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A COMPARISON OF UNIT-DOSE COSTS UNDER VARIOUS HOSPITAL  
DRUG DISTRIBUTION SYSTEMS

BY

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## CHAPTER I

### INTRODUCTION

Health care in North America has been undergoing rapid change and development. Populations are expanding, governments are assuming a larger share of health care costs, and there has been an accelerated expansion of medical service and technology. Because of these changes, the provision of health services to the public is becoming more complicated. An additional complicating factor is the public's growing concern about both the cost and quality of health care in general, and hospital care, in particular. This concern is evident in statements made by many persons involved in controlling health costs.

The Minister of National Health and Welfare in Canada, John Munro, stated:

"Reforms must precede any expansion in today's health services delivery system if national health standards are to be improved. . . . . Canadians cannot be asked to pay more for improving existing health standards until the government had made a more efficient use of resources available."<sup>1</sup>

The Ontario Minister of Health, Bert Lawrence, forecast, "hellish problems on the horizon in controlling soaring costs of health and

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1. Statement made at the Manitoba health conference in 1970. Esther Tennenhouse, "Health Costs Attacked," Winnipeg Free Press, 3 Dec. 1970, p. 29.

hospital care. .... There is the whole question of controlling the fantastic escalation in health costs while continuing to provide the necessary services."<sup>2</sup>

According to the executive director of New Mount Sinai Hospital, Toronto:

"the taxpayer is demonstrating an almost insatiable demand (not need) for health services and it is politically expedient to provide these, particularly, since a premium has been paid. The taxpayer must be informed that these costs are going up and why. Additionally, the taxpayer should be informed that either these costs will have to be met by additional taxes, by changing priorities in spending the tax dollar by governments, or by limiting the amount of service to something less than he wants."<sup>3</sup>

Expenditures in Canada for hospital care, physicians, dentists and prescribed drugs rose from \$1,047,403,000 in 1957 to \$3,924,667,000 in 1969.<sup>4</sup> As a percentage of Gross National Product, this represents a rise from 3.18 percent in 1957 to 5.03 percent in 1969.<sup>5</sup> The amount spent per Canadian on personal health care almost tripled between 1957 and 1969, rising from \$62.81 to \$186.10.<sup>6</sup>

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2. "Bert Lawrence Confronts Escalating Costs of Health," Toronto Star, 2 Mar. 1971.

3. S. Liswood, "Let's Stop Spoon-Feeding the Public on Health Cost Facts," Canadian Hospital (47:9) Sept. 1970, p. 5.

4. Expenditures on Personal Health Care in Canada 1957-1969, Research and Statistics Directorate, Department of National Health and Welfare, Ottawa, October 1970, p. 5.

5. Ibid., p. 8.

6. Ibid., p. 7.

Hospital care expenditures more than quadrupled from \$587,370,000 in 1957 to \$2,513,111,000 in 1969.<sup>7</sup> Expressed as a percentage of Gross National Product, hospitals' share moved from 1.78 percent to 3.22 percent.<sup>8</sup> Per capita expenditures for hospital care rose from \$35.22 in 1957 to \$119.17 in 1969.<sup>9</sup> Hospital costs per patient day between 1961 and 1968 increased by an average of 10 percent per year from \$23.10 in 1961 to \$44.88 in 1968.<sup>10</sup>

"Several factors account for the relatively large increase in hospital expenditures: hospital salaries have been rising more rapidly than salaries in other sectors of the labour force; a greater proportion of skilled people are being employed by hospitals and the amount of labour used has been increasing, which is borne out of the growing number of paid hours of work per patient day. These changes in the cost, type and amount of labour input and the changing procedures in the practice of medicine are among the factors accounting for the comparatively high rate of increase in hospital expenditures."<sup>11</sup>

A similar growth in health costs has occurred in the United States with expenditures for health care in 1970 reaching \$67,200,000,000 or seven percent of the Gross National Product, compared to \$3,600,000,000 or 3.6 percent of Gross National Product in 1929. Hospital care

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7. Ibid., p. 5.

8. Ibid., p. 8.

9. Ibid., p. 7

10. Health Care Price Movements in Canada, April 1961 to April 1970, Research and Statistics Directorate, Department of National Health and Welfare, Ottawa, Aug. 1970, pp. 7-8.

11. Expenditures on Personal Health in Canada, op.cit., pp. 2-3.

expenditures in 1970 were \$25,600,000,000. This represents 38 percent of total health care expenditures compared to 18 percent in 1929.<sup>12</sup>

According to Chairman Wilbur Mills of the House Ways and Means Committee:

"Health expenditures have risen from \$12 billion a year to more than \$60 billion over the last 20 years -- a five-fold increase. About 20% of this \$48 billion increase was due to population growth and 30% to increased use of services and development of new services. But one-half of the increase resulted solely from higher prices. It is this characteristic of the health industry -- rapidly escalating costs -- which has been so pronounced in recent years. In the last four years, medical care prices have increased almost twice as fast as prices for all consumer items."

"Mills centered particularly on the hospitals as a major factor in cost increases. He said: A hospital simply is not like the typical business firm. Its reason for existence is the care and healing of the sick and injured. Its effectiveness must always be judged on that standard. At the same time, this objective has, in all too many cases, stood as a reason to tolerate poor business practices and lax planning in even our very large hospitals. More and more people in the hospital field are coming to see that there need not be an inconsistency between good management practices and good patient care. In fact there is a growing awareness that good management supports good care."<sup>13</sup>

Rising costs of hospital care are not peculiar to hospitals in Canada and the United States. Anderson and Neuhauser compared hospital

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12. "Study of Health Plans Cites Drug and Other Costs," P.M.A. Newsletter (13:14) 9 April 1971, p. 5.
  13. "Mills Lists Rapidly Mounting Medical Care Costs," P.M.A. Newsletter (12:48) 4 Dec. 1970, pp. 4-5.

costs in the United States, England and Wales, and Sweden and found rapidly increasing costs in all countries. They concluded rising hospital costs should be regarded as inherent in progressive health care systems and the problem "is one of containing expenditures without inhibiting the progress inherent in modern health services systems."<sup>14</sup>

Many factors influence the economic allocation of resources in the health field. In most industries in North America, the allocation of resources and the price structure are determined mainly by the forces of supply and demand in a relatively free market economy.

"Health, on the other hand, has been a sector of the twentieth century economy in which the market or price system has been only a limited mechanism of coordination. Limitations of consumer knowledge, educational and licensing limitations on entry into the health disciplines, the setting or administering of prices for many services by professional bodies, and the substantial degree of government participation and regulation in the provision of health facilities and services have all combined to create a system in which the market does not provide any or 'natural' means of allocating and coordinating health services. The nature of the health system has not recently, in any event, been shaped primarily by market forces."<sup>15</sup>

In November 1968, the Committee on Costs of Health Services was established by the Conference of Ministers of Health of Canada "to enquire into ways of restraining the rate of increase in health service expenditures."<sup>16</sup> This Committee, consisting of representatives

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14. O. W. Anderson and D. Neuhauser, "Rising Costs are Inherent in Modern Health Care Systems," Hospitals, J.A.H.A. (43:4) 16 Feb. 1969, p. 52.

15. Report of the Committee on the Healing Arts, Vol. 1, Queen's Printer, Toronto, 1970, pp. 7-8.

16. Task Force Reports on the Cost of Health Services in Canada, Vol. 1, Queen's Printer for Canada, Ottawa, 1970, p. vii.

of federal and provincial governments, appointed seven task forces to examine costs in providing hospital and health services. The Committee's report, containing 348 recommendations on ways to improve health services in Canada and to control rising health costs, was presented to the provincial ministers of health in November 1969.

The task forces agreed the country faces a real dilemma in providing health services, mainly because of skyrocketing costs. They stated in their report:

"The cost of health services has risen so rapidly in Canada in recent years that three alternatives are now imminent. The standards of health care now available can be reduced, or; taxes, premiums or deterrent fees can be raised even higher, or; ways must be found to restrain the growth of cost increases through better operation of the health service structure now in existence, and serious consideration must be given to a future major revamping of the entire system."<sup>17</sup>

The task forces found the first alternative, reduction in health services, unacceptable; and the second alternative, increased taxes, undesirable. The third alternative, cost restraint, was accepted by the seven task forces, and they proceeded to look for ways to achieve economies without diminishing the quality of care.

The task force on operational efficiency recommended the establishment and evaluation of the Unit-Dose system of drug distribution "in at

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17. Ibid., p. 1.

least five hospitals of varying size in strategic locations in Canada."<sup>18</sup>

While on the surface, this recommendation does not seem to reduce hospital pharmacy operating costs, it was emphasized:

- "(1) There should not be any doubt that this system, due alone to its safer distribution of drugs, will be the trend in the future.
- (2) The drug industry will sooner or later come up with solutions to the packaging problem at lower prices.
- (3) Hospitals in Canada should not have to wait to the last moment to gain experience with this system and be in a position to assess the pros and cons first hand now.
- (4) This system, properly introduced, does allow more effective utilization of non-professional help, thereby permitting professional pharmacists and nurses to spend more time in direct patient care. It should be recognized that the present drug distribution system utilizes approximately 15% of available professional nursing time."<sup>19</sup>

#### Objectives

During the past 10 years numerous Unit-Dose systems for drug distribution in hospitals have been developed. Each has been designed in an attempt to provide a more professional and effective service to improve patient care. Cost often has been a secondary consideration. However, in the establishment of any new procedure, cost is one of the important factors in its success or failure. Mehl suggested, "The

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18. Task Force Reports on the Cost of Health Services in Canada, Vol. 2, Queen's Printer for Canada, Ottawa, 1970, p. 125.

19. Ibid., p. 126. No reference is given in the report for the source of the 15 percent figure for nursing time spent on drug distribution.

problem of cost of operating a given system is a prime consideration before initiating a new method of drug distribution. The cost of a particular system may be so prohibitive as to make it unrealistic."<sup>20</sup>

In view of the rapidly rising costs of hospital care, those in the hospital field have a responsibility to the public to control costs. New systems should be established only after careful cost analysis so the benefits of the innovation can be weighed against the economic effect.

At University Hospital, Saskatoon, a unique Computer-Assisted, Unit-Dose, Satellite System of drug distribution has been developed and implemented on three nursing wards. In addition, University Hospital is evaluating a new system of nursing service on several nursing wards -- the Unit Assignment System. With the development of the Unit-Dose system of drug distribution and unit assignment system of nursing service, there are four systems in operation through which drugs are made available and administered to patients: (a) Floor Stock-Prescription Order with Team Nursing System; (b) Floor Stock-Prescription Order with Unit Assignment Nursing System; (c) Unit-Dose with Team Nursing System; and (d) Unit-Dose with Unit Assignment Nursing System. Each of these systems varies in the type and amount of hospital resources utilized.

The primary objective of this study was to determine the difference, if any, in the cost of producing and administering a unit-dose of

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20. B. Mehl, "Drug Distribution in a 1000-Bed Hospital," Am. J. Hosp. Pharm. (25:2) Feb. 1968, p. 75.

medication under each of four drug distribution systems in operation at University Hospital, Saskatoon, Saskatchewan.

Secondary objectives were: (a) to determine the cost of the various components of each of the four drug distribution systems; and (b) to develop a cost analysis procedure which could be used to determine the cost of operating other drug distribution systems.

#### Definition of Terms

Misunderstanding between the writer and reader often results because there may be more than one meaning associated with a word. For example, a study of various publications showed such terms as Unit-Dose package, unit-of-use package, and single-unit package used synonymously. This example suggests the advisability of defining some of the terms appearing frequently in this paper which may result in confusion if misinterpreted.

Pharmacy - is the health profession which is concerned with the preparation and distribution of medicinal products. It embraces the art and science of preparing from natural and synthetic sources materials for the prevention, diagnosis or treatment of disease, and the professional, legal, and economic function of distributing medicinal products properly and safely.<sup>21</sup>

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21. Remington's Pharmaceutical Sciences, 14th ed. Mack Publishing Co., Easton, Pennsylvania, 1970, p. 3.

Drug - includes any substance or mixture of substances manufactured, sold, or represented for use in the diagnosis, treatment, mitigation or prevention of a disease, disorder, abnormal physical state, or the symptoms thereof, in man or animal.<sup>22</sup>

Prescription Order (Drug Order, Medication Order) - is a formula or direction given by a medical practitioner, dentist or veterinary surgeon of a remedy for, or as treatment for, a disease or disorder, stating the ingredients and the quantities thereof with or without the method of use.<sup>23</sup>

Prescription - is the finished product, that drug or mixture of drugs compounded and dispensed by the pharmacist pursuant to a prescription order.<sup>24</sup>

Nursing Ward - is an area in a hospital containing patient rooms for one or more clinical specialties grouped together and so arranged as to facilitate coordination. Nursing service on a ward usually is supervised by a head nurse.

Nursing Station (Head Nurse's Office) - is a centralized area on a nursing ward from which the head nurse supervises nursing service on

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22. Food and Drugs Act (Canada), Department of National Health and Welfare, Queen's Printer for Canada, Ottawa, 1954, p. 1.

23. An Act Respecting Pharmaceutical Chemists and Druggists, Legislative Assembly of Saskatchewan, Queen's Printer, Regina, Saskatchewan, R.S.S. 1965, p. 4898.

24. J. B. Sprowls, Jr., Prescription Pharmacy, J. B. Lippincott Co., Philadelphia, 1963, p. 3.

the ward. It usually contains the patients' signal system, patients' charts, facilities for receiving and transmitting patient orders and information, and storage for supplies and medications.

## CHAPTER II

### DEVELOPMENT OF HOSPITAL DRUG DISTRIBUTION SYSTEMS

A hospital drug distribution system has been defined as, "That system by which drugs get from outside the hospital to the patient."<sup>1</sup> While this definition tends to emphasize the physical activities of obtaining and providing the patient with his medication, other components of the system also are involved. As Brodie suggests, the mainstream function of pharmacy should be drug-use control. He defines drug-use control as "the sum total of knowledge, understanding, judgments, procedures, skills, controls, and ethics that assures optimal safety in the distribution and use of medication."<sup>2</sup> This concept recognizes the many aspects of a hospital drug distribution system in addition to the dispensing and administration of drugs.

#### Introduction

The historical and traditional relationship between the physician and the pharmacist in the hospital differs from that in community practice. In the community, the physician diagnoses and prescribes. The patient takes the prescription order to the pharmacist who

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1. K. N. Barker, "Trends in Drug Distribution Systems in Hospitals," Am. J. Hosp. Pharm. (19:12) Dec. 1962, p. 595.
  2. D. C. Brodie, The Challenge to Pharmacy in Times of Change, Report of the Commission on Pharmaceutical Services to Ambulant Patients by Hospitals and Related Facilities, American Pharmaceutical Association and the American Society of Hospital Pharmacists, Washington, D.C., 1966, p. 39.

interprets the order and prepares and dispenses the prescription for use by the patient. In the hospital, the pharmacist prepares the medication for the nurse to administer to the patient and self-administration is seldom permitted. However, in both the community pharmacy and in the hospital, it is the legal and ethical responsibility of the pharmacist "to review and to interpret the physician's order thereby facilitating a conference with the physician regarding any question about the prescription medication."<sup>3</sup>

Since the order for medication in the hospital originates with the physician's written order at the nursing station, some method of transmitting this order to the pharmacy must be devised. Three common techniques are used to transmit prescription order information to the pharmacy:

1. The prescription order is written on a separate form by the physician.
2. A carbon or other copy of the physician's chart order is sent to the pharmacy.
3. The chart order is transcribed by hospital personnel assigned to the nursing station.

The method most generally employed is that in which the registered nurse, licensed practical or vocational nurse, nursing unit manager, or ward clerk transcribes the physician's written order onto another document to be sent to the pharmacist for interpretation and dispensing.<sup>4</sup>

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3. "Statement on Hospital Drug Distribution Systems," Hospitals, J.A.H.A. (39:14) 16 July 1965, p. 140.

4. Ibid.

In every drug distribution system there are two major components:

(a) preparation and dispensing; and (b) administration. In most traditional systems, its operation is a joint responsibility of the pharmacy and nursing staffs with the nurse usually involved in administration and some preparation while the pharmacist usually is involved exclusively with preparation and dispensing. The components of the system may be grouped according to where they usually are performed in the hospital. Those which take place in the pharmacy include: (a) selecting drugs for use in the hospital; (b) ordering drugs; (c) receiving and inspecting drugs; (d) storing drugs and inventory control; (e) repackaging and preparing drugs for dispensing; (f) labeling and dispensing; and (g) transporting drugs to the nursing unit. Those which take place on the nursing ward include: (a) selecting drugs for administration; (b) ordering drugs; (c) storing drugs; (d) preparing drugs for administration; (e) administering drugs to the patient; (f) recording or charting the drugs' administration; (g) evaluating the effects of drugs administered to the patient; and, if indicated, (h) taking some action following this evaluation.<sup>5</sup>

The ideal drug distribution system protects the patient, provides for communication between nursing and pharmacy and assures the medication is available for administration by the nurse at the specified time. Systems which deviate from this plan neglect the legal and

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5. K. N. Barker, op. cit., pp. 595-596.

ethical responsibility of the pharmacist and jeopardize the safety of the patient.<sup>6</sup>

One of the earliest reports on hospital drug distribution appeared in 1940 when Chlebik stated that in her hospital (average daily census 80) all doses of medication were prepared under pharmaceutical supervision.<sup>7</sup> Flack, in 1947, suggested pharmacists should be responsible for diluting all injectables, providing for and supervising the delivery of medications to the nurses, and issuing printed procedures and instructions to nurses.<sup>8</sup> In 1955, Godley described a folder which served as a travelling requisition for each patient's medication and permitted the pharmacist to review the patient's therapy before filling each order. Charges and credits were recorded on the folder and upon discharge, the folder was sent to the business office for billing purposes.<sup>9</sup>

Probably the most comprehensive early discussion of drug distribution was presented by Heard in 1958. He divided inpatient dispensing systems into three traditional categories:

1. Prescription order system.
2. Complete floor stock system.
3. Various combinations of these two.

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6. I.E. Stauffer, "A Review of Drug Distribution Systems in Hospitals," Hosp. Pharmacist (19:4) July-Aug. 1966, p. 150.

7. Sister Mary Chlebik, "Dispensing Direct to the Patient," Am. Prof. Pharmacist (6:2) Feb. 1940, pp. 105-108.

8. H. Flack, "How the Hospital Pharmacist Can Contact the Doctor, Nurse, and Patient," Hosp. Management (64:4) Oct. 1947, p. 88.

9. L. F. Godley, "Rx Folders - A New Method of Ordering, Issuing, Charging Drugs," Hosp. Management (79:4) April 1955, pp. 46-47, 71-72.

He also mentioned the use of a carbonless order form which permitted the pharmacist to receive a copy of the physician's original order and eliminated the transcribing of orders by nursing personnel.<sup>10</sup>

#### Prescription Order System

In the prescription order system, virtually all medications are dispensed by the pharmacist pursuant to individual prescription orders. Advantages of this system include: (a) reduction in medication errors by having the pharmacist review at least a transcript of each prescription order before the drug is dispensed; (b) coordination of the patient's drug program through closer liaison among pharmacist, nurse, and physician; (c) closer inventory control; and (d) proper control of revenue. The disadvantages which may exist with the use of this system are: (a) the possible delay in obtaining medication for a patient; and (b) the need for additional personnel with a resulting increase in costs.

#### Complete Floor Stock System

In the complete floor stock system, most drugs are stocked at the nursing station. Drugs which are particularly expensive, rarely used, or which require especially strict control usually are omitted from floor stock and are sent upon receipt of a prescription order for the individual patient. Advantages of this system include: (a) a reduction in the number of inpatient prescription orders; (b) ready availability of most drugs to the nurses and physicians; (c) a reduction in the number of

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10. J. S. Heard, "Considerations in Inpatient Dispensing," Am. J. Hosp. Pharm. (15:5) May 1958, pp. 388-393.

medications returned to the pharmacy; and (d) a reduction in the number of pharmacy personnel required.

Potential disadvantages of this system are: (a) increased potential for errors because of the lack of the pharmacist's review of medication orders; (b) financial loss due to misappropriation of medication by hospital personnel and the administration of medication to patients without initiating charges; (c) increased drug inventory; (d) increased drug costs due to obsolescence and deterioration; (e) the limited storage facilities at the nursing station in many hospitals; and (f) the increased danger of unnoticed drug deterioration which may jeopardize patient safety.

#### Combinations of Prescription Order and Floor Stock Systems

Most traditional systems of drug distribution in hospitals fall into this category. In hospitals where the two systems are combined, the prescription order system usually is used to dispense the bulk of medication orders, but at least 20 items such as acetylsalicylic acid and milk of magnesia in addition to narcotics and other controlled drugs, are stored in bulk at the nursing station. The advantages and disadvantages of the combined system are the composite of those of the two separate systems, in proportion to the ratio of floor stock to prescription orders. If properly balanced, the best features of each system may be realized.<sup>11</sup>

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11. "Statement on Hospital Drug Distribution Systems," op. cit., pp. 140-144.

Interest in improving these traditional methods of drug distribution developed early in the 1960's primarily as a result of two factors:

1. The high percentage of medication errors reported in the literature.
2. The widespread shortage of personnel, especially nurses.<sup>12</sup>

Among the newer concepts and ideas were decentralized dispensing, automated processing of medication orders and inventory control, and automated storage and inventory devices. However, the most important and far-reaching was the development of the Unit-Dose concept of drug distribution.

#### Development of the Unit-Dose Concept of Drug Distribution

A unit-dose has been 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."<sup>13</sup> The Unit-Dose dispensing concept, therefore, is the concept of the pharmacist dispensing all doses ready to be administered by the nurse.<sup>14</sup> In most Unit-Dose systems in operation, the pharmacist sends the quantity of drugs needed at a nursing station for a period of time. Deliveries usually are made two to four times per 24 hour period.

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12. I. E. Stauffer, op. cit., p. 149.

13. K. N. Barker and W. Heller, "The Development of a Centralized Unit-Dose Dispensing System for U.A.M.C., Part I: Description of the Experimental System," Am. J. Hosp. Pharm. (20:11) Nov. 1963, p. 569.

14. K. N. Barker, "The Future Role of the Hospital Pharmacist in Drug Distribution Systems," Am. J. Hosp. Pharm. (24:4) April 1967, p. 224.

A differentiation is made between 'Unit-Dose packages' and 'single unit packages'. A Unit-Dose package contains the ordered amount of a drug in a dosage form ready for administration to a particular patient by the prescribed route at the prescribed time. A single unit package is one which contains one discrete pharmaceutical dosage form such as one tablet, one capsule, or one 2 milliliter quantity of a liquid. A single unit package becomes a Unit-Dose package when the physician happens to order that particular amount for a patient. In either case, the package is labelled and the contents are administered directly from the package.<sup>15</sup>

Little appeared in the literature prior to 1960 on the subject of drug distribution systems in hospitals. However, during the past 10 years a number of articles have been published and Lantos has suggested the decade of the 1960's may be referred to as "the period of the revolution in drug distribution systems."<sup>16</sup>

In 1961, the use of single dose forms and decentralization of the pharmacy were reported.<sup>17</sup> References to drug vending machines also

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15. "Guidelines for Single-Unit Packages of Drugs," Am. J. Hosp. Pharm. (24:2) Feb. 1967, p. 79.
16. R. L. Lantos, "Annual Administrative Reviews - Pharmacy," Hospitals, J.A.H.A. (43:7) 1 April 1969, p. 163.
17. The following three articles appeared in the first issue of Am. J. Hosp. Pharm. devoted entirely to drug distribution in hospitals: W. E. McConnell, K. N. Barker and L. F. Garrity, "Centralized Unit-Dose Dispensing: Report of a Study," pp. 531-542; N. Schwartz and M. Sturdevant, "A System of Packaging and Dispensing Drugs in Single Doses," pp. 542-559; and C. Simpson and D. C. Carner, "Memorial Hospital (Long Beach, Calif.) Decentralized Pharmacy," pp. 525-529, all in Am. J. Hosp. Pharm. (18:9) Sept. 1961.

appeared in the literature.<sup>18</sup> These developments indicated the following changes in traditional dispensing patterns:

1. The dispensing of medication in single doses ready for administration by the nurse.
2. The decentralization of dispensing, or the location of a sub-pharmacy on the nursing ward.
3. The automation of dispensing using a vending machine located at each nursing station.

