place it in the mail. Thank you for your time.

Respectfully,

Daniel B. Kingsley