Later experience with machine dispensing indicated most pharmacists were opposed to this development.<sup>19</sup>

According to Latiolais, in 1962 more than 20 individuals were involved in some manner with one drug from the time of its specification to the time it reached the patient.<sup>20</sup> The same year, Barker and McConnell reported the average nurse made "one error for every six medications given."<sup>21</sup> These studies presented an obvious challenge

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18. T. A. Manzelli, "Utilization of the Brewer System in the Controlled Distribution of Medication within the Hospital," Am. J. Hosp. Pharm. (18:9) Sept. 1961, pp. 560-566.
  19. For discussions of pharmacists' opinions on machine dispensing see: F. R. Kenna, "Pharmacist Looks at Drug Dispensing Machines," Hospitals, J.A.H.A. (37:3) 1 Feb. 1963, pp. 58-60; and D. F. Moravec, "Mechanical Control of Pharmaceuticals and Unit-Dose Dispensing," Hosp. Management (98:3) Sept. 1964, pp. 88-99.
  20. C. J. Latiolais, "Program Excellence Into Your Activities," Hosp. Management (94:3) Sept. 1962, pp. 80-84.
  21. K. N. Barker and W. E. McConnell, "The Problems of Detecting Medication Errors in Hospitals," Am. J. Hosp. Pharm. (19:8) Aug. 1962, p. 368. In this study, a medication error was defined as: "The administration of the wrong medication or dose of medication, drug, diagnostic agent, chemical, or treatment requiring the use of such agents, to the wrong patient or at the wrong time, or the failure to administer such agents at the specified time or in the manner prescribed or normally considered as accepted practice." p. 361.

to automation and emphasized the need for changes in the traditional methods of distributing drugs in hospitals. Earlier studies had illustrated the use of electronic data processing in various hospital activities and both Slavin and Deeb described applications to hospital pharmacy.<sup>22</sup> Webb suggested pharmaceutical manufacturers prepare single unit packages using strip packaging.<sup>23</sup>

By 1964, sufficient data had been collected on a centralized Unit-Dose system at the University of Arkansas to indicate the system provided a substantial reduction in the amount of time required by nurses on medication activities.<sup>24</sup> Also, a 60 percent reduction in the incidence of medication errors was reported with the experimental system. This study is described in more detail in the following section. In the same

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22. M. Slavin, "Automation and the Hospital Pharmacist," Am. J. Hosp. Pharm. (19:6) June 1962, pp. 274-280; and  
A. E. Deeb, "Electronic Data Processing System for Hospital Pharmacy," Am. J. Hosp. Pharm. (17:12) Dec. 1960, pp. 745-749.
23. J. W. Webb, "Strip Packaging," Am. J. Hosp. Pharm. (19:4) April 1962, pp. 173-175.
24. The study was described in the following series of articles:  
K. N. Barker and W. M. Heller, "The Development of a Centralized Unit-Dose Dispensing System for U.A.M.C., Part I: Description of the Experimental System," Am. J. Hosp. Pharm. (20:11) Nov. 1963, pp. 568-580;  
"Part II: Why Centralize the Preparation of Unit Doses?," (20:12) Dec. 1963, pp. 612-623;  
"Part III: An Editing Center for Physicians' Medication Orders," (21:2) Feb. 1964, pp. 67-77;  
"Part IV: The Roles and Responsibilities of the Pharmacist and Nurse Under the Experimental System," (21:5) May 1964, pp. 230-237;  
"Part V: The Pilot Study - Introduction and Work Measurement," (21:9) Sept. 1964, pp. 412-423; and  
"Part VI: The Pilot Study - Medication Errors and Drug Losses," (21:12) Dec. 1964, pp. 609-625.

year, a decentralized system of drug distribution was evaluated at the University of Iowa.<sup>25</sup>

During 1964, the use of automated data processing was reported in areas which indirectly were associated with drug distribution. These included applications in preprinting labels, drug purchasing, inventory control, formulary assembly, and narcotic control. Also, typewriters generating punched paper tape were used to provide statistical data on drug use.<sup>26</sup>

Weinzettel in 1965 described a Unit-Dose system of drug distribution without extensive capital expenditure for specialized equipment.<sup>27</sup> He reported on a variation of the system where a drug administration team composed primarily of registered nurses and a drug room supervisor promoted coordination between the nursing and pharmacy departments. Similar systems were reported by Beste in 1968 and by Knight and Cowley

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25. H. J. Black and W. W. Tester, "Decentralized Pharmacy Operations Utilizing the Unit Dose Concept," Am. J. Hosp. Pharm. (21:8) Aug. 1964, pp. 344-350. The results of this study also showed a reduction in medication errors and savings in nursing time. For a more detailed description of this system, see the section on Decentralized Unit-Dose Dispensing Systems.
  26. L. J. Motta, "Integrated Drug Purchasing and Pharmaceutical Communications," Am. J. Hosp. Pharm. (21:6) June 1964, pp. 274-276; T.W. Tober, "Applications of Data Processing to Hospital Pharmacy," Am. J. Hosp. Pharm. (21:3) Mar. 1964, pp. 105-111; and S. I. Allen, P. S. Hurd and A. W. Dodds, "A Method of Pharmacy Data Automation," Am. J. Hosp. Pharm. (21:7) July 1964, pp. 314-318.
  27. R. J. Weinzettel, "A Unit-Dose Dispensing System Without Extensive Capital Expenditure," Hosp. Management (100:3) Sept. 1965, pp. 86-92.

in 1969.<sup>28</sup>

Since 1965, Unit-Dose dispensing systems have been established in many hospitals.<sup>29</sup> Although most of the early research was performed in

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28. D. F. Beste, Jr., "An Integrated Pharmacist-Nurse Approach to the Unit-Dose Concept," Am. J. Hosp. Pharm. (25:8) Aug. 1968, pp. 397-407; and Sister M. E. Knight and K. K. Cowley, "A One-Year Look at Unit-Dose," Hosp. Prog. (50:1) Jan. 1969, pp. 26-34.
29. For example, see the following partial list of publications:  
 H. W. Carlin and A. K. O'Byrne, "Decentralized Dispensing System Brings Pharmacist to Nursing Floor," Hosp. Topics (44:12) Dec. 1966, pp. 81-83;  
 M. Thomason, "Unit-Dose Dispensing Trial in a Small Hospital," Hosp. Pharm. (1:7) July 1966, pp. 27-29;  
 R. G. Freund, "How the Centralized Unit-Dose Concept Works in a Community Hospital," Hospitals, J.A.H.A. (40:18) 16 Sept. 1966, pp. 152-158;  
 J. H. Beckerman, "The Logistics of a Drug Distribution System: Packaging, Labeling and Storage," Am. J. Hosp. Pharm. (24:2) Feb. 1967, pp. 63-65;  
 M. Slavin, "Design of an Automated Medication Subsystem," Am. J. Hosp. Pharm. (24:5) May 1967, pp. 254-261;  
 H. C. Walsh, M. R. Thomason and N. M. Davis, "Effective Decentralized Unit Dose Dispensing on a One-Shift Basis," Am. J. Hosp. Pharm. (25:5) May 1968, pp. 249-255;  
 N. M. Davis, "A Transition to Unit Dose Dispensing," Hosp. Pharm. (3:9) Sept. 1968, pp. 5-12, 29;  
 R. G. Freund, "A Centralized Unit Dose Dispensing Program," Hosp. Pharm. (3:9) Sept. 1968, pp. 13-18;  
 B. Mehl, "Drug Distribution in a 1000-Bed Hospital," Am. J. Hosp. Pharm. (25:2) Feb. 1968, pp. 71-75;  
 W. E. Slater and J. R. Hripko, "The Unit Dose System in a Private Hospital, Part One: Implementation," Am. J. Hosp. Pharm. (25:8) Aug. 1968, pp. 408-416;  
 W. E. Slater and J. R. Hripko, "The Unit Dose System in a Private Hospital, Part Two: Evaluation," Am. J. Hosp. Pharm. (25:11) Nov. 1968, pp. 641-648;  
 W. A. Thomas, "Drug Distribution in a Small Hospital," Am. J. Hosp. Pharm. (25:8) Aug. 1968, pp. 429-435;  
 D. Wastchak, "A.D.D.S.-100 - A Drug Distribution System for a 100-Bed Hospital," Am. J. Hosp. Pharm. (25:8) Aug. 1968, pp. 418-427;  
 M. Malmberg, "Small Hospital Converts to Unit Dose Medications," The Mod. Hosp. (110:6) June 1968, pp. 122-124;

university hospitals and other large teaching hospitals, the concepts now have been applied to hospitals of various types and capacities. In fact, while many of the pilot studies in large hospitals were confined to one or two nursing wards, complete Unit-Dose systems have been introduced in some small hospitals.

The many Unit-Dose systems developed over the past 10 years generally can be divided into either centralized or decentralized systems depending on where the individual doses actually are prepared. In a centralized system, each individual dose is prepared for administration in a centrally located pharmacy. In a decentralized system, each individual dose is prepared for administration in a subsidiary pharmacy located on the nursing ward.

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29. (continued)

- M. Falconer, "Drug Distribution System at Lions Gate Saves Staff Time, Ensures Patient Safety," Hosp. Admin. Can. (11:3) Mar. 1969, pp. 54-55;
- J. C. Bohl et al., "A Trinity of Units - Patient, Pharmacist and Doses, Part One: The Medication System," Am. J. Hosp. Pharm. (26:6) June 1969, pp. 316-323;
- D. J. Mueller, "Unit Doses in Vertical Stacks Saves Time, Conserve Space, Minimize Errors," The Mod. Hosp. (112:4) April 1969, pp. 107-110;
- W. J. Mueller, "The Unit-Dose Concept in a Community Hospital," Hosp. Pharm. (4:3) Mar. 1969, pp. 8-11, 34;
- H. J. Roche, "Services of Hospital Pharmacy Improved by Prepackaged Drugs," Hosp. Topics (47:1) Jan. 1969, pp. 55-60;
- M. Wolfe, "Implementing a Unit-Dose System of Drug Distribution," Can. J. Hosp. Pharm. (22:1) Jan.-Feb. 1969, pp. 24-29;
- W. T. Hill, W. T. Blair and N. M. Mitchell, "Satellite Service," Hospitals, J.A.H.A. (44:6) 16 Mar. 1970, pp. 96-102;
- W. J. Durant and J. D. Herrick, "A Unit Dose Drug Distribution System in a Children's Hospital," Am. J. Hosp. Pharm. (27:2) Feb. 1970, pp. 127-131; and
- T. J. Garrison, "Logistics and Dynamics of a Unit-Dose System," Hosp. Pharm. (5:14) May 1970, pp. 14-24.

### Centralized Unit-Dose Dispensing Systems

One of the earliest (1961) Unit-Dose studies was a pilot study in which a centralized Unit-Dose system was used in a 35-bed pediatric ward in the 250-bed University of Florida Teaching Hospital.<sup>30</sup> In the experimental system: (a) all doses were prepared by the pharmacy staff in a central location and delivered to the nursing station; (b) routine doses were prepared by nonprofessional staff under the supervision of a pharmacist; (c) doses were scheduled manually by a pharmacy clerk using a patient medication record; (d) individual doses were identified with the patient through the use of medicine cards which were written for each dose by the pharmacy clerk; and (e) individual doses were accompanied by drug information cards for the nurse.

Barker and Heller conducted a similar study in 1962 on a 28-bed medical ward at the University of Arkansas Medical Center.<sup>31</sup> Changes from the Florida study were: (a) use of punch cards and electronic data processing equipment to control drug order information and schedule doses (punch cards were sorted to determine doses due and the separated cards reproduced to serve as individual dose requisitions); (b) editing of drug orders to standard terminology by a pharmacist-keypuncher team; (c) printing of drug summaries for the nursing staff on teletype terminals

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30. W. E. McConnell, K. N. Barker and L. F. Garrity, "Centralized Unit-Dose Dispensing: Report of a Study," Am. J. Hosp. Pharm. (18:9) Sept. 1961, pp. 531-542.

31. K. N. Barker and W. M. Heller, op. cit.

located in the nursing stations; and (d) investigation of more extensive prepackaging of Unit-Doses. The study reported a reduction in medication errors and savings in nursing time.

The University of Arkansas Medical Center study was expanded in 1964 to include three medical, three surgical, and two pediatric units.<sup>32</sup> Improvements were made on the pilot system. The punch cards were used to print dose information on individual dose envelopes (uni-dose-pak). Pre-packaged Unit-Doses were picked and placed in the envelope accompanied by drug information cards (pharma-tip). This solved the problem of identifying the dose with the patient. Automatic conveyer systems were used to deliver the prepared doses to the nursing stations. Medication errors were reduced and the amount of time nurses spent in medication related activities was less than in the traditional system. However, because of the high cost of this demonstration system, the pre-1962 distribution system was reinstalled.

The first hospital-wide Unit-Dose system was installed in the University of Kentucky Medical Center's 345-bed hospital.<sup>33</sup> According to Stauffer, the following conclusions were made:

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32. K. N. Barker, "Experimental Distribution System Offers Total Drug Control," Hospitals, J.A.H.A. (39:18) 16 Sept. 1965, pp. 142-155; and K. N. Barker, The Demonstration and Evaluation of an Experimental Medication System for the U.A.M.C. Hospital, Vol. I and II, Drug Systems Research, University of Arkansas Medical Center, Little Rock, Arkansas, July 1967.

33. P. F. Parker, "This Unit-Dose System is Step to Future," The Mod. Hosp. (107:11) Nov. 1966, pp. 101-103; and P. F. Parker, "Unit-Dose Systems Reduce Error, Increase Efficiency," Hospitals, J.A.H.A. (42:23) 1 Dec. 1968, pp. 65-72.

"Patient care has been improved through the reduction of drug errors, the production of more accurate charts and the availability of data respecting drug usage. Organization consequences noted include the development of a relationship between pharmacy and nursing, the utilization of more nonprofessional personnel, the implementation of production methods to take advantage of automatic data processing, and the necessity for the pharmacist to develop skills in organizational management. Economic implications observed include the fact that the higher cost of individual doses and the need for additional staff has been somewhat offset by the decrease in drug losses and elimination of credits. Other observations made indicate that the increased availability of data could create new programs which might be costly; more drugs need to be commercially available in unit doses; and the pharmacist needs expert help in implementing the system. Nursing agreed that nurses were freed for patient care and thus patient care and patient safety improved."<sup>34</sup>

#### Decentralized Unit-Dose Dispensing Systems

One of the earliest decentralized Unit-Dose systems was reported in 1961 for a hospital in Long Beach, California.<sup>35</sup> The major characteristic of the system was the location of a dose preparation room staffed by a pharmacist adjacent to the nursing station. The pharmacist maintained the medication cards and prepared the doses.<sup>36</sup>

An extensive decentralized Unit-Dose demonstration system was

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34. I. E. Stauffer, op. cit., pp. 156-157.

35. C. Simpson and D. C. Carner, "Memorial Hospital (Long Beach, Calif.) Decentralized Pharmacy," Am. J. Hosp. Pharm. (18:9) Sept. 1961, pp. 525-529.

36. An economic analysis of this system was reported in 1970 and is discussed in a following section on Unit-Dose Cost Studies.

operated at the University of Iowa in 1964 and 1965.<sup>37</sup> The demonstration system was preceded by a 12-week pilot study in 1962. Characteristics of the system were: (a) establishment of a pharmacy substation located midway between four medical nursing stations; (b) preparation of all Unit-Doses in the substation by a pharmacist; (c) control of drug order information and dose scheduling performed manually by the pharmacist using a patient medication record; and (d) use of a special medication cart with individual drawers for each patient. The results of the study, reported as a number of substudies, indicated: (a) reduced drug errors and discrepancies; (b) increased dose packaging costs; (c) savings in nursing time; (d) increased inventory requirements; and (e) decreased space requirements. An analysis of salary costs was not completed which prevented an evaluation of the economic feasibility of the system.

An experimental decentralized Unit-Dose medication system was used on three general medical units at University Hospital, Madison, Wisconsin in 1965.<sup>38</sup> The investigators found the system, with some modifications, was feasible. In 1966, a modified system was implemented in the hospital to serve 300 of 792 beds. It was subsequently expanded to include over 700 beds and is known as the Wisconsin Information and Medication

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37. W. W. Tester, A Study of Patient Care Involving a Unit Dose System, Final Report, College of Pharmacy, University of Iowa, Iowa City, Iowa, 1 Jan. 1967.

38. W. J. Durant, H. T. Hamill and D. A. Zilz, "A Unique Decentralized Unit Dose Project," Am. J. Hosp. Pharm. (24:3) Mar. 1967, pp. 113-119.

Distribution program (WISMD).<sup>39</sup> Characteristics of the implemented system are: (a) preparation or picking of prepackaged Unit-Doses by pharmacy technicians in a central Unit-Dose dispensary; (b) location of the pharmacist on the ward; (c) transcription of drug orders by the pharmacist; and (d) checking of prepared doses by the pharmacist on the ward prior to administration.

The dispensing of ready-to-administer medications has encouraged hospital pharmacists to move out of their pharmacies and into the patient care area. When pharmacists receive a direct copy of a physician's order instead of a transcription, they find they must know more about the patient's total drug regimen to fulfill their duties effectively. Pharmacists have been protected from the dynamics of patient care by the traditional systems of drug distribution. "As the pharmacist approaches true membership on the patient care team, he finds that total coverage (24 hours a day, seven days a week), involvement on the patient care unit, and effective communication systems are fundamental."<sup>40</sup>

At the Ohio State University Hospitals, a pharmacy coordinated Unit-Dose dispensing and drug administration system has been developed. In this system, the pharmacy department is responsible for all

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39. W. J. Durant, "A New Medication Distribution System," Hosp. Prog. (50:5) May 1969, pp. 104-114.

40. H. S. Carlin, "Annual Administrative Reviews - Pharmacy," Hospitals, J.A.H.A. (41:7) 1 April 1967, pp. 149-150.

activities of drug distribution and administration.<sup>41</sup>

Because of the many changes occurring in drug distribution systems, in 1964 the American Society of Hospital Pharmacists issued a "Statement on Hospital Drug Distribution Systems."<sup>42</sup> The methods of transmitting prescription orders to the pharmacist are listed and the advantages and disadvantages of the three traditional methods of distribution are discussed. The Statement concludes with "Guidelines for Planning and Evaluating Drug Distribution Systems." The Guidelines are intended "as an aid to pharmacists, nurses, physicians, and administrators who are faced with making decisions concerning drug distribution systems during this period of change." They may be summarized as follows:

1. The pharmacist should review the prescriber's original medication order, or a direct copy.
2. Drugs should be dispensed properly labelled and ready for administration to the patient.

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41. The system was described in a series of articles in the Am. J. Hosp. Pharm. (27:11) Nov. 1970, under the general title, "A Pharmacy Coordinated Unit Dose Dispensing and Drug Administration System," C. J. Latiolais, "Philosophy, Objectives and Pharmaceutical Implications," pp. 886-889; C. C. Berry, "Description of the System," pp. 890-898; B. J. Lachner, "Administrative Implications," pp. 899-901; and R. M. Martin, "Nursing Implications," pp. 902-906.

42. "Statement on Hospital Drug Distribution Systems," Hospitals, J.A.H.A. (39:14) 16 July 1965, pp. 140-146.  
The Statement was approved by the American Society of Hospital Pharmacists Board of Directors, 1 Aug. 1964; the A.S.H.P. House of Delegates, 6 Aug. 1964; endorsed by the American Hospital Association Board of Trustees, 6-7 May 1965.

3. Storage facilities and equipment should be designed so drugs are available only to authorized physicians, pharmacists and nurses.
4. Storage facilities and equipment should be designed to permit inspection of drugs prior to administration.
5. It is mandatory provision be made for suitable pharmaceutical services in the event of failure of automated devices.
6. Repacked dosage forms, required for mechanical or electronic drug storage and dispensing devices, should conform to the standards established for good pharmacy practice, in particular those for stability and the United States Pharmacopeia standards for packaging and storage.
7. In considering the use of automated devices as pharmaceutical tools, a clear distinction should be made between the accuracy required in accounting practices and that required in dispensing practices.

The growth of Unit-Dose systems of drug distribution has resulted in an increased demand for manufacturers to produce a wider selection of medications in single unit packages. To assist pharmaceutical manufacturers and packagers who were hesitant to provide such packages because of uncertainty as to what was required in hospitals, the American Society of Hospital Pharmacists issued in 1966 "Guidelines for Single Unit Packages of Drugs."<sup>43</sup> The Guidelines cover general considerations in packaging material, shape and form, label copy, and outer dispensing container, as well as specific considerations for various dosage forms. Similar guidelines have been developed by the

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43. "Guidelines for Single Unit Packages of Drugs," Am. J. Hosp. Pharm. (24:2) Feb. 1967, pp. 79-80. The original Guidelines were revised in 1970 and published in Am. J. Hosp. Pharm. (28:2) Feb. 1971, pp. 110-112.

Canadian Society of Hospital Pharmacists.<sup>44</sup>

Use of Computers in Hospital Pharmacy

"Automation has played an important role in the development of improved methods of drug distribution. Hospital pharmacists have been experimenting with unit-dose dispensing systems, with either centralized or decentralized pharmacy service, and have used, to varying degrees, data processing and transmission equipment. To redesign the method of distribution of drug doses and to devise systems, which will become part of the computerized hospital of the future, have been the objectives of these studies. Automatic drug dispensing machines have been introduced on the nursing divisions. These have made use of simple electronic equipment to improve inventory control and to record charges for drugs for accounting purposes. In other studies, automated data processing has been applied to the whole hospital and the interest in the use of this equipment, in drug distribution, has developed as a secondary program. The primary objective of these projects has been the utilization of computers in the processing of all patient information in the hospital. Drug distribution, one of the many areas being investigated, has presented some unusual requirements for the application of data processing."<sup>45</sup>

Since Blumberg developed the Hospital Indicator for Physician Orders (HIPO) system in 1961 which made use of an automatic electronic device for processing physicians' orders, hospital pharmacists have been aware of the potential of the computer in the hospital medication system.<sup>46</sup> The literature includes descriptions of the control of restricted drugs by automated data processing and the application of these procedures

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44. "Guidelines for Single Unit Packaging of Pharmaceuticals in Canada," Canadian Society of Hospital Pharmacists, Unpublished, 1971.

45. I. E. Stauffer, op. cit., p. 149.

46. M. S. Blumberg, "Prospects for Automation in Handling Physicians' Medication Orders," Am. J. Hosp. Pharm. (18:9) Sept. 1961, pp. 567-570.

to pharmacy inventory control.<sup>47</sup> Systems using data processing in out-patient pharmacy operations and in the preparation of hospital formularies also have been reported.<sup>48</sup> A few articles have discussed more extensive applications of the computer in hospital drug distribution systems.<sup>49</sup>

Although the use of computers in hospital pharmacy is being reported with increased frequency, the ultimate use of electronics is no where

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47. C. F. Richards and H. F. Kabat, "Control of Restricted Drugs by Automatic Data Processing," Am. J. Hosp. Pharm. (21:8) Aug. 1964, pp. 377-379;  
 F. M. Eckel and C. J. Latiolais, "An Effective Narcotic Control System Using Electronic Data Processing," Am. J. Hosp. Pharm. (22:9) Sept. 1965, pp. 519-523;  
 B. P. Wirth, "A Computerized System for Restricted Drug Control and Inventory," Am. J. Hosp. Pharm. (24:10) Oct. 1967, pp. 556-560;  
 I. Title and C. A. Richardson, "Preparation of an Inventory Deck and a Drug Locator List by Electronic Data Processing," Am. J. Hosp. Pharm. (24:1) Jan. 1967, pp. 26-27; and  
 C. L. Waggoner, "Pharmacy Automated Data Processing System by Mail," Am. J. Hosp. Pharm. (24:1) Jan. 1967, pp. 22-25.
48. E. E. Madden and R. H. Dreyfus, "Outpatient Pharmacy Prescription Automation," Am. J. Hosp. Pharm. (25:1) Jan. 1968, pp. 20-25;  
 H. L. Flack, G. E. Downs and L. E. Lanning, "Electronic Data Processing and the Hospital Formulary," Am. J. Hosp. Pharm. (24:1) Jan. 1967, pp. 4-17;  
 P. P. Lamy, I. F. Bourn and H. L. Flack, "Application of Data Processing Equipment to the Hospital Formulary," Am. J. Hosp. Pharm. (18:11) Nov. 1961, pp. 642-649;  
 M. W. Skolaut, "Cataloging a Problem?," Am. J. Hosp. Pharm. (18:3) Mar. 1961, pp. 294-295; and  
 N. M. Davis, "Computer-Generated Formulary," Hosp. Pharm. (5:9) Sept. 1970, pp. 21-25.
49. T. W. Tober, "Applications of Data Processing to Hospital Pharmacy," Am. J. Hosp. Pharm. (21:3) March 1964, pp. 105-111;  
 W. A. Gouveia, P. B. Hofmann and G. O. Barnett, "Computers - Basic Principles and Hospital Pharmacy Implications," Am. J. Hosp. Pharm. (25:1) Jan. 1968, pp. 4-11;  
 W. A. Gouveia, C. Dimantis and G. O. Barnett, "Computer Applications in the Hospital Medication System," Am. J. Hosp. Pharm. (26:3) Mar. 1969, pp. 140-150; and  
 W. A. Gouveia, "Computer Applications in the Hospital Pharmacy," Hospitals, J.A.H.A. (45:1) 1 Jan. 1971, pp. 80-83.

in sight. As Oliver notes, "It seems the height of folly to be satisfied with minor triumphs when, with a little creative effort, hospitals could win complete dominion over the manipulative tasks of drug therapy."<sup>50</sup>

One of the most exciting possibilities for use of the computer will become feasible when large numbers of patient records, using standard drug nomenclature and codes, are computerized. Diagnosis, patient characteristics, and patient response will be matched against the drug, dose, route of administration, dosage form, and other characteristics of the medication. "Then more precise answers will be found to questions of drug efficacy, equivalency of competitive drug products, incidence of adverse drug reactions, drug-drug interactions in the body, and other points requiring large amounts of data."<sup>51</sup> The American Society of Hospital Pharmacists has designed a computer-processable Drug Products Information File with over 16,000 drug items coded on magnetic tape for use in such developments.<sup>52</sup>

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50. J. A. Oliver, "Electronic Data Processing," Hospitals, J.A.H.A. (44:11) 1 June 1970, p. 77.

51. W. M. Heller, "Data Processing in Drug Distribution Systems," Hospitals, J.A.H.A. (42:23) 1 Dec. 1968, p. 75.

52. G. P. Provost, "History and Status of the ASHP Drug Coding and Listing Services," Am. J. Hosp. Pharm. (25:1) Jan. 1968, pp. 12-19.

### CHAPTER III

#### HOSPITAL PHARMACY COST ANALYSIS

The various activities of a hospital are grouped together into departments and each department is placed under the supervision of a person responsible for the proper performance of its functions. The hospital accounting system is arranged so outlays for each department are grouped together as direct expenses of that department.

However, all departments are interrelated, with each department providing services to, and receiving services from, every other department. Therefore, when the total cost of operating a department or service is desired, some proportionate amount of the other hospital departments' expenses must be allocated to the department concerned as indirect costs of that department. These allocated amounts are called indirect costs because they do not represent expenditures directly incurred by that department and the amounts are only indirectly controllable by the activity receiving these intrahospital services.<sup>1</sup>

It can be seen, then, that the total cost of operating a hospital department or function should include the appropriate costs of all assets and services used in a given period. However, since the basic chart of hospital accounts accumulates only direct costs, it is necessary to use

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1. Cost Finding for Hospitals, American Hospital Association, Chicago, 1957, p. 10.

a cost allocation procedure to assign indirect costs to an activity in order to arrive at the total cost. The process of accumulation of total costs for a department or activity is called 'cost analysis' or 'cost finding.'

"Cost analysis should not be confused with cost accounting. Cost accounting involves the routine collection of data concerning the costs of departments, processes, products, or other desired breakdowns. Cost analysis, on the other hand, is the term used to describe the process of recasting the data derived from the accounts ordinarily kept by a hospital to obtain costs of services rendered. Cost analysis is done apart from the bookkeeping system."<sup>2</sup>

#### Uses of Cost Analysis

Cost analysis can be used to:

1. Provide information for setting hospital rates.
2. Furnish a basis for negotiation with contract purchasers of hospital services.
3. Fulfill requirements of hospital associations and/or governmental agencies for information.
4. Provide a measure of the efficiency of various functions.
5. Provide a basis for planning future operations.<sup>3</sup>

According to Hinderer, two erroneous uses frequently claimed for cost analysis are:

1. To provide a comparison of efficiency with other hospitals.

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2. Leon E. Hay, Budgeting and Cost Analysis for Hospitals, University Publications, Bloomington, Ind., 1958, p. 5.

3. Ibid., p. 6.

2. To afford a control mechanism for management by measuring the change in a department's total costs between periods.<sup>4</sup>

Hinderer claims the primary and possibly the only significant purpose of cost analysis is to aid management in establishing rates for the services rendered by the hospital. As the Canadian Hospital Council in its Hospital Accounting Manual has stated, "The main reason for cost analysis is to determine the cost of supplying each unit of service as a basis for substantiating the charge made for the unit."<sup>5</sup>

Although cost analysis is used most frequently to allocate the direct costs of nonrevenue producing departments as indirect costs to revenue producing departments, the procedure also can be used to determine the total cost of any department or activity whether revenue producing or not.

#### Cost Analysis Procedure

The general procedure for hospital cost analysis was outlined by Dawson in 1938. He suggested two steps are necessary to produce departmental and service costs - Preliminary Apportionment and Final Apportionment. "Apportionment means the allocation of the expense of each department or operating unit by the use of a related statistical base. Preliminary Apportionment is the distribution of all departmental expense.

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4. H. Hinderer, "Why General Cost Finding?," Hosp. Prog. (42:4) April 1961, p. 84.

5. Ibid., p. 85.

Final Apportionment is the distribution of departmental costs to patient services."<sup>6</sup>

Therefore, the first step in cost analysis is to determine departmental costs by adding the indirect expense (Preliminary Apportionment) to the direct expenses of each hospital department. The next step, Final Apportionment, involves the distribution of the departmental expense to each of the services of the department.

A department's costs are allocated to other departments or cost centers on some basis related to the amount of services rendered to each. The bases generally are: (a) quantity of service; and (b) actual dollar amount of service. Quantity of service bases are those which use actual counts of the amount of service rendered by a department or cost center. The actual dollar amount of service basis is used where the services rendered involve distribution of items for which the purchase price or the amount charged to patients is known. Other bases of allocation are proportions of area or space, and percentage of direct or accumulated costs of departments served.<sup>7</sup>

When statistics are used as a basis for cost apportionment, they need not always represent actual counts. When it is not practical or economical to obtain actual counts of service rendered, reasonable

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6. W. A. Dawson, "Cost Accounting in Small Hospitals," Hospitals, J.A.H.A. (12:7) July 1938, p. 96.

7. Cost Finding for Hospitals, op. cit., pp. 26-27.

estimates can be approximated by sampling techniques.<sup>8</sup> "The final determination of a basis for apportioning costs should be governed by whether the use of that basis will result in an equitable allocation of cost among the departments and cost centers which have received services from the one whose cost is being allocated."<sup>9</sup>

The American Hospital Association in its Cost Finding for Hospitals reports there are "mainly three currently accepted methods of accomplishing the actual cost apportionment."<sup>10</sup> They are known as Method Number 1, Method Number 2, and Method Number 3. Since results produced by each method vary slightly, it is important one method be used consistently so cost data may be compared from period to period. A description of each method is given in Budgeting and Cost Analysis for Hospital Management.<sup>11</sup>

Method 1 (The Government Reimbursable Cost Formula)

All costs of nonrevenue producing departments are allocated directly to revenue producing departments.

Method 2 (The Step-Down Method)

All costs of nonrevenue producing departments are allocated to all departments which they serve whether or not these produce revenue. As the costs of each nonrevenue producing department are allocated, the costing process for that department is considered closed. Thus, no further

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8. Ibid., p. 24.

9. Ibid., p. 26.

10. Ibid., p. 29.

11. Leon E. Hay, op. cit., pp. 17-18.

charges are made to it and no deductions are made from it in subsequent allocations.

Method Number 2 is called the 'step-down' method because the cost of the department rendering service to the greatest number of other departments while receiving service from the fewest is allocated first. Then there is a step-down to the department rendering service to the second largest number of departments and receiving service from the second smallest number of departments.

Method 3 (The Vicious Circle Method, or Double Distribution Method)

A preliminary allocation of nonrevenue producing departmental costs is made to other departments in an attempt to measure the cost of the service which each of these departmental functions renders to the others. Then a final apportionment of expense involving the allocation of all costs remaining in nonrevenue producing functions is made directly to revenue producing departments.

Other methods of cost apportionment use algebraic formulas to determine the costs to be apportioned. These formulas are designed to identify the costs in the departments that serve each other by recognizing the existing complex relationships. Cost apportionment is accomplished by solving a series of simultaneous equations. The number of departments serving each other may be large, necessitating a laborious task of solving equations with many unknowns.<sup>12</sup>

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12. Cost Finding for Hospitals, op. cit., p. 30.

### Hospital Pharmacy Cost Studies

Cost studies have been made to aid in determining prices to be charged for various hospital pharmacy services. A few of these studies have involved a cost analysis of the pharmacy department but, to date, a complete cost analysis of an entire drug distribution system has not appeared in the literature. However, with the development of new systems of drug distribution, accurate cost studies are necessary since most hospital administrations, expecting newer systems will increase costs, are hesitant about adopting these systems. This is to be expected since, as Berman noted in 1967:

"Traditionally a great deal of emphasis has been placed on the pharmacy department as a source of profit for the hospital. The introduction of 24-hour pharmacy service, unit-dose dispensing and electronic equipment substantially increases the operating expenses of the pharmacy department. To be sure, much of this expense would be offset by saving nursing time. Nevertheless, the newer concepts of drug distribution challenge the unreasonable assumption that the pharmacy service was somehow preordained to meet the deficits of other services in the hospital. Proponents of innovations in drug distribution systems, while conscious of their fiscal responsibility, are primarily concerned with patient care and with enhancing the pharmacist's professional scope."<sup>13</sup>

One of the earliest descriptions of a cost analysis procedure for hospital pharmacy was given by Jeffries in 1954. He suggested "inpatient and outpatient prescription dispensing, regardless of whether the prescription calls for a prefabricated or compounded medicine, or whether it is prepackaged in the pharmacy or dispensed from bulk on order, is

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13. A. Berman, "Review and Criticism of Traditional Drug Distribution Systems," Am. J. Hosp. Pharm. (24:2) Feb. 1967, p. 56.

still basically a manufacturing operation."<sup>14</sup> Therefore, standard cost analysis procedures could be used in computing the prescription cost of goods sold.

He included in his cost of goods calculation: (a) the cost of ingredients; (b) the cost of the container; (c) the cost of direct labor expended on the prescription or prepackaged prescription item; and (d) the overhead charge per prescription. The total of these four cost figures was the prescription break-even cost. Jeffries claimed "the use of the Jeffries Break-even Prescription Costing and Pricing Method permits, for the first time, a reasonable opportunity for sound profit planning by the pharmacist together with the hospital administrator."<sup>15</sup>

Provost and Heller in 1960 also described a system of break-even pricing for hospital pharmacy. In addition to direct costs, they included in their calculations a portion of the hospital costs for administration, physical plant and housekeeping, supplies and depreciation of equipment and fixtures, and other indirect costs. Also, they recognized there were personnel costs associated with the operation of the drug distribution system which were not directly associated with the dispensing function.

They assigned to each prescription a portion of 'professional overhead' which included: (a) costs of keeping the dispensing pharmacist on

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14. S. B. Jeffries, "A New Approach to Costing and Pricing Prescriptions in the Hospital Pharmacy," Bulletin of the Am. Soc. Hosp. Pharm. (11:6) Nov.-Dec. 1954, p. 456.

15. Ibid., p. 457.

duty when there were no prescriptions to be dispensed; (b) labor costs to receive and store medication; (c) labor costs involved in purchasing and paying for drugs; (d) costs of labor to talk and write to manufacturers and their representatives; and (e) costs of the time involved in continually working with the medical and nursing staffs to ensure the best drugs were available and were used most advantageously in therapy.<sup>16</sup>

A detailed description of a cost analysis procedure for the hospital pharmacy department was published by Barker and McConnell in 1961. They used their calculations to develop a schedule for pricing prescriptions at the University of Florida Teaching Hospital.<sup>17</sup>

Petrick in 1965, Winship and McEvilla in 1966, and Bachynsky in 1967 conducted extensive cost analyses of different hospital pharmacy departments.<sup>18</sup> Petrick analysed six different pharmacy service areas and established professional fees for each. He noted several methods may be

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16. G. P. Provost and W. M. Heller, "How Break-Even Pricing of Drugs Works," The Mod. Hosp. (94:5) May 1960, pp. 122-126.
  17. K. N. Barker and W. E. McConnell, "A Cost Accounting System and Pricing Schedule for Hospital Pharmacy," Am. J. Hosp. Pharm. (18:5) May 1961, pp. 283-293.
  18. R. J. Petrick, "Applicability of the Professional Fee Concept to Hospital Pharmacy," Unpublished M.S. Thesis, The Ohio State University, 1965;  
H. W. Winship and J. D. McEvilla, "The Determination of Pharmacy Department Dispensing Cost in Selected Hospitals," Unpublished Paper presented to the Economics and Administrative Science Section of the Academy of Pharmaceutical Sciences at the Annual Meeting of the A.Ph.A., Miami Beach, Florida, 6 May 1968; and  
J. A. Bachynsky, "Some Aspects of Drug Distribution Under Tax Supported Programs," Unpublished Ph.D. Thesis, University of Wisconsin, 1967.

used to allocate overhead costs, such as the number of units dispensed during the year, the cost of the items distributed, or the floor space occupied by a service. He calculated the allocation of various services using each of these methods and found there was little similarity among the three.

"Using free floor stock as an example, this service area required the most floor space for manufacturing, packaging and storage. Yet, because these drugs are inexpensive free floor stock, the cost of drugs for this service area was lowest. The service area that had the highest cost of drugs - interdepartmental requisitions - accounted for the second lowest percentage of all units dispensed."<sup>19</sup>

Because pharmacy is a service department of the hospital, Petrick concluded overhead costs could be allocated on the basis of man-hours spent in each service area.

Winship and McEvilla conducted a cost analysis of seven hospital pharmacy departments. The purposes of their study were: (a) to determine the direct and indirect costs associated with dispensing charge medication orders by the pharmacy department; and (b) to relate the derived total pharmacy costs, exclusive of the purchase cost of drugs, to pharmacy workload (cost per requisition) and patient load (cost per patient day). The determination of total pharmacy costs was done by two methods - The American Hospital Association Method Number 2 and the

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19. R. J. Petrick and C. J. Latiolais, "Applicability of the Professional Fee Concept to Hospital Pharmacy," Am. J. Hosp. Pharm. (23:9) Sept. 1966, p. 503.

Social Security Administration Step-Down method.<sup>20</sup>

The major difference in the two methods is the point at which the allocation of Administration and General cost center expenses are made. According to the American Hospital Association Method Number 2, the Administration and General cost center expenses are not allocated prior to closing of the pharmacy department account. The Social Security Administration Step-Down Method considers a portion of the Administration and General cost center expenses as one of the indirect expenses of the pharmacy department. This approach provides a more accurate analysis of the cost of the pharmacy department and therefore was used in this author's study.

Upon comparing the total pharmacy cost on a per requisition and per patient day basis, wide variations among hospitals were found. This could be expected since the staffing, distribution systems and services offered varied from hospital to hospital. Also, the number of inpatient requisitions dispensed in a pharmacy department is dependent upon a number of factors including: (a) the definition of a patient medication order or requisition; (b) the hospital's policy regarding floor stock medications; (c) variations in what is considered floor stock; (d) the hospital's procedure for charging for narcotics and other controlled drugs; and (e) the number of doses dispensed on each requisition.

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20. Cost Finding for Hospitals, American Hospital Assoc., Chicago, 1957; and Principles of Reimbursement for Provider Costs, Social Security Administration, Washington, D.C., HIM-5, 1966.

Bachynsky used cost analysis to calculate the mean cost of dispensing outpatient prescriptions in two hospitals. The hospital pharmacies were designated as cost centers and both direct and indirect costs were calculated for each pharmacy and, in turn, for the outpatient operations.<sup>21</sup>

Naylor and Tester studied the variables in hospitals and medication cycles to determine the effect, if any, each had on the cost of pharmacy service.<sup>22</sup>

"It was hoped that a mathematical formula or model could be formulated from the proper selection and combination of the influential variables. This model would be a basis from which predictions could be postulated concerning drug costs and direct cost of pharmacy service within the hospitals surveyed and possibly for all hospitals."<sup>23</sup>

Using stepwise regression, they developed two equations to predict drug cost per patient day and two equations to predict total pharmacy cost per patient day. They concluded, "Stepwise regression appears to be a satisfactory method for analysis of hospital costs, but certain limitations must be kept in mind."<sup>24</sup>

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21. J. A. Bachynsky and R. W. Hammel, "Cost of Providing Pharmaceuticals Under Tax-Supported Programs," J. Am. Ph. Assoc. (NS9:6) June, 1969, pp. 269-272.

22. M. J. V. Naylor and W. W. Tester, "Analyzing and Predicting Hospital Pharmacy Costs Using Stepwise Regression," Am. J. Hosp. Pharm. (28:3) Mar. 1971, pp. 162-171.

23. Ibid., p. 163.

24. Ibid., p. 168. Apparent major limitations are: (a) doubt or uncertainty that all significant variables are included in the equations; and (b) the inability to obtain valid and accurate information on all potentially significant variables.

### Unit-Dose Cost Studies

Since 1965, there have been a number of cost studies on various aspects of Unit-Dose systems. As part of the Unit-Dose study at the University of Ohio, Hepler in 1965 conducted a study to obtain an estimate of certain direct labor costs under the conventional method of drug distribution for the purpose of comparison with data collected from the Unit-Dose method. However, "since the main objective was to provide data for purposes of comparison, economic considerations demanded that the scope of this investigation be limited to those labor cost elements of the system which might be increased or decreased by the institution of the unit-dose system."<sup>25</sup>

In 1968, a similar study was conducted to compare time/cost data of the traditional system and a Unit-Dose system of drug distribution at Kettering Memorial Hospital, Kettering, Ohio. A research group conducted a series of time, motion and cost comparison studies under actual hospital operating conditions. The results of the time study data involving nursing showed a reduction of nursing time devoted to drug preparation and clerical effort relating to drugs. The time study data involving all pharmacy department personnel showed a significant decrease in preparation time. A study of costs per dose showed a decrease of \$0.03189 in labor costs between the two systems.<sup>26</sup>

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25. C. D. Hepler, "A Study of Direct Labor Costs in Hospital Pharmacy Systems Using the Model Concept," Am. J. Hosp. Pharm. (23:12) Dec. 1966, pp. 645-661.

26. W. E. Slater and J. R. Hripko, "The Unit-Dose System in a Private Hospital, Part Two: Evaluation," Am. J. Hosp. Pharm. (25:11) Nov. 1968, pp. 641-648.

Blasingame, et al., in 1969 reported on a time and motion study comparing the labor costs of dispensing, distributing and administering six oral solid drug products with conventional versus single unit (Identidose, Lilly) packages. The study was conducted in five hospitals of different type, size and geographic location, and with different drug distribution and administration systems. Overall pharmacy and nursing labor savings achieved with the single unit form amounted to two cents per unit. The average cost increase of the single unit packaged products over bulk containers was approximately one cent per unit. Therefore, it was concluded the use of single unit packages of drugs need not increase hospital medication costs and could be adapted to any type of drug distribution system.<sup>27</sup>

Smith and Mackewicz reported in 1970 on pharmacy and nursing personnel costs before and after implementation of a completely decentralized drug distribution system at Memorial Hospital in Long Beach, California. Pharmacy and nursing personnel costs before implementation of the Unit-Dose system were calculated at \$13.12 per patient day. After implementation of the new system, these costs increased by \$1.59 per patient day. However, it was calculated 17.5 additional nurses would have been required to perform the activity of dose preparation if the Unit-Dose

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27. W. G. Blasingame, et al., "Some Time and Motion Considerations with Single-Unit Packaged Drugs in Five Hospitals," Am. J. Hosp. Pharm. (26:6) June 1969, pp. 310-315; and P. Minott, "Drug Distribution Costs as Seen From a Time and Motion Study: Traditional vs. Unit Dose," Proceedings of the Second Nationwide Seminar on Unit Packaging for Pharmaceuticals, St. Louis, Missouri, 18-20 May 1970, The Packaging Institute, U.S.A., New York, pp. 52-59.

program had not been initiated. Taking this into account, the Unit-Dose system decreased personnel costs by \$0.49 per patient day. The study did not include consideration of other costs associated with drug distribution or the cost of drugs.<sup>28</sup>

#### Drug Distribution System Cost Studies

In 1969, Barker reported on a cost study of the experimental, centralized, Unit-Dose medication system at the University of Arkansas Medical Center Hospital. The study was designed to produce an estimate of the net cost of installing and operating the new system versus continuing the operation of the old system. Costs analyzed include materials, supplies, labor, rental of equipment, and overhead.

The experimental system was installed on only eight of the 15 nursing divisions and some components of the system were not operational when the cost study was done. Therefore, although the cost of the control system could be estimated directly from the control period data, some of the costs of the experimental system had to be estimated indirectly. Also, since the system actually evaluated was incomplete during the experimental period, the tested system was neither the system originally

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28. W. E. Smith and D. W. Mackewicz, "An Economic Analysis of the PACE Pharmacy Service," Am. J. Hosp. Pharm. (27:2) Feb. 1970, pp. 123-126. The nursing workload increased after implementation of the new drug distribution system because: (a) the number of medical-surgical patients over 65 increased 14 percent; (b) the number of acutely ill patients increased; and (c) there was an increase in patient days. The authors concluded the new drug distribution system, which included dose preparation by the pharmacy department, had prevented the necessity of hiring an additional 17.5 nurses who would have been needed to maintain the previous level of nursing care.

proposed nor was it recommended for future installation. It was estimated, however, that the recommended system would cost \$81,114 to install and an additional \$89,428 per annum to operate.<sup>29</sup>

A comprehensive cost analysis was performed to provide a cost comparison between the University of Kentucky Unit-Dose drug distribution system and the drug distribution systems at four comparison hospitals.<sup>30</sup> Three of these hospitals (A, B, D) had prescription order systems while hospital C had a floor stock system. Costs were accumulated for each distribution system in a cost model designed to facilitate comparisons among systems having similar objectives but alternative combinations of resources. Consequently, only costs that contributed directly to the objectives of the systems were considered. Indirect costs such as depreciation on buildings and fixed equipment, plant operation and maintenance, and hospital administration were not included in the

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29. K. N. Barker, "The Effects of an Experimental Medication System On Medication Errors and Costs, Part Two: The Cost Study," Am. J. Hosp. Pharm. (26:7) July 1969, pp. 388-397.

30. G. C. Hyde, "A Comparative Cost Analysis of the University of Kentucky Unit Dose System" Unpublished Study Report, Unit Dose Grant, Pharmacy Central Supply, University Hospital, Albert B. Chandler Medical Center, University of Kentucky, 1969;  
C. E. Hynniman, G. C. Hyde and P. F. Parker, "Some Results of Studies on the Cost and Effectiveness of Unit Dose Systems," Unpublished Paper presented to the Second Annual Hospital Pharmacy Seminar of the Virginia Soc. of Hosp. Pharm., Williamsburg, Virginia, 8 Nov. 1969; and  
C. E. Hynniman, "A Comparison of Costs Associated with the Unit Dose and Traditional Drug Distribution Systems," Proceedings of the Second Nationwide Seminar on Unit Packaging for Pharmaceuticals, St. Louis, Missouri, 18-20 May 1970, The Packaging Institute, U.S.A., New York, pp. 45-51.

analysis.<sup>31</sup>

The accumulated costs for each hospital were expressed in terms of cost per patient day, cost per administered dose, and cost per order so economic comparisons could be made. The Unit-Dose system at the University of Kentucky proved to be the more expensive in terms of cost per patient day. However, as shown in Table I, when cost per dose and cost per order were considered, the Unit-Dose system compared favorably with the other drug distribution systems from an economic standpoint.<sup>32</sup>

The economic analysis was performed on five drug distribution systems, each with its own objectives, a unique environment, and dissimilar constraints. A preferable course of action would have been to compare the University of Kentucky Unit-Dose system with other drug distribution systems having common facilities and equivalent requirements. However, that course of action could not be accomplished on a hospital wide scale.

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31. The results of this study should be used with care in estimating the total cost of operating a given drug distribution system. As Hyde noted on p. 26 of his report, "The completed cost model will fulfill its cost comparison functions. It will not, however, provide a complete cost accounting of the pharmacy operations at the University of Kentucky or the comparison hospitals. Such is not its intent. When comparing alternative drug distribution systems it is neither necessary nor desirable to account for all costs."

32. These findings indicate the importance of using a common basis for comparing drug distribution systems. Since the amount of drug administered at one time (unit-dose) is comparable in all systems, it is probably the most acceptable base to use in comparison studies.

Table I

UNIT COSTS PER PATIENT DAY, ADMINISTERED DOSE AND ORDER AT THE  
UNIVERSITY OF KENTUCKY AND FOUR COMPARISON HOSPITALS

| Hospital               | Cost/Patient Day | Cost/Dose | Cost/Order |
|------------------------|------------------|-----------|------------|
| University of Kentucky | \$3.50           | \$0.33    | \$2.79     |
| Community Hospital A   | 2.84             | 0.54      | 4.84       |
| Community Hospital B   | 3.12             | 0.51      | 4.60       |
| University Hospital C  | 2.73             | 0.32      | 2.85       |
| University Hospital D  | 3.10             | 0.38      | 3.36       |

CHAPTER IV

## BACKGROUND OF STUDY

University Hospital is a 546-bed, general, nonprofit, teaching hospital located on the University of Saskatchewan campus in Saskatoon, Saskatchewan. It is physically connected to the College of Medicine and the Cancer Research Foundation building. However, organizationally, the administration and financing of these three institutions are independent. Operating funds for the hospital are obtained largely from the provincial government through the universal hospital insurance plan.

The national hospital insurance system in Canada provides general hospital care for almost the entire population. It is financed by federal grants to the ten provinces of approximately 50 percent and by provincial funds raised through various tax methods. Hospitals operate autonomously under the system although there are national and provincial minimum standards stipulated for hospital service. Payments to hospitals do not include physicians' services except those of pathologists and radiologists employed by the hospital. The hospital insurance scheme is administered nationally by the Department of National Health and Welfare and usually by separate commissions in the provinces.

Hospitals are paid by the provincial authorities according to a formula based partly on costs per patient day but mainly on the fixed

costs of operation for the year.<sup>1</sup> Each hospital submits its expected budget for the next year's operation on an annual basis. The budget is reviewed by the responsible government agency and is approved on the basis of specified standards as, for example, a maximum number of nurse-hours per patient day. "The periodic payments to hospitals, based on an approved budget, greatly simplify the administration of the hospital insurance scheme, and they also discourage excessive use of hospitals with consequent financial waste."<sup>2</sup>

#### Hospital Systems Study Group

The Hospital Systems Study Group at the University of Saskatchewan is an organization formed to conduct research and develop projects through the application of work study methods, systems analysis techniques and computer science to the health field. "The overall goal of the Hospital Systems Study Group is to improve the quality of health care available, with particular emphasis on improvement of programs of Saskatchewan hospitals."<sup>3</sup>

The techniques used by the Hospital Systems Study Group have proven effective in business and industry. The activities of the Group are an attempt to apply and refine these techniques to the provision of health

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1. M. I. Roemer, The Organization of Medical Care Under Social Security, International Labour Office, Geneva, 1969, p. 32.
  2. Ibid., p. 88.
  3. C. R. Shanks and B. A. Holmlund, Hospital Systems Study Group Annual Report 1969, University of Saskatchewan, Saskatoon, Saskatchewan, p. 1.

care and, where required, to develop new techniques more appropriate to the health care area.

The development of the Hospital Systems Study Group began in 1965 with the formation of a committee reporting to the Dean of Medicine. This committee was concerned that institutions and organizations providing health care were not taking advantage of new methods of analyzing problem situations. A successful grant application was made to the Department of National Health and Welfare for funds to develop a special group of individuals specifically devoted to this area. The terms of reference of this grant were, in general, that the possibilities of applying systems analysis techniques should be studied in the setting of a modern teaching hospital, specifically in the University Hospital. Since then, the Hospital Systems Study Group has conducted a number of studies at University Hospital and other hospitals in the province. It receives financial support from both the federal and provincial governments.

#### Development of the Unit Assignment Nursing System

A study of the quantitative aspects of direct patient care and category of patients' nursing requirements, undertaken by the Hospital Systems Study Group, led to the development of the unit assignment nursing system.<sup>4</sup> Under this system, the nursing ward is divided into units, each the responsibility of a unit nurse and supporting staff. Each unit consists of a number of patients who require the same level of nursing

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4. The unit assignment nursing system is described in detail in, B. A. Holmlund, Nursing Research - Phase I - Initial Analysis and Categorization of Patients, Hospital Systems Study Group, University of Saskatchewan, Saskatoon, Saskatchewan, Sept. 1967.

care. There are four levels - intensive care, above average care, average care, and minimal or self-care. The number of patients on a unit depends on the level of care and ranges from two patients on an intensive care unit to 30 patients on a self-care unit. Each unit operates in a self-contained fashion with all services being coordinated by the unit nurse.

An important aspect of the unit assignment nursing system is the role played by the supporting hospital services which supply the nursing units. "The drug distribution system must provide the unit with a drug dose ready for administration to the patient at the required time, and relieve the nurse of the tasks of scheduling and preparing medications for the concept of the Unit Assignment System to be effective."<sup>5</sup>

Each nursing unit has a unit nursing station where patient charts, nursing supplies and medications for the unit are kept. These combination desk-storage units are portable with medications and supplies located in a movable cart which can be wheeled directly into the patient's room. The head nurse supervises nursing service on the nursing units from the centralized ward nursing station.

The unit assignment nursing system has been established on a number of nursing wards at University Hospital. Other nursing wards operate under the team nursing system. In this latter system, all nursing personnel work out of the ward nursing station where patient charts,

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5. C. D. Webster, Drug Distribution Study - VI, A Computer Assisted Satellite Pharmacy System for Hospital Drug Distribution, Hospital Systems Study Group, University of Saskatchewan, Saskatoon, Saskatchewan, Jan. 1968, p. 7.

physicians' order book, patient Kardex, medications, and nursing supplies are stored. Supervision of nursing care is under the direction of a head nurse. Nursing personnel are organized into teams with each team responsible for the care of a number of patients.

#### The Floor Stock-Prescription Order Drug Distribution System

The traditional drug distribution system at University Hospital is a combination of floor stocks of frequently used products and individual patient prescriptions. The operation of this system is a joint responsibility of the nursing department and pharmacy department.

The nurse is responsible for co-ordinating all communication and activity concerned with drugs in the nursing area. She is responsible for receiving and editing the physician's order for medications. She must ensure the correct drugs are available in the nursing area for administration to the patient. She must determine when a drug is to be administered, then prepare and administer it to the patient. She is responsible for recording this action and for evaluating the patient's reaction to the administered drug.<sup>6</sup>

Although the pharmacy department is responsible for all aspects of drug therapy in the hospital, the majority of its activities under the traditional system are directed to the procurement of medications from

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6. The nurses involvement in drug distribution under the floor stock-prescription order system is explained in detail in, C. D. Webster, Drug Distribution Study - II, Nursing Involvement in Drug Distribution, Hospital Systems Study Group, University of Saskatchewan, Saskatoon, Saskatchewan, Jan. 1968.

outside the hospital, and the repackaging and labeling of these prior to distribution to the nursing areas. In addition, an extensive pharmacy manufacturing area prepares from basic chemicals a variety of required items.

The pharmacy department also is involved in various research and educational programs and provides an out-patient service. These activities are excluded from this study since they do not have a direct bearing on the hospital drug distribution system.

#### Operation of the System

The pharmacy department specifies and purchases all drugs used in the hospital. Purchase orders, prepared by a pharmacist, are sent to pharmaceutical manufacturers, wholesale drug houses, and other hospitals and community pharmacy outlets.

Purchased drugs are delivered to the hospital receiving department where they subsequently are collected by the pharmacy storesman. Receiving slips are checked against the original purchase orders and the drugs placed in storage. The majority of items go into reserve storage in the main pharmacy stores area. However, drugs required for immediate use are placed in active storage in the dispensary.

When the invoices are received, they are checked against the original purchase orders and receiving slips. The stock is priced and the purchase recorded in the pharmacy department purchase record. Invoices then are sent to the business office for payment.

Physician's orders are written chronologically on individual patient order sheets kept in the Physicians' Order Book at the nursing station or in the patient's chart at the unit nursing station. Each entry may contain a variety of orders - laboratory work, nursing procedures, consultations, and drugs. Physicians must sign and date the order, but the content and wording are unrestricted.

On some nursing wards, procedures have been established to signal the nurse when a new entry on the order sheet has been written. The physician writes an entry on an index sheet giving the name of the patient and the date. The nurse then can determine which patients have new orders by reading the index sheet. However, this system fails as the procedure of indexing orders is not used by all physicians. Thus, the nurse has lost confidence in the procedure and relies on a check of each patient's order sheet to determine new orders rather than rely on the index sheet. On a large nursing ward, with many admitting physicians, the conscientious nurse must scan the order sheets several times each shift to ensure prompt action is taken on the orders.

Most orders are handwritten by physicians, the exception being pre-stamped orders given routinely on admission in some departments. There is a wide variation in the legibility and terminology of the orders. The nurse interpreting the order must rely on her experience with the type of medical treatment being given the patient and on her familiarity with the physician's handwriting.

The nurse often is required to edit the order. This especially is true of drug orders. Drugs may be ordered by generic name, proprietary

names and abbreviations for both. Information in the order may be incomplete. The physician may assume the name of the drug implies the dosage form and the route of administration. The strength and quantity may be stated in the apothecary system or the metric system.

The nurse is responsible for obtaining and maintaining a supply of drugs on the nursing ward for administration to patients. Drugs available on each nursing ward as floor stock are ordered in bulk on a collective patient basis three times weekly by nursing personnel who indicate on preprinted forms the quantity of each item required. The majority of floor stock drugs are prepackaged and pharmacy technicians, under the supervision of a pharmacist, place the ordered drugs in floor stock boxes which are delivered to the nursing wards and nursing units by the pharmacy porter. If additional floor stock items are required before the next regular delivery, an extra floor stock requisition is sent to the pharmacy and filled on receipt.

Each narcotic and other controlled drug floor stock is maintained on a two container basis and is ordered by the nurse on separate requisition forms. When the contents of one container are being used as a drug supply, the other container is being refilled in the pharmacy department. Orders are filled twice weekly and delivered to the nursing wards and nursing units by a pharmacist. The nurse is required to sign a register for each container of narcotic and other controlled drug floor stock received.

Drugs which are not available as floor stock are ordered for individual patients on a triplicate prescription form. Orders are

filled in the dispensary as received and sent to the nursing areas via a pneumatic tube system.

Floor stock requisitions and prescription orders are priced at the time of filling. Drugs which are chargeable to the patient are available on prescription only and two copies of the priced order are sent to the business office for posting to the patient's account.

When a patient is scheduled for discharge, all prescription medications remaining on the nursing ward for that patient are returned to the pharmacy. A credit, issued only for re-usable drugs, is sent to the business office prior to the patient's discharge from the hospital.

With the exception of a drug ordered for immediate administration (STAT), drug orders initiate repetitive tasks for the nurse. She must have working documents that are constantly available and kept current to facilitate the scheduling of drugs for administration. To achieve this, the nurse uses the medication ticket and the Kardex. When a drug order is written, the information is transcribed to a medication ticket and to the Kardex.

The medication ticket is used to schedule the administration of medications, give instructions regarding preparation and administration and to identify drugs removed from labelled containers. Scheduling is accomplished by placing the medication ticket in a compartmentalized rack according to the time of the next administration following each use of the card.

Because the medication tickets are individual documents and their movement is uncontrolled, a control procedure using the Kardex has been implemented. At each shift change, the nurse compares the medication tickets for each patient against the list of medications on the patient's Kardex. This checking procedure ensures early detection of misplaced or incorrect medication tickets.

Hospital policy places an automatic stop on some types of drugs and it is the nurse's responsibility to control the automatic stoppage of such drugs.

The procedure for scheduling medications described above applies only to those medications given at regular intervals. Orders may call for drugs to be administered immediately (STAT), or may call for drugs to be administered pro re nata (PRN). The nurse uses the order sheet directly in preparing and administering STAT medications. PRN medications are prepared and administered at irregular intervals as patients require them and the Kardex is used to verify the medication has been ordered for the patient.

When a patient requires medication, the nurse puts the drug in a form for administration. In many cases, she removes a tablet from a container. In other cases, she must cut a tablet or measure or dilute a liquid to obtain the dosage specified, or she must crush and dissolve a tablet to obtain the drug form specified, or she may have to prepare an injectable. Once she has removed the drug from its identified container, the nurse is responsible for identifying the drug by using the medication ticket.

Medication cups containing individual patient's medications and the medication tickets are placed on a tray for transportation to the patients' rooms. The nurse uses the medication ticket to identify the patient and administers the medication.

To provide the physician with information about drugs the patient has received, the nurse records each administration on the patient's chart. The nurse usually does this when she has returned to the nursing station after administering all medications. She refers to the medication tickets to provide her with the necessary information for charting. When many doses have been scheduled for administration to several patients at one time, the charting of the administration time often becomes meaningless. The time recorded is usually the time the dose was scheduled to be given and this time can vary as much as half an hour from the time the dose actually was given.

To satisfy legal requirements for the control of narcotics and other controlled drugs, the nurse must record each dose administered on an administration record sheet and a nursing check sheet, and calculate the amount of the drug remaining in stock. The purpose of the first sheet is to provide a permanent record of the disposition of all narcotics and other controlled drugs. The purpose of the second sheet is to facilitate a check of the narcotic and other controlled drug stock at the end of the nursing shift.

The Experimental Computer-Assisted Unit-Dose Satellite Drug Distribution System

A study of the drug distribution system in use at University Hospital was initiated in September 1966 by the Hospital Systems Study Group and the hospital. The purpose of the study was to examine some of the problems existing in the floor stock-prescription order system and to propose solutions to these problems.

Deficiencies of the Traditional System

The study revealed the following deficiencies in the traditional drug distribution system:<sup>7</sup>

1. The distribution cycle relied heavily on nursing involvement with many of her tasks being of a clerical nature.
2. The need of the medical and nursing staffs for readily accessible drug information in most cases was not being met due to the physical location of the pharmacy and the non-involvement of the pharmacist in the patient environment.
3. The time lag between initiation of a drug order and receipt of the medication on the nursing ward was excessive.
4. The increased volume and complexity of pharmacy service had been accompanied by an increased risk of medication error due to the distribution cycle itself which involved a large number of people and relied on several copying procedures after the drug order was written.

The major result of the study was the recommendation that a Computer-Assisted, Unit-Dose, Satellite Pharmacy system for hospital drug distribution be established.<sup>8</sup> A National Health Grant was received

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7. D. J. Howe and H. Skinner, A Computer-Assisted Decentralized Unit-Dose Drug Distribution System, Report II, Hospital Systems Study Group, University of Saskatchewan, Saskatoon, Saskatchewan, June 1969, pp. 1-2.

8. C. D. Webster, Drug Distribution Study - VI, A Computer Assisted Satellite Pharmacy System for Hospital Drug Distribution, Hospital Systems Study Group, University of Saskatchewan, Saskatoon, Saskatchewan, Jan. 1968.

to develop and evaluate such a system at University Hospital.<sup>9</sup> In April 1968, the design of an actual drug distribution system to serve one nursing ward was begun and in June 1969, an experimental system went into operation for a trial period of 22 weeks. The experimental ward was a combined neurosurgery and ophthalmology ward (4DE) with a bed capacity of 47 and an average census of approximately 30. This ward operated under the unit assignment system of nursing with the ward divided into six units. The pilot pharmacy system combined three important concepts:

1. The utilization of Unit-Doses.
2. A pharmacist working in the patient area.
3. The utilization of automatic data processing.

#### Operation of the Experimental System<sup>10</sup>

A satellite pharmacy is a space located in the patient area from which the pharmacist assumes responsibility for all pharmacy activity for the area. The satellite pharmacy concept attempts to answer the problem of noninvolvement of the pharmacist by placing him in the patient area where he becomes a ready source of information for medical and nursing personnel.

The satellite pharmacy in the experimental system was located in a

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9. Public Health Research Grant No. 606-7-137.

10. The experimental system is described in detail in, D. J. Howe and H. Skinner, A Computer-Assisted Decentralized Unit-Dose Drug Distribution System, Report II, Hospital Systems Study Group, University of Saskatchewan, Saskatoon, Saskatchewan, June 1969. Much of the material in this section is taken from that report.

single private room on ward 4DE. It contained the necessary computer equipment, a drug inventory in Unit-Dose form, a small work table, a refrigerator, and drug literature for use on the nursing ward. Along one wall were two sections of three-foot metal shelving in which were stored the Unit-Doses arranged alphabetically in cardboard bins (12" x 4" x 2"). There was a locked wall cabinet for narcotics and other controlled drugs and a wooden cabinet for intravenous solutions.

The initial inventory for the satellite pharmacy amounted to approximately \$1,500.00. The type and quantity of medication stocked was determined from a survey of one year's issues to the ward. All drugs commercially available in single unit packages were purchased. The remainder of the tablets and capsules were packaged by hand in plastic bubble-packs. Liquids initially were packaged in glass screw cap bottles. Later these were replaced by Unit-Dose brown bottles with a pull-off crimped top.

In addition to medication orders filled from the satellite pharmacy in Unit-Dose form, the ward required a small number of external preparations such as back lotion, rubbing alcohol, pHisoHex, and mouthwash. Because of the nature of these items, it was impossible to select a suitable Unit-Dose size. Therefore, these items remained at each nursing unit as floor stock. Each day a pharmacy technician from the satellite checked the floor stock at each unit and replaced items from stock kept in the satellite. All replacements were recorded in a floor stock book.

The use of a computer in the system was intended to: (a) aid the pharmacist by eliminating extra paper work; (b) act as a storage department for patient and drug information; and (c) print various types of paper copy for use in the system. The computer used in the experimental system was a Linc 300 computer manufactured by B-D Spear, Inc. In making the computer selection, cost, speed, storage capacity and reliability were considered. Of the few computers which satisfied the requirements, the Spear machine was chosen because the hospital already had a similar machine in the pathology department. This permitted the pharmacy and pathology computers to serve as backup for one another in case of hardware failure. A forty character per second printer was selected.

Input to the computer was through the use of a cathode ray tube display and keyboard. The computer was programmed so the screen displayed questions together with information as it was typed on the keyboard.

The pharmacy system used three tapes. One was reserved for programs, a second contained all drug orders, and a third had only active drug orders. Once the pharmacy system was loaded into the core, all operations were controlled via the keyboard and cathode ray tube.

Communication was carried out via an intercom system which connected the satellite to the six nursing units and to the ward nursing station. There also were two outside telephone lines on which calls could be channelled from the nursing station to the satellite from outside the ward or the hospital.

The drug distribution cycle was initiated by the physician who wrote

the order for medication. Under the unit assignment nursing system, the physician's order sheet is located as the first page in the patient's chart. Since one of the main objectives of the experimental pharmacy system was to eliminate transcription of orders, the order sheet had a second page of NCR (no carbon required) paper which was removed by the pharmacist and used as his copy of the orders. When the pharmacist removed this copy, a second sheet of NCR paper was inserted to let the physician continue writing orders to the bottom of the page. On return to the satellite, orders were reviewed by the pharmacist for possible error and entered into the computer via the keyboard using the new drug order screen.

Several times daily an administration list of scheduled doses for the following period, for example, 8 a.m. to 12 noon, was requested from the computer. The computer also printed a label for each dose on special label paper. Using the administration list for reference, the pharmacist or technician set out the medications and attached the labels. The doses were delivered to the nurse just prior to the time of administration. Doses were delivered to each of the two large nursing units (12 and 13 beds each) in a metal cabinet with sliding drawers, one drawer assigned to each patient in the unit. Each of the four smaller units (five patients maximum) had their doses delivered in a plastic tray divided into five sections.

At the scheduled time, the nurse took the tray into the patient's room, administered the medications and returned to the unit nursing station with the labels. The labels were attached to the patient charts

to provide the administration record. If a drug was not administered, the pharmacist picked up the dose on his next visit to the unit, returned it to the satellite stock, and cancelled the dose from the patient's file in the computer.

When a PRN order was initiated, it was entered into the computer and at least one label generated. The number of doses prepared was left to the pharmacist's discretion. Usually, enough doses were prepared to last until the next PRN round when all PRN's were checked for replacement. If a dose was required before this replacement, the nurse requested it via the intercom. PRN doses were stored at the unit nursing station in cubicles marked for each bed number in the unit.

STAT drug orders came to the satellite via intercom or by verbal communication if the pharmacist was at a unit. These orders were filled and delivered to the nursing unit where the dose was checked against the written order and the carbon copy was obtained. On return to the satellite, the pharmacist entered the order into the computer and requested a label which was delivered to the nurse for charting purposes.

Complete inventory responsibility for narcotics and other controlled drugs rested on the pharmacist. When a label was requested for one of these items, the computer printed a second control label which was entered in a ledger kept in the satellite. The prepared doses were placed in a locked cupboard at the unit nursing station until needed.

Information on admissions, transfers and discharges was recorded by the ward clerk on the appropriate form and placed on a clip at the

nursing station for the pharmacist to collect. The admission form was stamped with the patient's addressograph plate which contained all the information necessary to admit the patient to the computer files via the admission program. Once the admission was complete, drug orders could be entered for that patient. The computer used the bed number, hospital number, and year of birth as control words to place the orders in the proper file.

A special form was used to notify the pharmacist of patient transfer to another ward or from bed to bed on the experimental ward. If a patient was moved to another bed on the experimental ward, the transfer program was used to change the bed number in the files, and thereafter, all labels and printout for that patient appeared with the new bed number.

When a patient was discharged or moved to another ward, the pharmacist collected any unused PRN doses from the patient's cubicle at the unit nursing station. He then updated the computer files to count all doses given and generated a bill which listed all the medications, the number of doses administered, and computed the total patient bill. The bill was taken to the business office for posting to the patient's account and the patient was discharged from the computer files using the discharge screen.

During the patient's hospital stay, the computer printed daily a patient drug profile which was placed in the chart for use by the physician. The profile showed both current and discontinued orders, the start and stop date of each, the prescriber, and the number of doses given. This summary was an attempt to correlate physicians' orders and other

pertinent information into one page in the patient chart.

The satellite was staffed on a 24-hour basis by three shifts. There was one pharmacist per shift and a technician who worked from eight a.m. to five p.m., Monday through Friday. While no fixed schedule existed for the collection of orders, this was done on the average of every two hours during the day and evening shifts. Scheduled doses were delivered nine times daily, just prior to 6 a.m., 7 a.m., 10 a.m., 11 a.m., 12 noon, 2 p.m., 4 p.m., 6 p.m., and 10 p.m.

At the end of the trial period, it was realized the pilot system was not ideal. Although nursing and medical personnel were pleased with the experimental system, the amount of time required by pharmacy personnel to operate the system made it impractical. The basic problem was lack of flexibility. In order to achieve complete control of all medications, it was necessary to prepare and distribute medications just prior to administration. However, because of the many changes occurring in the patient's condition and drug orders each day, the satellite staff simply was not able to handle the work load generated by a relatively small number of patients, often less than 30. Hence the experimental system was discontinued. At the same time, it was realized the concepts on which the experimental system was based had merit. Therefore, based on the experience with the pilot system, the operation was modified and redesigned to develop a more flexible system for the hospital which would consist of several satellites, each serving approximately 120 beds.

### The Implemented Computer-Assisted Unit-Dose Satellite Drug Distribution System

In March 1970, the revised system was ready for implementation. The original experimental ward was serviced first. The gynecology nursing ward was added in May, followed by the obstetrics nursing ward in September. These additions brought the total bed complement handled by the satellite to 124 beds.

The revised system is basically the same as the experimental system with several major modifications which increase the flexibility of the system but sacrifice some of the satellite control over medications. The following major modifications were made:

1. The printing of labels by the computer to be affixed to each Unit-Dose was discontinued. The problems associated with keeping track of hundreds of labels and the time required to affix them to individual doses made this procedure impractical. In the experimental system, the labels were used by the nurse for charting. Since the labels are not available in the implemented system, the nurse has reverted to her traditional method of recording drugs administered in the patients' charts.
2. A number of frequently prescribed drugs, in addition to the external preparations, were stocked in Unit-Dose form on each nursing unit as floor stock. This reduced the number of doses to be entered into the computer and prepared by the pharmacist. However, the number of doses of these floor stock drugs can not be included in the patient drug profile.
3. The preparation of medication carts and trays was moved from the satellite to the central pharmacy. The difficulties of limited space and lack of inventory made this change necessary. No drug stocks are kept in the satellite in the implemented system.
4. The number of times medications were delivered to the nursing units was reduced to four times daily. Instead of delivering each dose just prior to administration, a number of doses are delivered at one time.
5. The number of hours the satellite pharmacy was staffed was

reduced from 24 to 16 hours per day, seven days per week. One pharmacist and one technician are assigned to each eight hour shift.

#### Operation of the Implemented System<sup>11</sup>

On receipt of an admission notice, the pharmacy technician notifies the computer of the arrival of a new patient and the computer requests information for patient identification. This information then is stored in the computer and a bed is reserved for the patient. If an admission is attempted to an occupied bed, the computer informs the user of this mistake and cancels the assignment.

The pharmacy technician collects direct copies of drug orders. The original order form remains the same as under the traditional pharmacy system but five NCR pages are attached to it. The entire six-part form can be addressographed at one time. When an order is written, the top NCR page is pulled and used by the satellite staff. The other NCR pages remain in place for further orders.

Drug orders are entered into the computer by the pharmacist or technician. If a technician enters the orders, they are put 'on hold' and not activated until the pharmacist verifies the orders. This is accomplished by requesting a list of temporary orders. It takes from 30 to 60 seconds to enter an order at the keyboard.

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11. The implemented system is described in detail in a report presented at the Am. Soc. of Hosp. Pharmacists, Clinical Mid-Year Meeting by S. J. Evans and D. J. Howe, "A Computerized Pharmacy System Utilizing Unit-Dose," Anaheim, California, 6-10 Dec. 1970.

Four times each day, the technician requests a list of drugs scheduled for administration in an interval of time. The computer generates an administration list for each unit for each hour in that interval with each patient's medications listed separately. As the computer generates the list of scheduled drugs, the number of doses to be administered for each drug is incremented in the computer so a record is maintained of each patient's orders. The computer edits each order for its start date, drug order status, and stop date to ensure post dated orders, orders on interrupt, orders which have been discontinued or orders which have expired do not appear on the administration lists.

Unit carts, filled in the central pharmacy by the technician using the administration lists, are brought to the satellite. Using the same lists, the pharmacist checks the drugs picked by the technician and places the doses into patient trays. There is one tray labelled for each patient and each tray is divided into three compartments. All drugs to be administered to one patient at a specific time are placed in one compartment. Thus, medications to be administered at different times can be placed in the trays without confusion to the nursing staff.

The medication trays are delivered to the nursing wards or nursing units where the nurse checks the administration list against her Kardex. After verifying there are no errors, she administers the drugs. If a dose is not given, it is noted on the administration list. After completing the medication round, the nurse uses the list to chart the medications and places it back in the medication tray. This list is collected with the trays and any exceptions are entered into the computer.

When a PRN drug order is written, the pharmacist decides the number of doses to be placed in the patient's cubicle at the ward nursing station or unit nursing station. Each time doses are delivered, the information is stored in the computer. At the end of the evening shift, the computer generates a list of all PRN orders indicating the number remaining in the patient's cubicle from the previous day as well as the number sent during the day. From the list, the number of doses administered to the patient is tabulated. This information is entered in the computer and added to the patient's record. If indicated, the supply of PRN doses is replenished at this time.

Drugs which are on the nursing wards as floor stock are refilled daily by the technician, according to predetermined standards. These include intravenous solutions, basic analgesics, laxatives, pre-operative medications and nursing supplies. All medications are supplied in Unit-Dose form.

The computer maintains a complete narcotic and other controlled drug inventory. The pharmacist replaces narcotics and other controlled drug floor stock daily according to a standard quantity established for each ward or nursing unit. The computer assigns a control number and generates two labels, one for the control sheet on which the nurse records administration of the drug and one for the drug container. A report then is generated listing by nursing unit or ward the drugs issued. These reports are initialled by the pharmacist and signed by the nurse upon receipt of the drugs.

The computer prints daily a patient drug profile which is placed

in the patient's chart. A second copy is kept in the satellite. The profile lists the patient's previous and current drug orders, allergies and special notes about his therapy.

Each evening, a renewal list is generated which indicates all medication orders which will expire during the following 24 hours. This is posted at the unit nursing station or ward nursing station to notify the physician a drug order must be renewed or the medication will be discontinued. The responsibility for control of renewal dates has been shifted from nursing to pharmacy.

When a patient is discharged, the computer generates an itemized drug bill of all chargeable drugs for the business office.

At the end of each day's operation, the computer provides a report on the number and cost of the drugs distributed during the day and accumulates information for a monthly report.

#### The Four Drug Distribution Systems

The Computer-Assisted, Unit-Dose, Satellite Pharmacy system has been established on three nursing wards. The remaining nursing wards operate under the traditional Floor Stock-Prescription Order Pharmacy system. Nursing wards under either pharmacy system may utilize team nursing or unit assignment nursing. Hence there are four different drug distribution systems in operation in the hospital, each utilizing a different combination of nursing service and pharmacy service. The four systems are:

1. Unit-Dose with Unit Assignment Nursing System.

2. Unit-Dose with Team Nursing System.
3. Floor Stock-Prescription Order with Unit Assignment Nursing System.
4. Floor Stock-Prescription Order with Team Nursing System.

An evaluation of these systems is necessary to determine the one best suited to the needs of the patient and the hospital. One aspect of such an evaluation is the cost of operating each system.

## CHAPTER V

### METHODOLOGY

The study was a cost analysis of four different drug distribution systems in operation at University Hospital, Saskatoon. The methodology is outlined in detail in the following sections. This is followed by the hypotheses formulated and the limitations of the study.

#### Introduction

The only comparable end product of all hospital drug distribution systems is the quantity of a drug administered to one patient at one time -- the 'unit-dose'. Therefore, the determination of the cost of this unit under various distribution systems provides a means of cost comparison of the systems.

In several of the cost studies cited in Chapter III, cost calculations were based only on the direct costs of producing and administering a unit-dose and did not consider the many indirect costs associated with operating the system. The end product can be produced only if other necessary, indirect, professional activities such as providing drug information, accounting, and administration are performed. Hence, a more realistic approach is to apply all the costs of operating a given system to the ultimate end product rather than to suggest the end product can, or will, be produced in isolation. Further, such an approach recognizes that any change in one component of a system has an effect on all other components of the system. For example, the number of requests for drug information

could be expected to increase in changing from a centralized to a decentralized system of drug distribution simply because the pharmacist is more accessible in the latter system. Cost analysis based only on the cost of dispensing and administering the unit-dose would not reflect this change, whereas, it would be reflected in calculations based on the total cost of the system.

The operation of most hospital drug distribution systems is a joint responsibility of the nursing department and the pharmacy department. Therefore, an analysis of the cost of operating the system must consider both the pharmacy and the nursing involvement. Cost studies comparing different drug distribution systems which do not consider nursing involvement are meaningless since pharmacy department costs can be reduced simply by reducing the amount of service provided by the department. However, if the same activities are to be performed, nursing costs will increase since nursing personnel must do the additional work.

To obtain the cost of producing and administering a unit-dose under each of the four drug distribution systems in operation at University Hospital, it was necessary to determine the total cost of operating each system for a period of time, and the number of unit-doses administered in each system during the same period of time. This was accomplished by a cost analysis involving the following steps:

1. Accumulation of all pharmacy department costs during a study period.
2. Apportionment of the accumulated costs to the various pharmacy activities.
3. Selection of four nursing wards, each operating with a different

drug distribution system.

4. Apportionment of accumulated pharmacy inpatient costs to each of the experimental wards.
5. Accumulation of nursing drug distribution costs on each of the experimental wards during the study period.
6. Determination of the number of unit-doses administered on each of the experimental wards during the study period.
7. Calculation of the unit-dose cost on each of the experimental wards.

Data on each system were collected simultaneously during a three month study period -- 1 October 1970 through 31 December 1970. Thus, the problems associated with longitudinal studies such as changes in wage rates and inflation were avoided. Also, since data on the different systems were collected in one hospital during the same time period, the objectives, environmental conditions, hospital policies and administration, and other external factors which may affect the comparability of the systems were constant.

All costs involved in operating the four drug distribution systems during the study period were included and costs were assigned directly to the systems whenever possible. However, since the four systems were in operation at the same time, it was necessary to divide certain common costs on an equitable basis among the systems.

Existing cost data and actual costs were used. No attempt was made to cost what the ideal staffing pattern of a system at a theoretical wage rate would be. Rather, the wages paid to those actually working in the various systems during the study period were used. However, to overcome seasonal fluctuations, one-quarter of the 1970 annual cost was used for

some cost items. Also, hospital overhead items were assigned to the pharmacy department and nursing service based on a cost analysis conducted at University Hospital in 1966.<sup>1</sup> The hospital accounting system, as required by the provincial government, is designed basically to provide information for third party paying agencies rather than to provide information for internal management. The system provides gross per diem costs and direct departmental costs but does not provide sufficient information for a detailed cost analysis.

#### 1966 Education Cost Study

In 1966, a study was undertaken at University Hospital to determine the cost of all formal education programs in the hospital. The study was conducted as part of a national program for a committee of the Association of Canadian Medical Colleges. Several cost studies were done in other teaching hospitals in Canada and the methodology used at University Hospital followed the pattern set by the other studies.

All hospital operating costs were allocated to the various hospital departments and then the department costs were further allocated to four programs -- research, education, outpatient care, and inpatient care. The Social Security Administration Step-Down Method of cost allocation was used to distribute hospital costs which could not be assigned directly to a department. Appendix A summarizes the allocation of 1966 hospital costs to the pharmacy department and details the bases of allocation used in the study.

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1. Education Cost Study, University Hospital, Saskatoon, Saskatchewan, 31 December 1966.

Although there were minor changes in hospital programs between 1966 and 1970, the percentage of total area occupied by pharmacy and nursing service remained relatively constant. Therefore, the 1970 hospital overhead costs for the study period were allocated to the pharmacy department and nursing service on the basis of the percentages developed in the 1966 study.

#### Accumulation of Pharmacy Costs for Study Period

The first step in the cost analysis was the collection of all pharmacy costs during the study period. Stine cautioned, "Recognizing, isolating and defining many of the so-called 'hidden costs' usually requires more knowledge of the activity than of accounting."<sup>2</sup> Keeping these words in mind, pharmacy costs were classified in the following categories:

1. Pharmacy Personnel Costs
2. Drug Cost
3. Inventory Holding Costs
4. Pharmacy Supplies Cost
5. Overhead Costs
6. Data Processing Costs
7. Satellite Pharmacy Cost

The methodology by which each of these costs was determined and apportioned to the pharmacy department is described in the following sections. Descriptions of the components of the various cost items

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2. H. I. Stine, "How to Compute Outpatient Department Costs," Hospitals, J.A.H.A. (32:5) 1 Mar. 1958, p. 102.

were taken from the Canadian Hospital Accounting Manual.<sup>3</sup>

#### Pharmacy Personnel Costs

Pharmacy Personnel Costs included gross salaries and wages paid to all pharmacy personnel, Canada Pension Plan, group pension plan, and group life insurance payments made by the hospital on behalf of these employees, and a portion of the expenses of the Personnel and Employee Health departments.

Data on each of these components, except Personnel and Employee Health, were obtained from payroll statistics. The actual expenditures for the study period were used.

Personnel and Employee Health department expenditures for 1970 were obtained from general ledger balances. Based on the 1966 Education Cost Study, 1.33 percent of the hospital total was apportioned to pharmacy. One-quarter of this amount was the allocation for the study period.

#### Drug Cost

Drug Cost was the cost to the hospital for drugs, intravenous solutions and anesthetics. It did not include the cost of intravenous administration sets or medical gases. The cost of drugs used during the study period was obtained from pharmacy department monthly reports for October, November and December 1970.

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3. The Canadian Hospital Association, Canadian Hospital Accounting Manual, The Ryerson Press, Toronto, Canada, 1968, pp. 237-256.

### Inventory Holding Costs

Inventory Holding Costs or inventory carrying costs are the costs incurred by the hospital in holding and handling inventory. Included in this cost are interest on average annual inventory investment, and annual losses from obsolescence, deterioration, loss, theft and damage. This cost is affected by many factors and will vary among hospitals.

The cost of holding inventory at the Milwaukee County General Hospital and the Veterans Administration Hospital, Wood, Wisconsin, was "estimated conservatively at five per cent" by Bachynsky.<sup>4</sup> Hyde included in his study "an alternative investment charge of six percent .... to reflect the fact that funds invested in floor stock are unavailable for investment elsewhere at a minimum market return."<sup>5</sup> Barker recommended "the Inventory Investment cost item could be calculated as 10 percent of the average inventory value."<sup>6</sup>

In view of the relatively high cost of money, 10 percent of the average annual pharmacy inventory was considered a reasonable amount for

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4. J. A. Bachynsky, "Some Aspects of Drug Distribution Under Tax Supported Programs," Unpublished Ph.D. Thesis, University of Wisconsin, 1967, p. 200.
  5. G. C. Hyde, "A Comparative Cost Analysis of the University of Kentucky Unit Dose System," Unpublished Study Report, Unit Dose Grant, Pharmacy Central Supply, University Hospital, Albert B. Chandler Medical Center, University of Kentucky, 1969, p. 11.
  6. K. N. Barker and W. E. McConnell, "A Cost Accounting System & Pricing Schedule for Hospital Pharmacy," Am. J. Hosp. Pharm. (18:5) May 1961, p. 291.

inventory holding costs. One-quarter of this amount was the cost for the study period.

Data on the inventory held by pharmacy were obtained from business office records. An addition was made later in this study under Nursing Costs to account for inventory held on the experimental wards as floor stock.

#### Pharmacy Supplies Cost

Pharmacy Supplies included packaging supplies, labels, forms, and other supplies used by the pharmacy department during the study period. Data on the cost of these items were obtained from an analysis of hospital stores' requisitions filled during October, November and December 1970. Since the stores' requisitions during this period did not include packaging supplies for the Unit-Dose project, the cost of these supplies was estimated using pharmacy department packaging records.

#### Overhead Costs

Overhead Costs included purchasing and stores, telephone and telegraph, fuel, electricity, water, building depreciation, equipment depreciation, repairs, physical plant, laundry and linen, housekeeping, administration and general, and miscellaneous costs.

Data on each of these components were obtained from business office statistics. Pharmacy Repairs and Pharmacy Miscellaneous are direct expense accounts and were obtained from the general ledger balances for 1970. Equipment Depreciation was determined by applying the hospital composite depreciation rate of 6.25 percent to the 20 February 1970

Pharmacy Equipment List. A portion of the 1970 hospital costs for the other overhead components was allocated to the pharmacy department on the basis of the percentages developed in the 1966 Education Cost Study. One-quarter of the amount of each cost component was the cost for the study period.

#### Data Processing Costs

Data Processing Costs included rental on various pieces of computer equipment and the cost of paper and other supplies used during the study period. Data on these costs were obtained from the Hospital Systems Study Group and the pharmacist in charge of the Unit-Dose project.

#### Satellite Pharmacy Cost

Satellite Pharmacy Cost was hospital overhead costs associated with the operation of the satellite pharmacy. Since the satellite was located in a former patient room on the nursing ward, it was necessary to determine the 1970 hospital overhead costs allocated to nursing service and then allocate a portion of these costs to the satellite.

Data were obtained from business office statistics and a portion of the 1970 hospital overhead costs allocated to nursing service on the basis of the percentages developed in the 1966 Education Cost Study. A portion of the nursing service overhead cost then was allocated to the satellite pharmacy on the basis of the number of square feet occupied by the satellite. One-quarter of the amount allocated to the satellite was the cost for the study period.

Apportionment of Accumulated Pharmacy Costs to Pharmacy Activities

In addition to providing inpatient services, the pharmacy department at University Hospital provides an outpatient service and is involved in a variety of teaching and research programs. All these activities take place in common facilities and use common supplies and equipment. In addition, pharmacy personnel may be involved in several, or all, of the departmental activities at different times during a working day. Hence, there is no clear cut means of determining the cost of the inpatient service alone. However, this cost must be separated from the cost of other activities before unit-dose costs can be calculated.

To determine the cost of inpatient services, the accumulated pharmacy costs for the study period were apportioned to the following pharmacy activities:

1. Inpatient Prescriptions
2. Floor Stock
3. Unit-Dose Project
4. Outpatient Services
5. Teaching and Research

Pharmacy Personnel Costs were apportioned to the various activities on the basis of a Pharmacy Effort Analysis study described below.

Drug Cost was allocated directly to the various activities on the basis of data from the October, November and December 1970 pharmacy monthly reports.

Inventory Holding Costs were apportioned to the various activities in proportion to drug cost. It was assumed inventory held was related to the value of drug issues to each activity.

Pharmacy Supplies Cost was divided into three groups: (a) Unit-Dose packaging supplies cost, (b) other packaging supplies cost; and (c) other supplies cost. Unit-Dose packaging supplies cost was allocated directly to the Unit-Dose project. Other packaging supplies cost was divided among the remaining pharmacy activities in proportion to drug cost excluding Unit-Dose project drug cost. Other supplies cost was allocated to all activities in proportion to drug cost.

Overhead Costs were apportioned to the various activities in the same ratio as Pharmacy Personnel Costs. A similar method of allocating overhead costs was used in the studies conducted by Hyde, Bachynsky, and Petrick.<sup>7</sup>

The total Data Processing Costs and Satellite Pharmacy Cost was allocated to the Unit-Dose project since these costs were associated only with that activity.

#### Pharmacy Effort Analysis Study

Work measurement is the process used "to arrive at a time value for

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7. G. C. Hyde, op. cit., p. 25;  
J. A. Bachynsky, op. cit., p. 212; and  
R. J. Petrick and C. J. Latiolais, "Applicability of the Professional Fee Concept to Hospital Pharmacy," Am. J. Hosp. Pharm. (23:9) Sept. 1966, p. 503.

the accomplishment of work."<sup>8</sup> Krick suggests the objective in selecting a method of work measurement should be "to employ those techniques and procedures that offer maximum return through results achieved, relative to the time and other resources expended."<sup>9</sup> He gives three major criteria to be considered -- applicability to the situation, acceptability to labor, and total cost.<sup>10</sup>

Heiland and Richardson list six methods of measuring work: (a) predetermined human work times; (b) stop-watch time study; (c) elemental time or standard data; (d) historical or statistical data; (e) self-reporting; and (f) subjective over-all evaluation.<sup>11</sup> Journal listing (self-listing or self-reporting of his activities by the employee) is the method selected for this study to determine the time spent by pharmacy personnel on the various pharmacy department activities.

The journal listing technique of work measurement has been used previously in hospital pharmacy studies. In 1961, Schwartau and Sturdevant reported on a study using a combination of journal listing and time study.<sup>12</sup>

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8. R. E. Heiland and W. J. Richardson, Work Sampling, McGraw-Hill Book Company, New York, 1967, p. 4.

9. E. V. Krick, Methods Engineering, Design and Measurement of Work Methods, John Wiley & Sons, Inc., New York, 1962, p. 437.

10. Ibid., pp. 438-439.

11. R. E. Heiland and W. J. Richardson, op. cit., pp. 4-7.

12. N. Schwartau and M. Sturdevant, "A System of Packaging and Dispensing Drugs in Single Doses," Am. J. Hosp. Pharm. (18:9) Sept. 1961, pp. 542-559. Journal listing was used by cashiers to record the time they spent on 14 consecutive days in each step of voucher processing, p. 552.

The following year, Rothenbuhler and Archambault used journal listing in a study on hospital pharmacy staff needs.<sup>13</sup> An extensive study at the University of Iowa in 1966 used time study, elemental times, work sampling, and journal listing to obtain an estimate of certain direct labor costs in drug distribution.<sup>14</sup>

"Journal listing, although seldom used in industrial work measurement, has the advantage of somewhat lower installation cost and much lower operating cost. Its disadvantages are inaccuracy resulting from the bias it introduces into the operations under study, insofar as it is, in effect an additional operation. Extreme inaccuracy can result from this method if the worker is not properly motivated to fully cooperate in determining and recording his times accurately. The effect of the bias inherent in the method, that of introducing an additional operation to be performed, would be reduced as the time for the operation or cycle grew longer, since the time to read and reset the timer and record the time would probably not increase with increased cycle times, and a point would be reached where the effect of the bias became small enough to be ignored."<sup>15</sup>

The evaluation of the Unit-Dose system of drug distribution at Kettering Memorial Hospital involved the use of work sampling, work reporting and time study techniques. "Work reporting used in the pharmacy section consisted of each employee classifying his daily activities into pre-established categories. For convenience, reporting was in fifteen-minute intervals. Thus, it was possible to calculate the percentage of

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13. E. F. Rothenbuhler and G. F. Archambault, "Hospital Pharmacy Staff Needs - A Preliminary Study Based on Total Departmental Measurable and Non-Measurable Workloads," Am. J. Hosp. Pharm. (19:4) April 1962, pp. 163-172.
  14. C. D. Hepler, "A Study of Direct Labor Costs in Hospital Pharmacy Systems Using the Model Concept," Am. J. Hosp. Pharm. (23:12) Dec. 1966, pp. 645-661.
  15. Ibid., pp. 646-647.

time devoted to each activity within the pharmacy."<sup>16</sup> When the data obtained from work reporting were compared with time study data, the results appeared "to be roughly comparable and do, in fact, support each other."<sup>17</sup>

All pharmacy personnel at University Hospital kept a journal for a four week period -- 26 October 1970 through 22 November 1970. Individual journals (folders) containing a record form (Appendix B) for each week of the study and a description of the various pharmacy activities (Appendix C) were prepared. A daily record was maintained of the time spent on the following activities: (a) inpatient prescriptions; (b) ward stock (floor stock); (c) satellite pharmacy; (d) outpatients; (e) teaching and research; and (f) administration. Times were listed to the nearest 15 minutes. In addition, an entry was made of the total hours worked each day. At the end of each week, the completed journal sheets were collected.

Before the four week period started, a staff meeting was held to explain the reasons for keeping the journal and the proper method of recording the required data.

At the end of the four week period, the completed journal sheets were tabulated and the total time spent by each pharmacy staff member on each activity determined. It then was necessary to reallocate the

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16. W. E. Slater and J. R. Hripko, "The Unit-Dose System in a Private Hospital, Part Two: Evaluation," Am. J. Hosp. Pharm. (25:11) Nov. 1968, p. 642.

17. Ibid., p. 645.

time spent on administration to the other pharmacy activities. This was accomplished by:

1. Summing the time spent by all personnel on each activity except administration.
2. Calculating the percentage of total time less administration time for each activity.
3. Applying the percentages to the administration time recorded by each individual.

The portion of recorded administration time by each individual was added to the recorded times for the other activities to give the total time spent on each activity. The percentage of effort devoted by each staff member to each pharmacy activity then was calculated. These data were used to apportion Pharmacy Personnel Costs to the five pharmacy activities.

#### Selection of Experimental Nursing Wards

During the study period, the various nursing wards in the hospital were operating under the different drug distribution systems as indicated in Table II.

To determine the unit-dose cost under each system of drug distribution on a comparable basis, four nursing wards, as similar as possible but each using a different drug distribution system, were selected. A study conducted in 1968 at University Hospital on nursing involvement in drug distribution produced data on the characteristics of each nursing ward in medication activities (Table III).<sup>18</sup> In addition to similarity of

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18. C. D. Webster, Drug Distribution Study - II, Nursing Involvement in Drug Distribution, Hospital Systems Study Group, University of Saskatchewan, Saskatoon, Saskatchewan, Jan. 1968, pp. 10-18.

Table II

## DRUG DISTRIBUTION SYSTEMS ON NURSING WARDS DURING STUDY PERIOD

| Service                           | Floor Stock-<br>Prescription Order |                    | Unit-Dose       |                    |
|-----------------------------------|------------------------------------|--------------------|-----------------|--------------------|
|                                   | Team<br>Nursing                    | Unit<br>Assignment | Team<br>Nursing | Unit<br>Assignment |
| Pediatrics                        | 1AB                                |                    |                 |                    |
| Surgery                           | 2CF, 2DE                           | 2AB                |                 |                    |
| Medicine                          | 3CF                                | 3AB, 3DE           |                 |                    |
| Gynecology                        |                                    |                    | 4AB             |                    |
| Obstetrics                        |                                    |                    | 4CF             |                    |
| Neurosurgery and<br>Ophthalmology |                                    |                    |                 | 4DE                |
| Rehabilitation<br>Medicine        | 5C, 5FG                            |                    |                 |                    |
| Psychiatry                        | 5DE                                |                    |                 |                    |

characteristics, other factors considered in the selection process were the degree of anticipated cooperation of nursing personnel and the length of time the drug distribution system had been in operation on that ward. The selection of the experimental wards was made in consultation with the Nursing Administrator.

Two medical wards (3CF, 3DE), the gynecology ward (4AB) and the neurosurgery & ophthalmology ward (4DE) were selected for this study. The Floor Stock-Prescription Order with Team Nursing System was studied on 3CF; the Floor Stock-Prescription Order with Unit Assignment Nursing

Table III

PER PATIENT DAY CHARACTERISTICS OF NURSING INVOLVEMENT  
IN MEDICATION ACTIVITIES

| Service                      | Entries on Doctors' Order Sheet |                          | Average Medication Orders | Average Number of Medications |       |
|------------------------------|---------------------------------|--------------------------|---------------------------|-------------------------------|-------|
|                              | All Entries                     | Entries With Drug Orders |                           | Scheduled                     | Total |
| All Services                 | 0.76                            | 0.46                     | 0.71                      | 4.3                           | 5.9   |
| Pediatrics                   | 0.77                            | 0.39                     | 0.41                      | 2.5                           | 3.5   |
| Surgery                      | 1.05                            | 0.61                     | 0.88                      | 4.0                           | 5.5   |
| Medicine                     | 0.67                            | 0.42                     | 0.63                      | 4.7                           | 6.7   |
| Gynecology                   | 0.62                            | 0.40                     | 1.08                      | 3.6                           | 4.9   |
| Obstetrics                   | 0.79                            | 0.54                     | 1.10                      | 5.0                           | 7.1   |
| Neurosurgery & Ophthalmology | 0.56                            | 0.43                     | 0.80                      | 4.7                           | 6.3   |
| Rehabilitation Medicine      | 0.64                            | 0.32                     | 0.45                      | 3.3                           | 5.7   |
| Psychiatry                   | 0.47                            | 0.25                     | 0.42                      | 4.0                           | 7.9   |

System was studied on 3DE; the Unit-Dose with Team Nursing System was studied on 4AB; and, the Unit-Dose with Unit Assignment Nursing System was studied on 4DE.

Apportionment of Accumulated Pharmacy Inpatient Costs to Experimental Wards

The sum of the costs previously apportioned to inpatient prescriptions and floor stock was the total pharmacy cost to provide drug distribution services to all hospital nursing wards under the floor stock-prescription order systems. Also, the sum of the costs apportioned to the Unit-Dose

project was the total pharmacy cost to provide drug distribution services to all hospital nursing wards under the Unit-Dose systems. Since this study was concerned with costs on only four nursing wards, it next was necessary to allocate a portion of each cost component to each of the experimental wards.

During the study period, three nursing wards were involved in the Unit-Dose project. Using data obtained from computer printouts and pharmacy department monthly reports, the number of unit-doses administered on each of these wards was determined. Pharmacy Personnel Costs apportioned to the Unit-Dose project then were allocated to 4DE and 4AB in proportion to the number of unit-doses administered on those wards.

Pharmacy Personnel Costs were apportioned to the experimental wards not on the Unit-Dose system (3DE, 3CF) in proportion to the number of work units handled by pharmacy for those wards. A work unit was defined as: (a) an inpatient prescription; (b) a unit of floor stock; or (c) a credit issued for medication returned from the nursing ward. Data on the number of work units handled for all nursing wards, except those on the Unit-Dose systems, were obtained from pharmacy monthly reports for October, November and December 1970 and the percentage of the total work units for 3DE and 3CF calculated.

Drug Cost was allocated directly to each experimental ward using data from pharmacy monthly reports for October, November and December 1970.

Inventory Holding Costs were apportioned to the experimental wards in proportion to Drug Cost.

Pharmacy Supplies Cost for the Unit-Dose project was apportioned to the experimental wards on the Unit-Dose systems in proportion to the drug cost for the Unit-Dose project. Similarly, Pharmacy Supplies Cost for the other experimental wards was apportioned in proportion to the drug cost on those wards.

Overhead Costs were assumed to be relatively constant regardless of the drug distribution system. Therefore, the total pharmacy overhead allocated to inpatients was apportioned to each of the experimental wards in proportion to the number of beds on each ward.

Data Processing Costs and Satellite Pharmacy Cost were apportioned on the basis of the number of unit-doses administered under the Unit-Dose project. These data were obtained from computer printouts and pharmacy department monthly reports for October, November and December, 1970.

Accumulation of Nursing Drug Distribution Costs on Experimental Wards

The following nursing costs were accumulated on each experimental ward during the study period:

1. Nursing Personnel Costs
2. Medication Supplies Cost
3. Medication Storage Costs
4. Floor Stock Inventory Holding Costs

### Nursing Personnel Costs

Nursing Personnel Costs included salaries and wages paid to all nursing personnel involved in drug distribution activities on the experimental wards, Canada Pension Plan, group pension plan, and group life insurance payments made by the hospital on behalf of these personnel, and a portion of the expenses of the Personnel and Employee Health departments.

Data on each of these components, except Personnel and Employee Health, were obtained from payroll statistics. The actual expenditures for the study period were used.

Personnel and Employee Health department expenditures for 1970 were obtained from general ledger balances. Based on the 1966 Education Cost Study, 31.21 percent of the hospital total was apportioned to nursing service. One-quarter of this amount was the allocation for the study period. The allocated amount then was divided by the number of nursing personnel to obtain the allocation per person. This figure was used to determine the allocation to each experimental ward based on the number of nursing personnel on that ward.

Nursing personnel spent only a portion of their working time on medication activities. The amount of Nursing Personnel Costs to be apportioned to the drug distribution system on each experimental ward was based on a Nursing Effort Analysis study described in a following section.

#### Medication Supplies Cost

Medication supplies included the various medication order and record forms used by nursing service, medication tickets, medication trays and cups, intravenous administration sets, syringes and needles, and other supplies, except dressings, used in medication activities. Data were obtained for each experimental nursing ward from an analysis of Purchasing and Stores Department requisitions and Central Supply Service records.

#### Medication Storage Costs

On some nursing wards, a separate 'medication room' was maintained where drug products and medication supplies were stored and medication trays were prepared. On other nursing wards, a portion of the nursing station was used for this purpose. Nursing wards on the unit assignment system of nursing had specially designed medication storage units. Nursing wards on the Unit-Dose project had drug cabinets with individual patient trays.

The number of square feet utilized for medication storage on each experimental ward was determined. A portion of the 1970 nursing service overhead costs then was apportioned to each experimental ward in the same manner as explained previously under Satellite Pharmacy Cost. On experimental wards using medication storage units and drug cabinets, the annual depreciation cost of these items was determined. One-quarter of the annual cost was the allocation for the study period.

### Floor Stock Inventory Holding Costs

A physical inventory of the floor stock of drug products on each experimental ward was taken on 1 October 1970 and 31 October 1970 and the estimated average annual inventory calculated from these data. The annual cost of holding inventory was estimated at 10 percent. One-quarter of this amount was the cost of holding the floor stock inventory on the experimental wards for the study period.

### Nursing Effort Analysis Study

To provide the data for determining the amount of time spent by nursing personnel on medication activities on each of the experimental wards, an effort analysis study was conducted. It was not possible to conduct the study on all experimental wards at the same time because of other studies being conducted in the hospital.

All nursing personnel involved in drug distribution activities on wards 3CF, 4AB and 4DE kept a journal for a four week period -- 26 October through 22 November 1970. Nursing personnel involved in drug distribution activities on ward 3DE kept a journal for a two week period -- 7 December through 20 December 1970.

Individual journals (folders) containing a record form (Appendix D) for each week of the study and a description of the various medication activities (Appendix E) were prepared. A daily record was maintained of the time spent on the following activities: (a) checking order book for drug orders; (b) transcribing orders to Kardex; (c) ordering drugs; (d) preparing and checking medication tickets or medication lists; (e) preparing medications; (f) giving medications; (g) charting

medications; (h) checking narcotics and other controlled drug inventory; and (i) other drug activity. Times were recorded to the nearest minute. In addition, an entry was made of the hours worked each day. The completed journal sheets were collected at the end of each week.

Before the start of each study period, meetings were held with nursing personnel. The reasons for keeping the journal and the proper method of recording the data were explained.

At the end of the study periods, the completed journal sheets were tabulated and the percentage of time devoted to drug distribution activities by nursing personnel was calculated. These data were used to apportion Nursing Personnel Costs on each experimental ward.

#### Determination of Doses Administered on Experimental Wards

On wards 3CF and 3DE (floor stock-prescription order systems), the average number of doses per patient day on each ward was determined by summing all doses recorded on patients' charts during October 1970,<sup>19</sup> and dividing by the number of patient days. The total number of unit-doses administered on 3CF and 3DE during the study period (1 October through 31 December 1970) then was estimated by multiplying the average number of doses per patient day during October on each ward by the number of patient days during the study period.

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19. It is assumed all doses administered were recorded on the patients' charts. This is required hospital procedure.

All doses administered to patients on wards 4DE and 4AB (Unit-Dose systems) were recorded on four lists: (a) Drug Administration List; (b) PRN List; (c) Master Control Sheet (narcotics and other controlled drugs); and (d) Floor Stock List. The first three lists were generated daily for each nursing ward or unit under the Unit-Dose project. The Floor Stock List was a record prepared daily by the pharmacy technician when he replaced floor stock drugs, in Unit-Dose form, on the ward to maintain stock at predetermined levels.

The average number of doses per patient day during October 1970 on 4DE and 4AB, less floor stock doses, was determined by summing all doses recorded on the first three lists and dividing by the number of patient days for each ward. The number of unit-doses, less floor stock doses, administered during the study period then was estimated by multiplying the average number of doses per patient day during October on each ward by the number of patient days during the study period. Finally, to obtain the total number of unit-doses administered on 4DE and 4AB during the study period, the floor stock doses administered were added to this estimate.

#### Hypotheses

The following hypotheses were formulated for the study on the basis of prior research, reports in the pharmaceutical literature, and intuition of the author.

1. The cost of producing and administering a unit-dose under each of the four drug distribution systems at University Hospital, Saskatoon, will vary by less than \$0.10.
2. Pharmacy personnel costs will be at least 25 percent higher in

the Unit-Dose drug distribution systems than in the floor stock-prescription order systems.

3. Nursing personnel costs will be at least 25 percent lower in the Unit-Dose drug distribution systems than in the floor stock-prescription order systems.
4. Drug cost will be at least 10 percent lower in the Unit-Dose drug distribution systems than in the floor stock-prescription order systems.

#### Limitations

The limitations resulting from the methodology used in this study should be considered in evaluating the results and in applying the findings to other institutions or situations. These limitations apply to all the drug distribution systems studied. Therefore, while they may affect the absolute amount of some of the cost figures, their effect on the comparability of the systems should be minimal.

1. The study was conducted for only a three month period. Occupancy rates, disease conditions, personnel and equipment used vary over the year. Hence, the study period may not be representative of the hospital situation over a 12 month period.
2. Each of the drug distribution systems was studied on a different nursing ward. Variations in layout and personnel would have some effect on the time devoted to medication activities. This limitation must be weighed against the disadvantages of a longitudinal study where the same ward and personnel could be used to evaluate the different drug distribution systems.
3. Only a portion of the hospital was included in the study and the nursing wards selected may not be representative of the whole hospital. Consequently, care must be taken in interpreting findings based on a study of a single ward to the rest of the hospital. Also, certain economies of scale would be expected if the entire hospital were operating under one drug distribution system.
4. The time required to prepare and administer all unit-doses in a given drug distribution system is considered constant. However, the time to prepare an intravenous additive solution for administration may be much greater than that

required to prepare a tablet for administration. Similarly, the time required to prepare a liquid dose may be greater than that required to prepare a dose of a solid dosage form.

5. Changes in layout, procedures and personnel have occurred since 1966. Therefore, use of the 1966 education cost study to apportion hospital overhead costs may introduce some error.
6. The journal listing method of work measurement may result in employee bias affecting the accuracy of the times recorded for various activities.

CHAPTER VI

## COST ANALYSIS

The results of the effort analysis studies, the cost data collected on the four drug distribution systems, and the cost analysis study are presented in the following sections.

Pharmacy Effort Analysis Study Results

A total of 3,513 hours was recorded for the various pharmacy activities by the 26 pharmacy personnel employed between 26 October and 22 November 1970, inclusive. Of this total, 774.25 hours were spent on administration. Thus, 2,738.75 hours were spent on the remaining five pharmacy activities -- inpatient prescriptions, floor stock, satellite pharmacy, outpatients, and teaching and research. The time spent by all pharmacy personnel on each pharmacy activity as a percentage of total recorded time less administration time is presented in Table IV.

Using these percentages, the administration time recorded by each individual was allocated to the other pharmacy activities to obtain the total time spent on each activity by that individual. The results of these calculations are given in Appendix F. The percentage of total time spent by each individual on each activity is shown in Table V.

Twenty staff members devoted some portion of their time to each activity while six staff members were involved in fewer than five activities. There were wide variations in the percentage of time devoted to the various activities by different staff members. For

example, the percentage of time spent on inpatient prescriptions varied from a high of 98.79 percent by Student Helper C to a low of zero percent by Porter B.

Table IV

TIME SPENT BY PHARMACY PERSONNEL ON PHARMACY ACTIVITIES DURING STUDY PERIOD<sup>1</sup> AS A PERCENTAGE OF RECORDED TIME LESS ADMINISTRATION TIME

| Activity                | Recorded Time (Hours) | Recorded Time Less Administration Time | % of Recorded Time Less Administration Time |
|-------------------------|-----------------------|--|---|
| Inpatient Prescriptions | 870.75                | 870.75                                 | 31.80%                                      |
| Floor Stock             | 524.25                | 524.25                                 | 19.14                                       |
| Satellite Pharmacy      | 848.50                | 848.50                                 | 30.98                                       |
| Outpatients             | 208.75                | 208.75                                 | 7.62  |
| Teaching and Research   | 286.50                | 286.50                                 | 10.46                                       |
| Administration          | 774.25                | --                                     | --  |
| Totals                  | 3,513.00              | 2,738.75                               | 100.00%                                     |

1. 26 October - 22 November 1970

Table V

PERCENTAGE OF TOTAL TIME SPENT ON PHARMACY ACTIVITIES BY PHARMACY  
PERSONNEL DURING STUDY PERIOD

| Position       | Inpatient<br>Prescriptions | Floor<br>Stock | Satellite<br>Pharmacy | Outpatients | Teaching<br>& Research |
|----------------|----------------------------|----------------|-----------------------|-------------|------------------------|
| Pharmacist A   | 31.38%                     | 18.38%         | 29.74%                | 7.31%       | 13.19%                 |
| Pharmacist B   | 27.98                      | 13.14          | 18.84                 | 9.77        | 30.27                  |
| Pharmacist C   | 39.31                      | 35.32          | 3.59                  | 7.40        | 14.38                  |
| Pharmacist D   | 40.93                      | 23.83          | .52                   | 34.54       | .18                    |
| Pharmacist E   | 69.76                      | 18.81          | 1.13                  | 9.91        | .39                    |
| Pharmacist F   | 88.98                      | 1.55           | 1.02                  | 5.00        | 3.45                   |
| Pharmacist G   | 3.06                       | .30            | 69.77                 | .05         | 26.82                  |
| Pharmacist H   | 16.76                      | 6.55           | 54.59                 | 2.54        | 19.56                  |
| Pharmacist I   | 6.51                       | .13            | 88.14                 | .05         | 5.17                   |
| Pharmacist J   | 5.36                       | --             | 93.87                 | --          | .77                    |
| Pharmacist K   | 35.02                      | 14.73          | .68                   | 45.67       | 3.90                   |
| Resident A     | 56.99                      | 6.55           | 9.21                  | 5.50        | 21.75                  |
| Resident B     | 49.04                      | 8.78           | .93                   | .77         | 40.48                  |
| Resident C     | 31.85                      | 13.73          | 2.14                  | 6.73        | 45.55                  |
| Secretary      | 32.91                      | 18.83          | 30.48                 | 7.49        | 10.29                  |
| Pharmacy Aide  | 49.55                      | 38.28          | .53                   | 11.57       | .07                    |
| Pharmacy Clerk | 65.51                      | 8.26           | 8.80                  | 14.46       | 2.97                   |
| Technician A   | 5.59                       | --             | 93.75                 | --          | .66                    |
| Technician B   | 8.29                       | .20            | 91.32                 | .08         | .11                    |
| Technician C   | 4.51                       | --             | 95.49                 | --          | --                     |
| Storeman       | 25.21                      | 35.90          | 24.56                 | 6.04        | 8.29                   |
| Porter A       | 8.16                       | 79.26          | 7.95                  | 1.95        | 2.68                   |
| Porter B       | --                         | 98.68          | --                    | 1.32        | --                     |
| Student        |                            |                |                       |             |                        |
| Helper A       | 90.38                      | 9.62           | --                    | --          | --                     |
| Student        |                            |                |                       |             |                        |
| Helper B       | 74.29                      | 25.71          | --                    | --          | --                     |
| Student        |                            |                |                       |             |                        |
| Helper C       | 98.79                      | .34            | .55                   | .14         | .18                    |

### Nursing Effort Analysis Study Results

Only registered nurses were involved in drug distribution activities on the nursing wards under the Unit-Dose systems. On wards under the floor stock-prescription order systems, other nursing groups were involved in drug distribution activities in addition to registered nurses. However, the time spent by these other nursing groups was small in all cases.

A summary of the time spent by nursing personnel on drug distribution activities as a percentage of available nursing time under the various drug distribution systems is presented in Table VI. Appendix G provides a detailed break down of these data by drug distribution system, personnel group, and working shift.

Available time was defined as the time available for nursing activities during the study period. Meal times were excluded but no allowance was made for personal, fatigue and delay time since no data were available to estimate these times accurately. The available time varied depending on the nursing ward and personnel group.

The amount of time spent by registered nurses varied from 4.59 percent of available time under the Unit-Dose with Unit-Assignment Nursing System to 10.99 percent under the Floor Stock-Prescription Order with Unit Assignment Nursing System. Under the Unit-Dose with Team Nursing System, registered nurses spent 5.11 percent of available time on medication activities. Under the Floor Stock-Prescription Order with Team Nursing System, registered nurses devoted 8.05 percent of available time to medication activities.

Table VI

SUMMARY OF TIME SPENT BY NURSING PERSONNEL ON DRUG DISTRIBUTION ACTIVITIES UNDER VARIOUS DRUG DISTRIBUTION SYSTEMS AS A PERCENTAGE OF AVAILABLE TIME

| Drug Distribution System   | Nursing Ward | Registered Nurses | Service Coordinator | Ward Aides | Ward Clerks | Certified Nursing Assistants |
|--|--------------|-------------------|---------------------|------------|-------------|------------------------------|
| Unit-Dose with Unit Assignment Nursing System                      | 4DE          | 4.59%             | ----                | ----       | ----        | ----                         |
| Unit-Dose with Team Nursing System                                 | 4AB          | 5.11              | ----                | ----       | ----        | ----                         |
| Floor Stock-Prescription Order with Unit Assignment Nursing System | 3DE          | 10.99             | 3.89%               | 1.41%      | 1.23%       | ----                         |
| Floor Stock-Prescription Order with Team Nursing System            | 3CF          | 8.05              | ----                | .50        | .76         | .21%                         |

These results varied from those of a previous study conducted at University Hospital in June 1970 using the continuous observation method of work study.<sup>1</sup> In that study, registered nurses spent 10.75 percent of available time on drug distribution activities under the Unit-Dose with Team Nursing System and 9.56 percent of available time under the Floor Stock-Prescription Order with Team Nursing System. The other two systems were not included in the study.

The June 1970 study showed a higher percentage of available time spent on medication activities by registered nurses. However, available time in that study was defined as time available for nursing activities less 15 percent for personal, fatigue, and delay time. If a similar definition of available time had been used in the author's study, the variations in nursing time spent on medication activities between the two studies would have been smaller.

The June 1970 study also showed registered nurses spent more time on medication activities under the Unit-Dose with Team Nursing System (10.75%) than under the Floor Stock-Prescription Order with Team Nursing System (9.56%). This is the reverse of the author's findings. Evans concluded more time was required by registered nurses under the Unit-Dose system in her study because approximately 15 to 20 injections per day were prepared on the Unit-Dose ward she included in her study while only one per day was prepared on the floor stock-prescription order ward she studied. Virtually all medications on the floor stock-prescription

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1. S. J. Evans, "Report on Observation of Nursing Activity in Drug Distribution and Description of Study Methodology," Unpublished, University Hospital, Saskatoon, Saskatchewan, 31 July 1970.

order ward were in tablet dosage form during her observation period.

Care should be exercised in applying the results of nursing time spent on medication activities in this study to other hospitals. Wide variations can occur due to different staffing patterns, physical layout, procedures, and other factors. This is evident from studies conducted in other hospitals. A study at Western Memorial Hospital in Newfoundland, Canada, showed registered nurses spent 3.70 percent of their time on medication activities.<sup>2</sup> This is a very low percentage. At the other extreme, another study conducted at the Ohio State University Hospitals reported, "a registered nurse spent an average of 47.3 percent of her time with medication procedures."<sup>3</sup>

#### Pharmacy Costs During Study Period

Three steps were required to determine the pharmacy costs on the experimental wards during the study period.

1. Accumulation of all pharmacy costs.
2. Apportionment of accumulated costs to the various pharmacy activities.
3. Apportionment of accumulated inpatient pharmacy costs to each of the experimental wards.

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2. "Percentage of Time Spent on Selected Activities by Nursing Personnel in Four Hospitals - 1968," Unpublished study conducted by Hospital Insurance and Diagnostic Services Nursing Consultants, Canadian Department of National Health and Welfare, Ottawa, 1968.

3. Ruby B. Martin, "A Pharmacy Coordinated Unit Dose Dispensing and Drug Administration System - Nursing Implications," Am. J. Hosp. Pharm. (27:11) Nov. 1970, p. 902.

Pharmacy Personnel Costs

The total pharmacy personnel cost for the study period was \$40,769.44. A breakdown of this total by cost components and employee position is shown in Table VII.

The total hospital cost during 1970 for the Personnel and Employee Health Departments was \$96,088.76. Of this amount, 1.33 percent was allocated to the Pharmacy Department. One-quarter of the allocated amount was the cost for the study period. This was divided by 26, the number of pharmacy employees, to give a cost per employee of \$12.29.

The apportionment of pharmacy personnel costs to the various pharmacy activities, based on the percentages from the pharmacy effort analysis study, is shown in Table VIII.

Pharmacy personnel costs for the Unit-Dose project were \$12,027.38. Of the total unit-doses administered during the study period under the Unit-Dose project, 39.08 percent were administered on 4DE and 41.01 percent were administered on 4AB (Table IX). Using these percentages, the pharmacy personnel costs on 4DE were \$4,700.30 and on 4AB, \$4,932.43. These calculations are shown in Table XI.

Pharmacy personnel costs for inpatient prescriptions and floor stock were \$21,010.45. A total of 74,124 pharmacy inpatient work units were handled during the study period for nursing wards not on the Unit-Dose project. As indicated in Table X, 7.20 percent of the total work units were handled on 3DE and 4.71 percent were handled on 3CF. Using these percentages, the pharmacy personnel costs on 3DE were

Table VII

## PHARMACY PERSONNEL COSTS DURING STUDY PERIOD

| Position         | Salary      | Canada Pension Plan | Group Pension Plan | Group Life Insurance | Personnel and Employee Health | Total Personnel Cost |
|------------------|-------------|---------------------|--------------------|----------------------|-------------------------------|----------------------|
| Pharmacist A     | \$3,525.00  | \$----              | \$176.25           | \$23.16              | \$12.29                       | \$3,736.70           |
| Pharmacist B     | 2,745.00    | -----               | 137.25             | 8.01                 | 12.29                         | 2,902.55             |
| Pharmacist C     | 2,505.00    | -----               | 125.25             | 7.14                 | 12.29                         | 2,649.68             |
| Pharmacist D     | 2,210.89    | 4.60                | 39.25              | -----                | 12.29                         | 2,267.03             |
| Pharmacist E     | 1,606.41    | .63                 | -----              | 2.08                 | 12.29                         | 1,621.41             |
| Pharmacist F     | 2,399.14    | -----               | 114.75             | 14.25                | 12.29                         | 2,540.43             |
| Pharmacist G     | 2,085.00    | -----               | -----              | 5.34                 | 12.29                         | 2,102.63             |
| Pharmacist H     | 2,175.00    | -----               | -----              | 6.24                 | 12.29                         | 2,193.53             |
| Pharmacist I     | 1,965.00    | -----               | -----              | 5.34                 | 12.29                         | 1,982.63             |
| Pharmacist J     | 1,905.00    | 19.10               | -----              | 3.56                 | 12.29                         | 1,939.95             |
| Pharmacist K     | 1,905.00    | 31.59               | -----              | 5.34                 | 12.29                         | 1,954.22             |
| Resident A       | 960.00      | 14.58               | -----              | 1.77                 | 12.29                         | 988.64               |
| Resident B       | 640.00      | 9.72                | -----              | 1.18                 | 12.29                         | 663.19               |
| Resident C       | 976.61      | 14.87               | -----              | 1.77                 | 12.29                         | 1,005.54             |
| Secretary        | 1,325.70    | 21.16               | -----              | 2.67                 | 12.29                         | 1,361.82             |
| Pharmacy Aide    | 915.00      | 13.77               | -----              | 1.77                 | 12.29                         | 942.83               |
| Pharmacy Clerk   | 1,108.12    | 16.34               | -----              | 1.77                 | 12.29                         | 1,138.52             |
| Technician A     | 921.07      | -----               | -----              | 1.77                 | 12.29                         | 935.13               |
| Technician B     | 956.69      | 14.52               | -----              | 1.77                 | 12.29                         | 985.27               |
| Technician C     | 1,116.70    | 16.96               | -----              | 1.77                 | 12.29                         | 1,147.72             |
| Storeman         | 1,335.00    | 21.33               | 45.42              | 7.14                 | 12.29                         | 1,421.18             |
| Porter A         | 1,337.60    | 18.09               | -----              | 3.26                 | 12.29                         | 1,371.24             |
| Porter B         | 1,857.83    | 29.39               | -----              | 1.77                 | 12.29                         | 1,901.28             |
| Student Helper A | 225.04      | 1.82                | -----              | -----                | 12.29                         | 239.15               |
| Student Helper B | 328.16      | 3.20                | -----              | -----                | 12.29                         | 343.65               |
| Student Helper C | 415.19      | 6.04                | -----              | -----                | 12.29                         | 433.52               |
| Totals           | \$39,445.15 | \$257.71            | \$638.17           | \$108.87             | \$319.54                      | \$40,769.44          |

Table VIII

APPORTIONMENT OF PHARMACY PERSONNEL COSTS DURING STUDY PERIOD TO PHARMACY ACTIVITIES

| Position         | Total Personnel |       | Inpatient Prescriptions |       | Floor Stock |       | Unit-Dose Project |             | Outpatient Services |            | Teaching and Research |            |
|------------------|-----------------|-------|-------------------------|-------|-------------|-------|-------------------|-------------|---------------------|------------|-----------------------|------------|
|                  | Cost            | %     | \$                      | %     | \$          | %     | %                 | \$          | %                   | \$         | %                     | \$         |
| Pharmacist A     | \$3,736.70      | 31.38 | \$1,172.58              | 18.38 | \$686.81    | 18.38 | 29.74             | \$1,111.29  | 7.31                | \$273.15   | 13.19                 | \$192.87   |
| Pharmacist B     | 2,902.55        | 27.98 | 812.13                  | 13.14 | 381.40      | 13.14 | 18.84             | 546.84      | 9.77                | 283.58     | 30.27                 | 878.60     |
| Pharmacist C     | 2,649.68        | 39.31 | 1,041.59                | 35.32 | 935.87      | 35.32 | 3.59              | 95.12       | 7.40                | 196.08     | 14.38                 | 381.02     |
| Pharmacist D     | 2,267.03        | 40.93 | 927.90                  | 23.83 | 540.23      | 23.83 | .52               | 11.79       | 34.54               | 783.03     | .18                   | 4.08       |
| Pharmacist E     | 1,621.41        | 69.76 | 1,131.10                | 18.81 | 304.99      | 18.81 | 1.13              | 18.32       | 9.91                | 160.68     | .39                   | 6.32       |
| Pharmacist F     | 2,540.43        | 88.98 | 2,260.47                | 1.55  | 39.38       | 1.55  | 1.02              | 25.91       | 5.00                | 127.02     | 3.45                  | 87.65      |
| Pharmacist G     | 2,102.63        | 3.06  | 64.34                   | .30   | 6.31        | .30   | 69.77             | 1,467.00    | .05                 | 1.05       | 26.82                 | 563.93     |
| Pharmacist H     | 2,193.53        | 16.76 | 367.64                  | 6.55  | 143.68      | 6.55  | 54.59             | 1,197.45    | 2.54                | 55.71      | 19.56                 | 429.05     |
| Pharmacist I     | 1,982.63        | 6.51  | 129.07                  | .13   | 2.58        | .13   | 88.14             | 1,747.49    | .05                 | .99        | 5.17                  | 102.50     |
| Pharmacist J     | 1,939.95        | 5.36  | 103.98                  | ----- | -----       | ----- | 93.87             | 1,821.03    | -----               | -----      | .77                   | 14.94      |
| Pharmacist K     | 1,954.22        | 35.02 | 684.37                  | 14.73 | 287.86      | 14.73 | .68               | 13.29       | 45.67               | 892.49     | 3.90                  | 76.21      |
| Resident A       | 988.64          | 56.99 | 563.43                  | 6.55  | 64.76       | 6.55  | 9.21              | 91.05       | 5.50                | 54.37      | 21.75                 | 215.03     |
| Resident B       | 663.19          | 49.04 | 325.23                  | 8.78  | 58.23       | 8.78  | .93               | 6.17        | .77                 | 5.10       | 40.48                 | 268.46     |
| Resident C       | 1,005.54        | 31.85 | 320.27                  | 13.73 | 138.06      | 13.73 | 2.14              | 21.52       | 6.73                | 67.67      | 45.55                 | 458.02     |
| Secretary        | 1,361.82        | 32.91 | 448.18                  | 18.83 | 256.43      | 18.83 | 30.48             | 415.08      | 7.49                | 102.00     | 10.29                 | 140.13     |
| Pharmacy Aide    | 942.83          | 49.55 | 467.17                  | 38.28 | 360.91      | 38.28 | .53               | 5.00        | 11.57               | 109.09     | .07                   | .66        |
| Pharmacy Clerk   | 1,138.52        | 65.51 | 745.84                  | 8.26  | 94.04       | 8.26  | 8.80              | 100.19      | 14.46               | 164.63     | 2.97                  | 33.82      |
| Technician A     | 935.13          | 5.59  | 52.27                   | ----- | -----       | ----- | 93.75             | 876.69      | -----               | -----      | .66                   | 6.17       |
| Technician B     | 985.27          | 8.29  | 81.68                   | .20   | 1.97        | .20   | 91.32             | 899.75      | .08                 | .79        | .11                   | 1.08       |
| Technician C     | 1,147.72        | 4.51  | 51.76                   | ----- | -----       | ----- | 95.49             | 1,095.96    | -----               | -----      | -----                 | -----      |
| Storeman         | 1,421.18        | 25.21 | 358.28                  | 35.90 | 510.20      | 35.90 | 24.56             | 349.04      | 6.04                | 85.84      | 8.29                  | 117.82     |
| Porter A         | 1,371.24        | 8.16  | 111.89                  | 79.26 | 1,086.85    | 79.26 | 7.95              | 109.01      | 1.95                | 26.74      | 2.68                  | 36.75      |
| Porter B         | 1,901.28        | ----- | -----                   | 98.68 | 1,876.18    | 98.68 | -----             | -----       | 1.32                | 25.10      | -----                 | -----      |
| Student Helper A | 239.15          | 90.38 | 216.14                  | 9.62  | 23.01       | 9.62  | -----             | -----       | -----               | -----      | -----                 | -----      |
| Student Helper B | 343.65          | 74.29 | 255.30                  | 25.71 | 88.35       | 25.71 | -----             | -----       | -----               | -----      | -----                 | -----      |
| Student Helper C | 433.52          | 98.79 | 428.27                  | .34   | 1.47        | .34   | .55               | 2.39        | .14                 | .61        | .18                   | .78        |
| Totals           | \$40,769.44     | ----- | \$13,120.88             | ----- | \$7,889.57  | ----- | -----             | \$12,027.38 | -----               | \$3,415.72 | -----                 | \$4,315.89 |

Table IX

UNIT-DOSES ADMINISTERED ON EXPERIMENTAL WARDS DURING STUDY PERIOD  
AS A PERCENTAGE OF TOTAL UNIT-DOSES ADMINISTERED  
UNDER UNIT-DOSE SYSTEMS

| Ward        | Period       | Administration List Doses |              |        | Floor Stock Doses | Total Unit-Doses | Percent of Total Unit-Doses |
|-------------|--------------|---------------------------|--------------|--------|-------------------|------------------|-----------------------------|
|             |              | Doses/Patient Day         | Patient Days | Doses  |                   |                  |                             |
| 4DE         | Oct.         | --                        | 786          | 4,734  | 2,138             | 6,872            | 37.93%                      |
|             | Nov.         | 6.02                      | 875          | 5,268  | 2,290             | 7,558            | 40.47                       |
|             | Dec.         | 6.02                      | 795          | 4,786  | 1,885             | 6,671            | 38.78                       |
|             | Study Period | --                        | --           | 14,788 | 6,313             | 21,101           | 39.08%                      |
| 4AB         | Oct.         | --                        | 1,020        | 4,655  | 3,183             | 7,838            | 43.26%                      |
|             | Nov.         | 4.56                      | 997          | 4,546  | 3,105             | 7,651            | 40.97                       |
|             | Dec.         | 4.56                      | 845          | 3,853  | 2,803             | 6,656            | 38.69                       |
|             | Study Period | --                        | --           | 13,054 | 9,091             | 22,145           | 41.01%                      |
| Other Wards | Oct.         | --                        | 439          | 2,351  | 1,056             | 3,407            | 18.81%                      |
|             | Nov.         | 5.36                      | 470          | 2,519  | 946               | 3,465            | 18.56                       |
|             | Dec.         | 5.36                      | 530          | 2,841  | 1,036             | 3,877            | 22.53                       |
|             | Study Period | --                        | --           | 7,711  | 3,038             | 10,749           | 19.91%                      |
| Totals      | Oct.         | ---                       | --           | 11,740 | 6,377             | 18,117           | 100.00%                     |
|             | Nov.         | ---                       | --           | 12,333 | 6,341             | 18,674           | 100.00                      |
|             | Dec.         | ---                       | --           | 11,480 | 5,724             | 17,204           | 100.00                      |
|             | Study Period | --                        | --           | 35,553 | 18,442            | 53,995           | 100.00%                     |

Table X

PHARMACY INPATIENT WORK-UNITS ON EXPERIMENTAL WARDS DURING STUDY PERIOD  
AS A PERCENTAGE OF TOTAL INPATIENT WORK-UNITS

| Ward           | Period          | Inpatient<br>Prescription<br>Units | Floor<br>Stock<br>Units | Credit<br>Units | Total<br>Work-Units | Percent<br>of Total<br>Work-Units |
|----------------|-----------------|------------------------------------|-------------------------|-----------------|---------------------|-----------------------------------|
| 3DE            | Oct.            | 602                                | 691                     | 155             | 1,448               | 6.08%                             |
|                | Nov.            | 635                                | 1,079                   | 161             | 1,875               | 8.11                              |
|                | Dec.            | 565                                | 1,282                   | 166             | 2,013               | 7.40                              |
|                | Study<br>Period | 1,802                              | 3,052                   | 482             | 5,336               | 7.20%                             |
| 3CF            | Oct.            | 466                                | 438                     | 176             | 1,080               | 4.54%                             |
|                | Nov.            | 526                                | 332                     | 162             | 1,020               | 4.41                              |
|                | Dec.            | 579                                | 569                     | 245             | 1,393               | 5.12                              |
|                | Study<br>Period | 1,571                              | 1,339                   | 583             | 3,493               | 4.71%                             |
| Other<br>Wards | Oct.            | 4,074                              | 15,965                  | 1,230           | 21,269              | 89.38%                            |
|                | Nov.            | 3,161                              | 15,847                  | 1,212           | 20,220              | 87.48                             |
|                | Dec.            | 4,003                              | 18,484                  | 1,319           | 23,806              | 87.48                             |
|                | Study<br>Period | 11,238                             | 50,296                  | 3,761           | 65,295              | 88.09%                            |
| Totals         | Oct.            | 5,142                              | 17,094                  | 1,561           | 23,797              | 100.00%                           |
|                | Nov.            | 4,322                              | 17,258                  | 1,535           | 23,115              | 100.00                            |
|                | Dec.            | 5,147                              | 20,335                  | 1,730           | 27,212              | 100.00                            |
|                | Study<br>Period | 14,611                             | 54,687                  | 4,826           | 74,124              | 100.00%                           |

\$1,512.75 and on 3CF, \$989.59. These calculations also are shown in

Table XI.

Table XI

APPORTIONMENT OF INPATIENT PHARMACY PERSONNEL COSTS  
DURING STUDY PERIOD TO EXPERIMENTAL WARDS

| Ward        | Percent of Total<br>Unit-Doses | Percent of Total<br>Work Units | Pharmacy<br>Personnel Costs |
|-------------|--------------------------------|--------------------------------|-----------------------------|
| 4DE         | 39.08%                         | --                             | \$ 4,700.30                 |
| 4AB         | 41.01                          | --                             | 4,932.43                    |
| 3DE         | --                             | 7.20%                          | 1,512.75                    |
| 3CF         | --                             | 4.71                           | 989.59                      |
| Other Wards | 19.91                          | 88.09                          | 20,902.76                   |
| Totals      | 100.00%                        | 100.00%                        | \$33,037.83                 |

Pharmacy Personnel Costs for Unit-Dose Project = \$12,027.38  
 Pharmacy Personnel Costs for Inpatient Prescriptions and Floor Stock  
 = \$21,010.45

Drug Cost

The total cost of drugs used during the study period, less credits issued, was \$113,947.31. Table XII shows the breakdown of this total.

Drugs supplied to Other Departments cost \$16,492.30. This was the cost of drugs purchased by the Pharmacy Department for hospital laboratories and drugs sold to purchasers outside the hospital. In most cases, these drugs were purchased by the hospital pharmacy and collected immediately by the other departments when received. Little storage, packaging or labelling of these items was done. The costs associated with this service are included in Outpatient Services.

Drug cost was apportioned to the various pharmacy activities as

indicated in Table XIII.

Table XII

DRUG COST DURING STUDY PERIOD

|                          | October            | November           | December           | Study<br>Period     |
|--------------------------|--------------------|--------------------|--------------------|---------------------|
| Inpatient Prescriptions  | \$14,650.94        | \$17,006.51        | \$18,804.40        | \$50,461.85         |
| Floor Stock              | 13,153.74          | 14,597.67          | 15,250.20          | 43,001.61           |
| Unit-Doses               | 1,291.40           | 1,849.95           | 1,355.00           | 4,496.35            |
| Less Credits             | <u>\$3,143.49</u>  | <u>\$3,184.84</u>  | <u>\$4,523.78</u>  | <u>\$10,852.11</u>  |
| Inpatient Drug Cost      | \$25,952.59        | \$30,269.29        | \$30,885.82        | \$87,107.70         |
| Outpatient Prescriptions | 3,442.56           | 2,970.46           | 3,934.29           | 10,347.31           |
| Other Departments        | 6,837.76           | 4,129.64           | 5,524.90           | 16,492.30           |
| Totals                   | <u>\$36,232.91</u> | <u>\$37,369.39</u> | <u>\$40,345.01</u> | <u>\$113,947.31</u> |

Table XIII

APPORTIONMENT OF DRUG COST DURING STUDY PERIOD  
TO PHARMACY ACTIVITIES

| Activity                                | Drug Cost   |              |
|---|---|--------------|
| Inpatient Prescriptions<br>Less Credits | \$50,461.85<br><u>10,852.11</u>                       | \$ 39,609.74 |
| Floor Stock                             |   | 39,659.49    |
| Unit-Dose Project                       | Unit-Doses \$ 4,496.35<br>Floor Stock <u>3,342.12</u> | 7,838.47     |
| Outpatient Services                     |   | 26,839.61    |
| Teaching and Research                   |   | ---          |
| Total                                   |   | \$113,947.31 |

The total inpatient drug cost during the study period was \$87,107.70. The drug cost on each experimental ward is shown in Table XIV.

Table XIV

APPORTIONMENT OF INPATIENT DRUG COST DURING STUDY PERIOD  
TO EXPERIMENTAL WARDS

| Ward           | Period          | Inpatient<br>Prescriptions | Floor<br>Stock | Unit-Doses | Credits     | Drug Cost   |
|----------------|-----------------|----------------------------|----------------|------------|-------------|-------------|
| 4DE            | Oct.            | --                         | \$296.43       | \$520.74   | --          | \$ 817.17   |
|                | Nov.            | --                         | 340.87         | 790.20     | --          | 1,131.07    |
|                | Dec.            | --                         | 340.02         | 564.75     | --          | 904.77      |
|                | Study<br>Period | --                         | \$977.32       | \$1,875.69 | --          | \$2,853.01  |
| 4AB            | Oct.            | --                         | \$678.85       | \$512.05   | --          | \$1,190.90  |
|                | Nov.            | --                         | 621.42         | 681.90     | --          | 1,303.32    |
|                | Dec.            | --                         | 456.97         | 455.01     | --          | 911.98      |
|                | Study<br>Period | --                         | \$1,757.24     | \$1,648.96 | --          | \$3,406.20  |
| 3DE            | Oct.            | \$1,308.17                 | \$208.97       | --         | \$213.53    | \$1,303.61  |
|                | Nov.            | 1,174.66                   | 361.15         | --         | 173.14      | 1,362.67    |
|                | Dec.            | 1,239.47                   | 483.29         | --         | 300.87      | 1,421.89    |
|                | Study<br>Period | \$3,722.30                 | \$1,053.41     | --         | \$687.54    | \$4,088.17  |
| 3CF            | Oct.            | \$987.43                   | \$127.72       | --         | \$321.19    | \$ 793.96   |
|                | Nov.            | 1,286.91                   | 109.13         | --         | 402.77      | 993.27      |
|                | Dec.            | 1,967.33                   | 212.14         | --         | 643.04      | 1,536.43    |
|                | Study<br>Period | \$4,241.67                 | \$448.99       | --         | \$1,367.00  | \$3,323.66  |
| Other<br>Wards | Oct.            | \$12,355.34                | \$11,841.77    | \$258.61   | \$2,608.77  | \$21,846.95 |
|                | Nov.            | 14,544.94                  | 13,165.10      | 377.85     | 2,608.93    | 25,478.96   |
|                | Dec.            | 15,597.60                  | 13,757.78      | 335.24     | 3,579.87    | 26,110.75   |
|                | Study<br>Period | \$42,497.88                | \$38,764.65    | \$971.70   | \$8,797.57  | \$73,436.66 |
| Totals         | Oct.            | \$14,650.94                | \$13,153.74    | \$1,291.40 | \$3,143.49  | \$25,952.59 |
|                | Nov.            | 17,006.51                  | 14,597.67      | 1,849.95   | 3,184.84    | 30,269.29   |
|                | Dec.            | 18,804.40                  | 15,250.20      | 1,355.00   | 4,523.78    | 30,885.82   |
|                | Study<br>Period | \$50,461.85                | \$43,001.61    | \$4,496.35 | \$10,852.11 | \$87,107.70 |

Inventory Holding Costs

The average pharmacy inventory during 1970 was \$79,041.12. At 10 percent of average inventory, annual holding costs were \$7,904.11. The inventory holding costs during the study period were one-quarter of this amount, \$1,976.03. Details of this calculation are shown in Table XV.

Table XV

## INVENTORY HOLDING COSTS DURING STUDY PERIOD

|   |             |
|---|-------------|
| Pharmacy Inventory - 31 December 1969       | \$78,581.33 |
| Pharmacy Inventory - 31 December 1970       | \$79,500.91 |
| Average Pharmacy Inventory                  | \$79,041.12 |
| Annual Inventory Holding Costs (10%)        | \$ 7,904.11 |
| Inventory Holding Costs During Study Period | \$ 1,976.03 |

Inventory holding costs were apportioned to the various pharmacy activities in proportion to drug cost as shown in Table XVI.

Table XVI

APPORTIONMENT OF INVENTORY HOLDING COSTS DURING STUDY PERIOD  
TO PHARMACY ACTIVITIES

| Activity                | Drug<br>Cost | Percent of<br>Drug Cost | Inventory<br>Holding Costs |
|-------------------------|--------------|-------------------------|----------------------------|
| Inpatient Prescriptions | \$ 39,609.74 | 34.76%                  | \$ 686.87                  |
| Floor Stock             | 39,659.49    | 34.81                   | 687.86                     |
| Unit-Dose Project       | 7,838.47     | 6.88                    | 135.95                     |
| Outpatient Services     | 26,839.61    | 23.55                   | 465.35                     |
| Teaching and Research   | --           | --                      | --                         |
| Totals                  | \$113,947.31 | 100.00%                 | \$1,976.03                 |

The total inpatient inventory holding costs were \$1,510.68.

A portion of this was allocated to each experimental ward in proportion to drug cost. As shown in Table XVII, 3.28 percent was allocated to 4DE; 3.91 percent to 4AB; 4.69 percent to 3DE; and 3.82 percent to 3CF.

Table XVII

APPORTIONMENT OF INPATIENT INVENTORY HOLDING COSTS DURING STUDY  
PERIOD TO EXPERIMENTAL WARDS

| Ward           | Inpatient<br>Drug Cost | Percent of Inpatient<br>Drug Cost | Inventory<br>Holding Costs |
|----------------|------------------------|-----------------------------------|----------------------------|
| 4DE            | \$ 2,853.01            | 3.28%                             | \$ 49.55                   |
| 4AB            | 3,406.20               | 3.91                              | 59.07                      |
| 3DE            | 4,088.17               | 4.69                              | 70.85                      |
| 3CF            | 3,323.66               | 3.82                              | 57.71                      |
| Other<br>Wards | 73,436.66              | 84.30                             | 1,273.50                   |
| Totals         | \$87,107.70            | 100.00%                           | \$1,510.68                 |

Pharmacy Supplies Cost

The cost of pharmacy supplies during the study period was \$2,983.87. The supplies used were divided into three groups -- packaging supplies, Unit-Dose packaging supplies, and other supplies (Table XVIII).

Pharmacy supplies cost was apportioned to the various pharmacy activities in proportion to drug cost as shown in Table XIX. The cost of pharmacy supplies for inpatient activities was \$2,586.22.

Table XVIII

## PHARMACY SUPPLIES COST DURING STUDY PERIOD

|   |              |              |
|---|--------------|--------------|
| Packaging Supplies                          |              | \$1,480.00   |
| Unit-Dose Packaging Supplies                |              |              |
| Blister Pacs 42,989 at \$28.50/1,000        | \$1,225.19   |              |
| Liquid Ampaks (15 cc.) 2,977 at \$17.93/500 | 106.58       |              |
| Liquid Ampaks (30 cc.) 832 at \$20.29/500   | 33.70        |              |
| Aluminum Seals 3,809 at \$103.13/10,000     | <u>39.23</u> |              |
|   |              | 1,404.70     |
| Other Supplies                              |              | <u>99.17</u> |
| Total                                       |              | \$2,983.87   |

Table XIXAPPORTIONMENT OF PHARMACY SUPPLIES COST DURING STUDY PERIOD  
TO PHARMACY ACTIVITIES

| Activity                   | Unit-Dose<br>Packaging<br>Supplies | Other<br>Packaging<br>Supplies |            | Other<br>Supplies |         | Supplies<br>Cost |
|----------------------------|------------------------------------|--------------------------------|------------|-------------------|---------|------------------|
|                            |                                    | %                              | \$         | %                 | \$      |                  |
| Inpatient<br>Prescriptions | --                                 | 37.33%                         | \$ 552.49  | 34.76%            | \$34.47 | \$ 586.96        |
| Floor Stock                | --                                 | 37.38                          | 553.22     | 34.81             | 34.52   | 587.74           |
| Unit-Dose<br>Project       | \$1,404.70                         | --                             | --         | 6.88              | 6.82    | 1,411.52         |
| Outpatient<br>Services     | --                                 | 25.29                          | 374.29     | 23.55             | 23.36   | 397.65           |
| Teaching and<br>Research   | --                                 | --                             | --         | --                | --      | --               |
| Totals                     | \$1,404.70                         | 100.00                         | \$1,480.00 | 100.00            | \$99.17 | \$2,983.87       |

The cost of pharmacy supplies for the Unit-Dose project was \$1,411.52. As shown in Table XX, 36.40 percent of this was apportioned to 4DE, and 43.45 percent to 4AB. The cost of pharmacy supplies for inpatient prescriptions and floor stock was \$1,174.70. Of this amount, 5.16 percent was apportioned to 3DE, and 4.19 percent to 3CF. These data also are presented in Table XX.

Table XX

APPORTIONMENT OF INPATIENT PHARMACY SUPPLIES COST DURING  
STUDY PERIOD TO EXPERIMENTAL WARDS

| Ward        | Percent of Drug Cost for Unit-Dose Project | Percent of Drug Cost For Inpatient Prescriptions and Floor Stock | Pharmacy Supplies Cost |
|-------------|--|--|------------------------|
| 4DE         | 36.40%                                     | --   | \$ 513.79              |
| 4AB         | 43.45                                      | --   | 613.31                 |
| 3DE         | --   | 5.16%  | 60.61                  |
| 3CF         | --   | 4.19   | 49.22                  |
| Other Wards | 20.15                                      | 90.65  | 1,349.29               |
| Totals      | 100.00%                                    | 100.00%  | \$2,586.22             |

Pharmacy Supplies Cost for Unit-Dose Project = \$1,411.52

Pharmacy Supplies Cost for Inpatient Prescriptions and Floor Stock = \$1,174.70.

Overhead Costs

Pharmacy overhead costs during the study period were \$17,339.82.

The overhead items and the percentages used to allocate hospital overhead to the Pharmacy Department are listed in Table XXI.

Pharmacy equipment was valued at \$43,462.26. Applying the hospital composite depreciation rate of 6.25 percent to this figure resulted in an annual depreciation charge of \$2,716.39.

Table XXI

OVERHEAD COSTS DURING STUDY PERIOD

| Overhead Item                 | 1970<br>Hospital<br>Cost | Pharmacy Allocation |             | Study<br>Period<br>Cost |
|-------------------------------|--------------------------|---------------------|-------------|-------------------------|
|                               |                          | %                   | \$          |                         |
| Pharmacy Repairs              | \$ 187.57                | 100.00%             | \$ 187.57   | \$ 46.89                |
| Pharmacy Miscellaneous        | 5,817.19                 | 100.00              | 5,817.19    | 1,454.30                |
| Equipment Depreciation        | 2,716.39                 | 100.00              | 2,716.39    | 679.10                  |
| Purchasing and Stores         | 122,761.50               | .80                 | 982.09      | 245.52                  |
| Telephone and Telegraph       | 74,274.13                | 1.35                | 1,002.70    | 250.68                  |
| Fuel                          | 74,584.80                | 1.40                | 1,044.18    | 261.04                  |
| Electricity                   | 71,548.23                | 1.40                | 1,001.67    | 250.42                  |
| Water                         | 25,358.08                | 1.40                | 355.01      | 88.75                   |
| Building Depreciation         | 251,016.32               | 2.04                | 5,120.73    | 1,280.18                |
| Physical Plant                | 369,746.04               | 2.03                | 7,505.84    | 1,876.46                |
| Laundry and Linen             | 282,304.52               | .11                 | 310.53      | 77.63                   |
| Housekeeping                  | 441,648.02               | 1.34                | 5,918.08    | 1,479.52                |
| Administration and<br>General | 575,343.25               | 6.50                | 37,397.31   | 9,349.33                |
| Totals                        |                          |                     | \$69,359.29 | \$17,339.82             |

Overhead costs were apportioned to the various pharmacy activities as shown in Table XXII.

Table XXII

APPORTIONMENT OF OVERHEAD COSTS DURING STUDY PERIOD  
TO PHARMACY ACTIVITIES

| Activity                | Pharmacy<br>Personnel<br>Costs | Percent of<br>Personnel<br>Costs | Overhead<br>Costs |
|-------------------------|--------------------------------|----------------------------------|-------------------|
| Inpatient Prescriptions | \$13,120.88                    | 32.18%                           | \$ 5,579.95       |
| Floor Stock             | 7,889.57                       | 19.35                            | 3,355.25          |
| Unit-Dose Project       | 12,027.38                      | 29.50                            | 5,115.25          |
| Outpatient Services     | 3,415.72                       | 8.38                             | 1,453.08          |
| Teaching and Research   | 4,315.89                       | 10.59                            | 1,836.29          |
| Totals                  | \$40,769.44                    | 100.00%                          | \$17,339.82       |

The total inpatient pharmacy overhead costs were \$14,050.45. This total was divided among the nursing wards in proportion to the number of beds on each ward. As shown in Table XXIII, 8.79 percent was apportioned to 4DE; 7.51 percent to 4AB; 8.61 percent to 3DE; and 4.94 percent to 3CF.

Data Processing Costs

Data processing costs during the study period were \$3,057.66. The items included and their cost are listed in Table XXIV.

The rental of computer equipment to service the 124 hospital beds with the Unit-Dose systems was \$1,800.00 per month. However, this figure overstates the cost of data processing since the computer rental to service all 546 hospital beds would be \$3,800.00 per month. A more

Table XXIII

APPORTIONMENT OF INPATIENT OVERHEAD COSTS DURING STUDY PERIOD  
TO EXPERIMENTAL WARDS

| Ward        | Hospital Beds |         | Overhead Costs |
|-------------|---------------|---------|----------------|
|             | Number        | Percent |                |
| 4DE         | 48            | 8.79%   | \$ 1,235.04    |
| 4AB         | 41            | 7.51    | 1,055.19       |
| 3DE         | 47            | 8.61    | 1,209.74       |
| 3CF         | 27            | 4.94    | 694.09         |
| Other Wards | 383           | 70.15   | 9,856.39       |
| Totals      | 546           | 100.00% | \$14,050.45    |

Table XXIV

DATA PROCESSING COSTS DURING STUDY PERIOD

| Item              | Quantity      | Unit Cost      | Total Cost |
|-------------------|---------------|----------------|------------|
| Computer Rental   | 3 months      | \$863.00/month | \$2,589.00 |
| Computer Paper    | 33,000 sheets | 9.52/1,000     | 314.16     |
| Computer Tapes    | 12            | 9.00 each      | 108.00     |
| Tape Head Cleaner | 9 cans        | 3.00 each      | 27.00      |
| Labels            | 1,000         | 19.50/1,000    | 19.50      |
| Total             |               |                | \$3,057.66 |

accurate cost for computer rental was obtained by taking 124/546 of \$3,800.00. This calculation resulted in a monthly computer rental of \$863.00.

The total data processing costs were allocated to the Unit-Dose project since these costs were associated only with that activity. The inpatient data processing cost of \$3,057.66 was divided among the wards under the Unit-Dose systems in proportion to the number of unit-doses administered on each ward. As reported in Table XXV, 39.08 percent of data processing costs were apportioned to 4DE, and 41.01 percent to 4AB. Using these percentages, data processing costs were \$1,194.93 on 4DE, and \$1,253.95 on 4AB.

Table XXV

APPORTIONMENT OF DATA PROCESSING COSTS DURING STUDY PERIOD  
TO EXPERIMENTAL WARDS

| Ward        | Unit-Doses | Percent of Unit-Doses | Data Processing Costs |
|-------------|------------|-----------------------|-----------------------|
| 4DE         | 21,101     | 39.08%                | \$1,194.93            |
| 4AB         | 22,145     | 41.01                 | 1,253.95              |
| 3DE         | --         | --                    | --                    |
| 3CF         | --         | --                    | --                    |
| Other Wards | 10,749     | 19.91                 | 608.78                |
| Totals      | 53,995     | 100.00%               | \$3,057.66            |

Satellite Pharmacy Cost

Nursing service overhead costs during 1970 were \$908,484.77. The overhead items and the percentages used to apportion hospital overhead to nursing service are listed in Table XXVI. The number of square feet of hospital building space allocated to nursing service was 139,037. Thus, the nursing service overhead costs per square foot were \$6.53.

The satellite pharmacy occupied 170 square feet. At \$6.53 per square foot, the annual cost was \$1,110.10. The satellite pharmacy cost during the study period was one-quarter of the annual cost, or \$277.53. This calculation is shown in Table XXVII.

The total satellite pharmacy cost was allocated to the Unit-Dose project and was divided among the wards under the Unit-Dose systems in proportion to the number of unit-doses administered on each ward. Thus, 39.08 percent was apportioned to 4DE, and 41.01 percent was apportioned to 4AB. Using these percentages, the satellite pharmacy cost on 4DE was \$108.46, and on 4AB, \$113.81. These calculations are shown in Table XXVIII.

Table XXVI

## NURSING SERVICE OVERHEAD COSTS DURING 1970

| Overhead Item              | 1970<br>Hospital<br>Cost | Nursing Service Allocation |              |
|----------------------------|--------------------------|----------------------------|--------------|
|                            |                          | Percent                    | Cost         |
| Purchasing and Stores      | \$122,761.50             | 1.81%                      | \$ 2,221.98  |
| Telephone and Telegraph    | 74,274.13                | 11.77                      | 8,742.06     |
| Fuel                       | 74,584.80                | 31.60                      | 23,568.79    |
| Electricity                | 71,548.23                | 28.70                      | 20,534.34    |
| Water                      | 25,358.08                | 27.60                      | 6,998.83     |
| Building Depreciation      | 251,016.32               | 34.11                      | 85,621.66    |
| Equipment Depreciation     | 261,807.98               | 12.18                      | 31,888.21    |
| Physical Plant             | 369,746.04               | 30.89                      | 114,214.55   |
| Laundry and Linen          | 282,304.52               | 68.15                      | 192,390.53   |
| Housekeeping               | 441,648.02               | 52.50                      | 231,865.21   |
| Administration and General | 575,343.25               | 33.10                      | 190,438.61   |
| Total                      |                          |                            | \$908,484.77 |

Table XXVII

## SATELLITE PHARMACY COST DURING STUDY PERIOD

|                                      |                 |
|--------------------------------------|-----------------|
| Satellite Pharmacy Area              | 170 Square Feet |
| Overhead Cost Per Square Foot        | \$ 6.53         |
| Annual Satellite Pharmacy Cost       | \$1,110.10      |
| Study Period Satellite Pharmacy Cost | \$ 277.53       |

Table XXVIII

APPORTIONMENT OF SATELLITE PHARMACY COST DURING STUDY PERIOD  
TO EXPERIMENTAL WARDS

| Ward        | Unit-Doses | Percent of<br>Unit-Doses | Satellite<br>Pharmacy Cost |
|-------------|------------|--------------------------|----------------------------|
| 4DE         | 21,101     | 39.08%                   | \$108.46                   |
| 4AB         | 22,145     | 41.01                    | 113.81                     |
| 3DE         | --         | --                       | --                         |
| 3CF         | --         | --                       | --                         |
| Other Wards | 10,749     | 19.91                    | 55.26                      |
| Totals      | 53,995     | 100.00%                  | \$277.53                   |

Summary of Pharmacy Costs

The total pharmacy costs during the study period, as summarized in Table XXIX, amounted to \$180,351.66. This total was allocated to the five pharmacy activities as summarized in Table XXX.

Table XXIX

## SUMMARY OF PHARMACY COSTS DURING STUDY PERIOD

| Cost Item                | Amount       |
|--------------------------|--------------|
| Pharmacy Personnel Costs | \$ 40,769.44 |
| Drug Cost                | 113,947.31   |
| Inventory Holding Costs  | 1,976.03     |
| Pharmacy Supplies Cost   | 2,983.87     |
| Overhead Costs           | 17,339.82    |
| Data Processing Costs    | 3,057.66     |
| Satellite Pharmacy Cost  | 277.53       |
| Total                    | \$180,351.66 |

Table XXX

## SUMMARY OF PHARMACY ACTIVITIES COST DURING STUDY PERIOD

| Cost Item                | Inpatient Prescriptions | Floor Stock | Unit-Dose Project | Out-Patient Services | Teaching and Research | Total Cost   |
|--------------------------|-------------------------|-------------|-------------------|----------------------|-----------------------|--------------|
| Pharmacy Personnel Costs | \$13,120.88             | \$ 7,889.57 | \$12,027.38       | \$ 3,415.72          | \$4,315.89            | \$ 40,769.44 |
| Drug Cost                | 39,609.74               | 39,659.49   | 7,838.47          | 26,839.61            | ---                   | 113,947.31   |
| Inventory Holding Costs  | 686.87                  | 687.86      | 135.95            | 465.35               | ---                   | 1,976.03     |
| Pharmacy Supplies Cost   | 586.96                  | 587.74      | 1,411.52          | 397.65               | ---                   | 2,983.87     |
| Overhead Costs           | 5,579.95                | 3,355.25    | 5,115.25          | 1,453.08             | 1,836.29              | 17,339.82    |
| Data Processing Costs    | ---                     | ---         | 3,057.66          | ---                  | ---                   | 3,057.66     |
| Satellite Pharmacy Cost  | ---                     | ---         | 277.53            | ---                  | ---                   | 277.53       |
| Totals                   | \$59,584.40             | \$52,179.91 | \$29,863.76       | \$32,571.41          | \$6,152.18            | \$180,351.66 |

Subtracting the pharmacy costs associated with outpatient services, and teaching and research, the cost of the inpatient activities alone was \$141,628.07 as shown in Table XXXI.

Table XXXI

SUMMARY OF INPATIENT PHARMACY ACTIVITIES COST DURING STUDY PERIOD

| Cost Item                | Inpatient Prescriptions | Floor Stock | Unit-Dose Project | Inpatient Pharmacy Cost |
|--------------------------|-------------------------|-------------|-------------------|-------------------------|
| Pharmacy Personnel Costs | \$13,120.88             | \$ 7,889.57 | \$12,027.38       | \$ 33,037.83            |
| Drug Cost                | 39,609.74               | 39,659.49   | 7,838.47          | 87,107.70               |
| Inventory Holding Costs  | 686.87                  | 687.86      | 135.95            | 1,510.68                |
| Pharmacy Supplies Cost   | 586.96                  | 587.74      | 1,411.52          | 2,586.22                |
| Overhead Costs           | 5,579.95                | 3,355.25    | 5,115.25          | 14,050.45               |
| Data Processing Costs    | --                      | --          | 3,057.66          | 3,057.66                |
| Satellite Pharmacy Cost  | --                      | --          | 277.53            | 277.53                  |
| Totals                   | \$59,584.40             | \$52,179.91 | \$29,863.76       | \$141,628.07            |

A summary of the pharmacy costs on each experimental ward during the study period is presented in Table XXXII. The pharmacy cost was \$10,655.08 on 4DE; \$11,433.96 on 4AB; \$6,942.12 on 3DE; and \$5,114.27 on 3CF.

Table XXXII

## SUMMARY OF PHARMACY COSTS DURING STUDY PERIOD ON EXPERIMENTAL WARDS

| Ward        | Pharmacy Personnel Costs | Drug Cost   | Inventory Holding Costs | Pharmacy Supplies Cost | Overhead Costs | Data Processing Costs | Satellite Pharmacy Cost | Total Pharmacy Costs |
|-------------|--------------------------|-------------|-------------------------|------------------------|----------------|-----------------------|-------------------------|----------------------|
| 4DE         | \$ 4,700.30              | \$ 2,853.01 | \$ 49.55                | \$ 513.79              | \$ 1,235.04    | \$1,194.93            | \$108.46                | \$ 10,655.08         |
| 4AB         | 4,932.43                 | 3,406.20    | 59.07                   | 613.31                 | 1,055.19       | 1,253.95              | 113.81                  | 11,433.96            |
| 3DE         | 1,512.75                 | 4,088.17    | 70.85                   | 60.61                  | 1,209.74       | --                    | --                      | 6,942.12             |
| 3CF         | 989.59                   | 3,323.66    | 57.71                   | 49.22                  | 694.09         | --                    | --                      | 5,114.27             |
| Other Wards | 20,902.76                | 73,436.66   | 1,273.50                | 1,349.29               | 9,856.39       | 608.78                | 55.26                   | 107,482.64           |
| Totals      | \$33,037.83              | \$87,107.70 | \$1,510.68              | \$3,586.22             | \$14,050.45    | \$3,057.66            | \$277.53                | \$141,628.07         |

Nursing Drug Distribution Costs on Experimental Wards During Study Period

The nursing drug distribution costs accumulated on each of the experimental wards during the study period were: (a) nursing personnel costs; (b) medication supplies cost; (c) medication storage costs; and (d) floor stock inventory holding costs.

Nursing Personnel Costs

The total cost of nursing personnel involved in drug distribution activities on the experimental wards during the study period was \$111,352.09 as shown in Table XXXIII.

The hospital cost during 1970 for the Personnel and Employee Health Departments was \$96,088.76. Of this amount, 31.21 percent was allocated to nursing service. One-quarter of the allocated amount, \$7,497.32, was the cost for the study period. Dividing this by 622, the number of nursing personnel in the hospital, gave a cost per nursing employee of \$12.05.

Using the percentages obtained from the nursing effort analysis study (Table VI), a portion of the total cost of nursing personnel on each experimental ward was apportioned to drug distribution activities. These calculations are presented in table XXXIV.

Medication Supplies Cost

The medication supplies cost on each experimental ward during the study period is shown in Table XXXV.

Table XXXIII

TOTAL COST OF NURSING PERSONNEL INVOLVED IN DRUG DISTRIBUTION  
ACTIVITIES ON EXPERIMENTAL WARDS DURING STUDY PERIOD

| Ward   | Position               | Salary       | Canada Pension Plan | Group Pension Plan | Group Life Insurance | Personnel and Employee Health | Total Personnel Cost |
|--------|------------------------|--------------|---------------------|--------------------|----------------------|-------------------------------|----------------------|
| 4DE    | Registered Nurses (17) | \$ 27,598.93 | \$ 257.28           | \$186.51           | \$ 71.43             | \$204.85                      | \$ 28,319.00         |
| 4AB    | Registered Nurses (14) | 22,532.14    | 167.82              | 176.43             | 41.10                | 168.70                        | 23,086.19            |
| 3DE    | Registered Nurses (16) | 25,534.95    | 177.13              | 106.50             | 47.33                | 192.80                        | 26,058.71            |
|        | Ward Clerks (3)        | 2,436.16     | 35.75               | 37.44              | 3.57                 | 36.15                         | 2,549.07             |
|        | Ward Aides (6)         | 3,010.81     | 44.30               | --                 | 2.40                 | 72.30                         | 3,129.81             |
|        | Service Coordinator    | 1,200.00     | 18.90               | --                 | 2.67                 | 12.05                         | 1,233.62             |
| 3CF    | Registered Nurses (12) | 15,526.82    | 186.34              | --                 | 52.32                | 144.60                        | 15,910.08            |
|        | Ward Clerks (3)        | 2,486.79     | 36.67               | 37.44              | 1.77                 | 36.15                         | 2,598.82             |
|        | Ward Aides (1)         | 915.00       | 13.77               | 31.98              | 1.77                 | 12.05                         | 974.57               |
|        | Nursing Assistants (6) | 7,239.24     | 96.74               | 78.09              | 5.85                 | 72.30                         | 7,492.22             |
| Totals |                        | \$108,480.84 | \$1,034.70          | \$654.39           | \$230.21             | \$951.95                      | \$111,352.09         |

Table XXXIV

APPORTIONMENT OF NURSING PERSONNEL COSTS ON EXPERIMENTAL WARDS  
DURING STUDY PERIOD TO DRUG DISTRIBUTION SYSTEMS

| Ward | Position            | Total<br>Personnel<br>Costs | Apportionment to Drug<br>Distribution |                   |
|------|---------------------|-----------------------------|---------------------------------------|-------------------|
|      |                     |                             | Percent                               | Cost              |
| 4DE  | Registered Nurses   | \$28,319.00                 | 4.59%                                 | \$1,299.84        |
| 4AB  | Registered Nurses   | 23,086.19                   | 5.11                                  | 1,179.70          |
| 3DE  | Registered Nurses   | 26,058.71                   | 10.99                                 | 2,863.85          |
|      | Ward Clerks         | 2,549.07                    | 1.23                                  | 31.35             |
|      | Ward Aides          | 3,129.81                    | 1.41                                  | 44.13             |
|      | Service Coordinator | 1,233.62                    | 3.89                                  | 47.99             |
|      |                     |                             |                                       | <u>\$2,987.32</u> |
| 3CF  | Registered Nurses   | 15,910.08                   | 8.05                                  | 1,280.76          |
|      | Ward Clerks         | 2,598.82                    | .76                                   | 19.75             |
|      | Ward Aides          | 974.57                      | .50                                   | 4.87              |
|      | Nursing Assistants  | 7,492.22                    | .21                                   | 15.73             |
|      |                     |                             |                                       | <u>\$1,321.11</u> |

Table XXXV

MEDICATION SUPPLIES COST ON EXPERIMENTAL WARDS  
DURING STUDY PERIOD

|     |          |
|-----|----------|
| 4DE | \$382.48 |
| 4AB | 559.56   |
| 3DE | 489.75   |
| 3CF | 162.95   |

Medication Storage Costs

The medication storage facilities on each experimental ward and their cost during the study period are shown in Table XXXVI.

Table XXXVI

MEDICATION STORAGE COSTS ON EXPERIMENTAL WARDS DURING STUDY PERIOD

| Ward | Storage Facilities            | Annual Cost  | Study Period Cost |
|------|-------------------------------|--------------|-------------------|
| 4DE  | 6 Medication Storage Units    | \$ 36.00     | \$ 9.00           |
|      | 6 Drug Cabinets               | <u>36.00</u> | <u>9.00</u>       |
|      | Total                         | \$ 72.00     | \$ 18.00          |
| 4AB  | 128 Square Feet - \$6.53/foot | \$ 835.84    | \$208.96          |
|      | 4 Drug Cabinets               | <u>24.00</u> | <u>6.00</u>       |
|      | Total                         | \$ 859.84    | \$214.96          |
| 3DE  | 128 Square Feet - \$6.53/foot | \$ 835.84    | \$208.96          |
|      | 5 Medication Storage Units    | <u>30.00</u> | <u>7.50</u>       |
|      | Total                         | \$ 865.84    | \$216.46          |
| 3CF  | 240 Square Feet - \$6.53/foot | \$1,567.20   | \$391.80          |

The storage units used on 4DE and 3DE were valued at \$240.00 each. Since approximately one-half of the space was used for the storage of medications, the cost of each medication storage unit was estimated at \$120.00. The life expectancy of the storage units is 20 years. Using the straight-line method, annual depreciation was calculated to be \$6.00 per unit.

The drug cabinets cost \$30.00 and have a life expectancy of five years. Annual depreciation was calculated to be \$6.00 per unit using

the straight-line method of calculation.

Nursing service overhead costs were calculated previously under Satellite Pharmacy Cost to be \$6.53 per square foot.

Floor Stock Inventory Holding Costs

The floor stock inventory holding costs on each of the experimental wards during the study period are shown in Table XXXVII. Floor stock inventory on wards under the Unit-Dose systems remained constant at predetermined levels. However, floor stock inventory fluctuated on the other experimental wards.

Table XXXVII

FLOOR STOCK INVENTORY HOLDING COSTS ON EXPERIMENTAL WARDS  
DURING STUDY PERIOD

| Ward | Floor Stock Inventory |          |          | Annual<br>Inventory<br>Holding<br>Costs | Study<br>Period<br>Costs |
|------|-----------------------|----------|----------|---|--------------------------|
|      | Oct. 1                | Oct. 31  | Average  |   |                          |
| 4DE  | \$485.75              | \$485.75 | \$485.75 | \$48.58                                 | \$12.15                  |
| 4AB  | 250.30                | 250.30   | 250.30   | 25.03                                   | 6.26                     |
| 3DE  | 510.01                | 527.12   | 518.57   | 51.86                                   | 12.97                    |
| 3CF  | 428.29                | 406.38   | 417.34   | 41.73                                   | 10.43                    |

Summary of Nursing Costs

A summary of the nursing drug distribution costs on each experimental ward during the study period is presented in Table XXXVIII. The nursing cost was \$1,712.47 on 4DE; \$1,960.48 on 4AB; \$3,706.50 on 3DE; and \$1,886.29 on 3CF.

Table XXXVIIISUMMARY OF NURSING DRUG DISTRIBUTION COSTS ON EXPERIMENTAL WARDS  
DURING STUDY PERIOD

| Ward   | Nursing<br>Personnel<br>Costs | Medication<br>Supplies<br>Cost | Medication<br>Storage<br>Costs | Floor Stock<br>Inventory<br>Holding<br>Costs | Total<br>Costs |
|--------|-------------------------------|--------------------------------|--------------------------------|--|----------------|
| 4DE    | \$1,299.84                    | \$ 382.48                      | \$ 18.00                       | \$12.15                                      | \$1,712.47     |
| 4AB    | 1,179.70                      | 559.56                         | 214.96                         | 6.26   | 1,960.48       |
| 3DE    | 2,987.32                      | 489.75                         | 216.46                         | 12.97  | 3,706.50       |
| 3CF    | 1,321.11                      | 162.95                         | 391.80                         | 10.43  | 1,886.29       |
| Totals | \$6,787.97                    | \$1,594.74                     | \$841.22                       | \$41.81                                      | \$9,265.74     |

## CHAPTER VII

### RESULTS

Completion of the cost analysis study provided all the data required to calculate the cost of the drug distribution system on each of the experimental wards during the study period. The final step in the author's study was to divide the cost on each ward by the number of unit-doses administered on that ward to determine the cost per unit-dose under each drug distribution system.

#### Summary of Drug Distribution Costs on Experimental Wards

Summing the pharmacy costs and the nursing drug distribution costs gave the total cost of providing and administering drugs on each of the experimental wards during the study period. The total cost was \$12,367.55 on 4DE; \$13,394.44 on 4AB; \$10,648.62 on 3DE; and \$7,000.56 on 3CF. A break down of these totals by cost component is given in Table XXXIX.

#### Unit-Doses Administered on Experimental Wards

During October 1970, 4,734 unit-doses were recorded on the drug administration lists, PRN lists, and master control sheets for 4DE. Dividing by 786, the number of patient days in October, gave an average unit-doses per patient day, less floor stock unit-doses, figure of 6.02. This figure was multiplied by the number of patient days in November and December 1970 to obtain an estimate of the unit-doses, less floor stock unit-doses, administered on 4DE during those months. By adding the floor

Table XXXIX

SUMMARY OF DRUG DISTRIBUTION COSTS ON EXPERIMENTAL WARDS  
DURING STUDY PERIOD

| Cost Component                      | 4DE         | 4AB         | 3DE         | 3CF        |
|-------------------------------------|-------------|-------------|-------------|------------|
| Pharmacy Personnel Costs            | \$ 4,700.30 | \$ 4,932.43 | \$ 1,512.75 | \$ 989.59  |
| Drug Cost                           | 2,853.01    | 3,406.20    | 4,088.17    | 3,323.66   |
| Inventory Holding Costs             | 49.55       | 59.07       | 70.85       | 57.71      |
| Pharmacy Supplies Cost              | 513.79      | 613.31      | 60.61       | 49.22      |
| Overhead Costs                      | 1,235.04    | 1,055.19    | 1,209.74    | 694.09     |
| Data Processing Costs               | 1,194.93    | 1,253.95    | --          | --         |
| Satellite Pharmacy Cost             | 108.46      | 113.81      | --          | --         |
| Nursing Personnel Costs             | 1,299.84    | 1,179.70    | 2,987.32    | 1,321.11   |
| Medication Supplies Cost            | 382.48      | 559.56      | 489.75      | 162.95     |
| Medication Storage Costs            | 18.00       | 214.96      | 216.46      | 391.80     |
| Floor Stock Inventory Holding Costs | 12.15       | 6.26        | 12.97       | 10.43      |
| Totals                              | \$12,367.55 | \$13,394.44 | \$10,648.62 | \$7,000.56 |

stock unit-doses administered during October, November, and December, the total unit-doses administered on 4DE during the study period was estimated to be 21,101. These calculations are shown in Table XL.

Table XL

## UNIT-DOSES ADMINISTERED ON EXPERIMENTAL WARDS DURING STUDY PERIOD

| Ward | Period          | Administration List, PRN List,<br>Master Control Sheet,<br>or Chart Unit-Doses |              |                | Floor<br>Stock<br>Unit-<br>Doses | Total<br>Unit-<br>Doses |
|------|-----------------|--|--------------|----------------|----------------------------------|-------------------------|
|      |                 | Doses Per<br>Patient Day   | Patient Days | Unit-<br>Doses |                                  |                         |
| 4DE  | Oct.            | --   | 786          | 4,734          | 2,138                            | 6,872                   |
|      | Nov.            | 6.02   | 875          | 5,268          | 2,290                            | 7,558                   |
|      | Dec.            | 6.02   | 795          | 4,786          | 1,885                            | 6,671                   |
|      | Study<br>Period |  | 2,456        | 14,788         | 6,313                            | 21,101                  |
| 4AB  | Oct.            | --   | 1,020        | 4,655          | 3,183                            | 7,838                   |
|      | Nov.            | 4.56   | 997          | 4,546          | 3,105                            | 7,651                   |
|      | Dec.            | 4.56   | 845          | 3,853          | 2,803                            | 6,656                   |
|      | Study<br>Period |  | 2,862        | 13,054         | 9,091                            | 22,145                  |
| 3DE  | Oct.            | --   | 1,020        | 6,780          | --                               | 6,780                   |
|      | Nov.            | 6.65   | 1,105        | 7,348          | --                               | 7,348                   |
|      | Dec.            | 6.65   | 919          | 6,111          | --                               | 6,111                   |
|      | Study<br>Period |  | 3,044        | 20,239         | --                               | 20,239                  |
| 3CF  | Oct.            | --   | 662          | 4,775          | --                               | 4,775                   |
|      | Nov.            | 7.21   | 651          | 4,694          | --                               | 4,694                   |
|      | Dec.            | 7.21   | 597          | 4,304          | --                               | 4,304                   |
|      | Study<br>Period |  | 1,910        | 13,773         | --                               | 13,773                  |

Similarly, on 4AB the number of unit-doses administered during the study period was estimated at 22,145.

On 3DE, the number of unit-doses recorded on patients' charts during October 1970 was 6,780. Dividing by 1,020, the number of patient days, the average unit-doses per patient day was 6.65. Multiplying by the number of patient days in November and December gave an estimate of 20,239 unit-doses administered on 3DE during the study

period. Similar calculations on 3CF resulted in an estimate of 13,773 unit-doses administered during the study period on that ward. These calculations also are shown in Table XL.

#### Unit-Dose Costs

Dividing the total cost of operating the drug distribution system on each of the experimental wards by the number of unit-doses administered gave the cost per unit-dose under each drug distribution system during the study period. The results of these calculations, along with the cost per unit-dose for each of the cost components, are presented in Table XLI.

The cost per unit-dose under the Unit-Dose with Unit Assignment Nursing System (4DE) was \$0.5861.

The cost per unit-dose under the Unit-Dose with Team Nursing System (4AB) was \$0.6048.

The cost per unit-dose under the Floor Stock-Prescription Order with Unit Assignment Nursing System (3DE) was \$0.5261.

The cost per unit-dose under the Floor Stock-Prescription Order with Team Nursing System (3CF) was \$0.5083.

#### Analysis of Differences in Unit-Dose Costs

The four drug distribution systems ranked in order of increasing total cost per unit-dose are:

Table XLI

DRUG DISTRIBUTION COSTS PER UNIT-DOSE ON EXPERIMENTAL WARDS  
DURING STUDY PERIOD

| Cost Component                         | 4DE             | 4AB             | 3DE             | 3CF             |
|--|-----------------|-----------------|-----------------|-----------------|
| ✓ Pharmacy Personnel Costs             | \$0.2228        | \$0.2227        | \$0.0747        | \$0.0718        |
| Drug Cost                              | 0.1352          | 0.1538          | 0.2020          | 0.2413          |
| Inventory Holding Costs                | 0.0024          | 0.0027          | 0.0035          | 0.0042          |
| Pharmacy Supplies Cost                 | 0.0243          | 0.0277          | 0.0030          | 0.0036          |
| Overhead Costs                         | 0.0585          | 0.0476          | 0.0598          | 0.0504          |
| Data Processing Costs                  | 0.0566          | 0.0566          | ---             | ---             |
| Satellite Pharmacy Cost                | 0.0051          | 0.0051          | ---             | ---             |
| ✓ Nursing Personnel Costs              | 0.0616          | 0.0533          | 0.1476          | 0.0959          |
| Medication Supplies Cost               | 0.0181          | 0.0253          | 0.0242          | 0.0118          |
| Medication Storage Costs               | 0.0009          | 0.0097          | 0.0107          | 0.0285          |
| Floor Stock Inventory<br>Holding Costs | 0.0006          | 0.0003          | 0.0006          | 0.0008          |
| <b>Total Cost Per Unit-Dose</b>        | <b>\$0.5861</b> | <b>\$0.6048</b> | <b>\$0.5261</b> | <b>\$0.5083</b> |

|  |           |
|--|-----------|
| Floor Stock-Prescription Order with Team Nursing System -            | \$0.5083  |
| Floor Stock-Prescription Order with Unit Assignment Nursing System - | \$0.5261  |
| Unit-Dose with Unit Assignment Nursing System -                      | \$0.5861  |
| Unit-Dose with Team Nursing System -                                 | \$0.6048. |

Using the Floor Stock-Prescription Order with Team Nursing System (FPTN) as a basis of comparison, the total cost per unit-dose was 3.50 percent higher in the Floor Stock-Prescription Order with Unit

Assignment Nursing System (FPUA); 15.31 percent higher in the Unit-Dose with Unit Assignment Nursing System (UDUA); and 18.98 percent higher in the Unit-Dose with Team Nursing System (UDTN).

The difference in total cost per unit-dose between the least expensive system (FPTN) and the most expensive system (UDTN) was \$0.0965. However, the difference in total cost per unit-dose between the two floor stock-prescription order systems was \$0.0178, and between the two Unit-Dose systems, \$0.0187. Because of these small variations, it was concluded the system of nursing service had little effect on the cost per unit-dose. This conclusion was further substantiated by the fact the team nursing system was used in both the most expensive and least expensive systems while the unit assignment nursing system was employed in the two systems with intermediate costs.

Variations among the four systems in the value of the cost components of the total cost per unit-dose were large in some cases and small in others.

Pharmacy personnel costs per unit-dose were approximately three times higher in the Unit-Dose systems than in the floor stock-prescription order systems (\$0.2228 and \$0.2227 versus \$0.0747 and \$0.0718). The higher pharmacy personnel costs in the Unit-Dose systems were due to the increased number of pharmacists and technicians required to operate these systems. This increase in pharmacy personnel was necessary because several of the drug distribution activities performed by nursing personnel under the floor stock-prescription order systems were assumed by the pharmacy department in the Unit-Dose systems. Consequently, a

portion of the increase in pharmacy personnel costs was offset by a decrease in nursing personnel costs. Nursing personnel costs were approximately \$0.06 (\$0.0616) per unit-dose in the UDU system and \$0.05 (\$0.0533) per unit-dose in the UDTN system versus \$0.15 (\$0.1476) in the FPUA system and \$0.10 (\$0.0959) in the FPTN system.

Drug cost per unit-dose was approximately \$0.14 (\$0.1352) in the UDU system; \$0.15 (\$0.1538) in the UDTN system; \$0.20 (\$0.2020) in the FPUA system; and \$0.24 (\$0.2413) in the FPTN system. It is thought the lower drug cost in the Unit-Dose systems was due to decreased wastage and pilferage resulting from the use of Unit-Dose packaging and better control by the pharmacy department in these systems. However, data were not collected to substantiate this opinion.<sup>1</sup>

Under the floor stock-prescription order systems, a dose of a liquid preparation, for example, may be poured and not administered to the

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1. In a study conducted at Orange County Medical Center, California, it was concluded the Unit-Dose, satellite pharmacy drug distribution system tested in that hospital would result in an annual saving of \$40,000 from a reduction in inventory loss. "Drug loss due to deterioration was reduced because the pharmacist was able to control outdated drugs and seldom used items. The loss due to drugs poured but not administered was reduced almost completely because the dosage form was not contaminated in the unopened package."

W. T. Hill, Jr., et al, "Satellite Service," Hospitals, J.A.H.A. (44:6) 16 Mar. 1970, p. 102.

Beste also noted "a marked decrease in purchases of many commonly used pharmaceuticals" with the Unit-Dose system. He commented, "The waste and shrinkage factors must have been far greater than we had imagined." D. F. Beste, Jr., "An Integrated Pharmacist-Nurse Approach to the Unit-Dose Concept," Am. J. Hosp. Pharm. (25:8) Aug. 1968, pp. 405-406.

patient. This medication is discarded. However, under the Unit-Dose system, the dose would be re-useable because of Unit-Dose packaging. There is a greater opportunity for pilferage under the floor stock-prescription order systems because of the large quantities of a drug available on the nursing ward as floor stock and the relatively large number of doses dispensed at one time on a prescription. Under the Unit-Dose systems, pilferage would be almost non-existent because only a few doses of a drug are available on the ward at one time and there is closer control by the pharmacist up to the time of drug administration.

The decrease in drug cost in the Unit-Dose systems, resulting from Unit-Dose packaging and greater pharmacy control, was largely offset by the additional cost of these factors. Pharmacy supplies cost, which included packaging materials, was approximately \$0.02 per unit-dose higher in the Unit-Dose systems than in the floor stock-prescription order systems (\$0.0243 and \$0.0277 versus \$0.0030 and \$0.0036). In the floor stock-prescription order systems, many of the containers were re-useable. However, the Unit-Dose packages were disposable and discarded after use.

Much of the additional pharmacy control over drug distribution in the Unit-Dose systems resulted from the use of data processing. The data processing costs per unit-dose were \$0.0566. This cost was associated only with the Unit-Dose systems.

If drug cost was redefined to include pharmacy supplies cost and data processing costs, the difference in drug cost among the four systems would be much smaller. Recalculating drug cost in this manner would

result in a drug cost per unit-dose of \$0.2161 in the UDU system; \$0.2381 in the UDTN system; \$0.2050 in the FPUA system; and \$0.2449 in the FPTN system.

Medication storage costs varied from a low of \$0.0009 per unit-dose in the UDU system to a high of \$0.0285 per unit-dose in the FPTN system. This wide variation was due to the variety of storage facilities used in the different systems. Again, the lower medication storage costs in the Unit-Dose systems are offset partially by the cost of the satellite pharmacy which amounted to \$0.0051 per unit-dose.

Inventory holding costs per unit-dose and floor stock inventory holding costs per unit-dose were relatively small cost items and each amounted to less than \$0.005 in all four systems. Variations among the systems were small with a maximum variation in inventory holding costs per unit-dose of \$0.0018 and maximum variation in floor stock inventory holding costs per unit-dose of \$0.0005.

Overhead costs per unit-dose were relatively constant at approximately \$0.055 (\$0.0585, \$0.0476, \$0.0598, \$0.0504). Overhead costs initially were allocated in proportion to the number of beds on each experimental ward. These data were adjusted by the number of unit-doses administered to patients on these wards and thus, are not affected by differences in the drug distribution system.

Medication supplies cost varied from a low of \$0.0118 per unit-dose in the FPTN system to a high of \$0.0253 per unit-dose in the UDTN system. It was expected medication supplies cost would be less in the Unit-Dose

systems since medication order forms and medication tickets were not required. Also, the use of Unit-Dose packages reduced the need for medication cups, syringes and needles in the Unit-Dose systems. However, this expectation was not substantiated by the data.

CHAPTER VIII

## SUMMARY

During the past 10 years numerous Unit-Dose systems for drug distribution in hospitals have been developed. Each has been designed in an attempt to provide a more professional and effective service to improve patient care. Cost often has been a secondary consideration. However, in view of the rapidly rising costs of hospital care, new systems should be established only after careful cost analysis so the benefits of the innovation can be weighed against the economic effect.

At University Hospital, Saskatoon, a unique Computer-Assisted, Unit-Dose, Satellite System of drug distribution has been developed. In this system, a small computer is located in a satellite pharmacy on the nursing ward. Rather than keeping records manually, the pharmacist enters into the computer all drug orders and other information for each patient on the ward. The computer generates drug profiles for each patient as well as preparing administration schedules and accounting data. All medications are supplied in Unit-Dose form.

In addition to the experimental drug distribution system, University Hospital is evaluating a new system of nursing service on a number of nursing wards - the Unit Assignment System. Under this system, the traditional team nursing ward is divided into a number of smaller wards or 'units'. Patients are assigned to a specific unit on the basis of the level of nursing care they require. Nursing personnel are assigned to a

unit and remain in close proximity to their patients rather than working out of the traditional nursing station.

The Computer-Assisted, Unit-Dose, Satellite Pharmacy System has been established on three nursing wards. The remaining nursing wards operate under the traditional floor stock-prescription order system. Nursing wards under either system may utilize team nursing or unit assignment nursing. Hence, there are four different drug distribution systems in operation in the hospital, each utilizing a different combination of nursing service and pharmacy service. The four drug distribution systems are:

1. Unit-Dose with Unit Assignment Nursing System.
2. Unit-Dose with Team Nursing System.
3. Floor Stock-Prescription Order with Unit Assignment Nursing System.
4. Floor Stock-Prescription Order with Team Nursing System.

An evaluation of these four drug distribution systems is necessary to determine the one best suited to the needs of the patient and the hospital. One aspect of such an evaluation is the cost of operating each system.

The only comparable end product of all hospital drug distribution systems is the quantity of a drug administered to one patient at one time - the unit-dose. Therefore, the determination of the cost of this unit under various distribution systems provides a means of cost comparison of these systems.

The primary objective of this study was to determine the difference, if any, in the cost of producing and administering a unit-dose of

medication under each of the four drug distribution systems in operation at University Hospital. Secondary objectives were: (a) to determine the cost of the various components of each of the four drug distribution systems; and (b) to develop a cost analysis procedure which could be used to determine the cost of operating other drug distribution systems.

To obtain the cost of producing and administering a unit-dose under each of the four drug distribution systems, it was necessary to determine the total cost of operating each system for a period of time, and the number of unit-doses administered in each system during the same period of time. This was accomplished using cost analysis and work study techniques in the following manner:

1. Accumulation of all pharmacy department costs, both direct and indirect, during a study period.
2. Apportionment of the accumulated costs to the various pharmacy activities since the pharmacy department was involved in several activities in addition to inpatient services.
3. Selection of four nursing wards, each operating with a different drug distribution system.
4. Apportionment of accumulated pharmacy inpatient costs to each of the experimental wards.
5. Accumulation of nursing drug distribution costs on each of the experimental wards during the study period.
6. Determination of the number of unit-doses administered on each of the experimental wards during the study period.
7. Calculation of the unit-dose cost on each of the experimental wards.

Data on each system were collected simultaneously during a three-month study period - 1 October 1970 through 31 December 1970. All costs involved in operating the four drug distribution systems during the study period were included. Data were obtained from business office

records, personnel department records, pharmacy department reports, computer printouts, patient charts, and work studies.

The cost per unit-dose under the Unit-Dose with Unit Assignment Nursing System was \$0.5861. The cost per unit-dose under the Unit-Dose with Team Nursing System was \$0.6048. The cost per unit-dose under the Floor Stock-Prescription Order with Unit Assignment Nursing System was \$0.5261. The cost per unit-dose under the Floor Stock-Prescription Order with Team Nursing System was \$0.5083. Hence, the Floor Stock-Prescription Order with Team Nursing System was found to be the least expensive system of drug distribution at University Hospital and the Unit-Dose with Team Nursing System, the most expensive system. The difference in total cost per unit-dose between these two systems was \$0.0965.

The difference in total cost per unit-dose between the two floor stock-prescription order systems was \$0.0178, and between the two Unit-Dose systems, \$0.0187. Because of these small variations, it was concluded the system of nursing service had little effect on the cost per unit-dose. This conclusion was further substantiated by the fact the team nursing system was used in both the most expensive and least expensive systems while the unit assignment nursing system was employed in the two systems with intermediate costs.

Variations among the four systems in the value of the cost components of the total cost per unit-dose were large in some cases and small in others.

The higher cost of the Unit-Dose systems resulted primarily from

increased pharmacy personnel costs, data processing costs, and packaging costs. These increases were partially offset by lower nursing personnel costs and reduced drug cost.

The higher pharmacy personnel costs in the Unit-Dose systems were due to the increased number of pharmacists and technicians required to operate these systems. This increase in pharmacy personnel was necessary because several of the drug distribution activities performed by nursing personnel under the floor stock-prescription order systems were assumed by the pharmacy department in the Unit-Dose systems. Consequently, nursing personnel costs were less in the Unit-Dose systems.

It is thought the lower drug cost in the Unit-Dose systems was due to the decreased wastage and pilferage resulting from the use of Unit-Dose packaging and better control by the pharmacy department up to the time of drug administration. However, data were not collected to substantiate this opinion.

The limitations resulting from the methodology used in this study should be considered in evaluating the results and care should be exercised in applying the findings to other institutions or situations. These limitations apply to all the drug distribution systems studied. Therefore, while they may affect the absolute amount of some of the cost figures, their effect on the comparability of the systems studied should be minimal.

#### Evaluation of Hypotheses

Four hypotheses were formulated prior to the start of this study

on the basis of previous research, reports in the pharmaceutical literature and intuition of the author.

1. The cost of producing and administering a unit-dose under each of the four drug distribution systems at University Hospital, Saskatoon, will vary by less than \$0.10.

The difference in cost per unit-dose between the least expensive system and the most expensive system was \$0.0965. Therefore, hypothesis one was accepted.

2. Pharmacy personnel costs will be at least 25 percent higher in the Unit-Dose drug distribution systems than in the floor stock-prescription order systems.

Pharmacy personnel costs in the Unit-Dose with Unit Assignment Nursing System were 210.31 percent higher per unit-dose than pharmacy personnel costs in the Floor Stock-Prescription Order with Team Nursing System, and 198.26 percent higher than in the Floor Stock-Prescription Order with Unit Assignment Nursing System. Also, pharmacy personnel costs in the Unit-Dose with Team Nursing System were 210.17 percent higher per unit-dose than pharmacy personnel costs in the Floor Stock-Prescription Order with Team Nursing System, and 198.13 percent higher than in the Floor Stock-Prescription Order with Unit Assignment Nursing System. Therefore, hypothesis two was accepted.

3. Nursing personnel costs will be at least 25 percent lower in the Unit-Dose drug distribution systems than in the floor stock-prescription order systems.

Nursing personnel costs per unit-dose in the Unit-Dose with Unit Assignment Nursing System were 58.33 percent less than in the Floor Stock-Prescription Order with Unit Assignment Nursing System, and 35.77 percent less than in the Floor Stock-Prescription Order with Team Nursing

System. Also, nursing personnel costs per unit-dose in the Unit-Dose with Team Nursing System were 63.89 percent less than in the Floor Stock-Prescription Order with Unit Assignment Nursing System, and 44.42 percent less than in the Floor Stock-Prescription Order with Team Nursing System. Therefore, hypothesis three was accepted.

4. Drug cost will be at least 10 percent lower in the Unit-Dose drug distribution systems than in the floor stock-prescription order systems.

Drug cost per unit-dose in the Unit-Dose with Unit Assignment Nursing System was 33.07 percent less than in the Floor Stock-Prescription Order with Unit Assignment Nursing System, and 52.52 percent less than in the Floor Stock-Prescription Order with Team Nursing System. Also, drug cost per unit-dose in the Unit-Dose with Team Nursing System was 23.86 percent less than in the Floor Stock-Prescription Order with Unit Assignment Nursing System, and 43.32 percent less than in the Floor Stock-Prescription Order with Team Nursing System. Therefore, hypothesis four was accepted.

APPENDIX A

ALLOCATION OF 1966 HOSPITAL COSTS  
TO PHARMACY DEPARTMENT AND BASES  
OF ALLOCATION

## PHARMACY COSTS FOR YEAR ENDING 31 DECEMBER 1966

|                                    |              |               | Percent of<br>Hospital Total |
|------------------------------------|--------------|---------------|------------------------------|
| (a) Salaries                       |              | \$90,832      |                              |
| (b) Supplies                       | \$357,334    |               |                              |
| (c) Repairs                        | 13           |               |                              |
| (d) Miscellaneous                  | <u>1,752</u> |               |                              |
|                                    |              | 359,099       |                              |
| (e) Super-annuation,<br>C.P.P.     | \$ 1,165     |               | 1.60                         |
| (f) Super-annuation,<br>Group Plan | 571          |               | 1.80                         |
| (g) Group Life Insurance           | 25           |               | 1.50                         |
| (h) Workmen's Compensation         | 463          |               | 1.61                         |
| (i) Telephone and Telegraph        | 781          |               | 1.35                         |
| (j) Fuel                           | 865          |               | 1.40                         |
| (k) Electricity                    | 739          |               | 1.40                         |
| (l) Water                          | <u>234</u>   |               | 1.40                         |
|                                    |              | 4,843         |                              |
| (m) Building Depreciation          | \$ 4,871     |               | 2.04                         |
| (n) Equipment Depreciation         | 15,300       |               | 9.16                         |
| (o) Personnel & Employee<br>Health | 1,033        |               | 1.33                         |
| (p) Purchasing & Stores            | 731          |               | 0.80                         |
| (q) Physical Plant                 | 5,066        |               | 2.03                         |
| (r) Laundry & Linen                | 244          |               | 0.11                         |
| (s) Housekeeping                   | <u>4,328</u> |               | 1.34                         |
|                                    |              | 31,573        |                              |
| (t) Administration &<br>General    |              | <u>17,776</u> | 6.50                         |
|                                    |              | \$504,123     |                              |

Source: Education Cost Study, University Hospital, Saskatoon, Saskatchewan, 31 December 1966.

BASES OF ALLOCATION OF HOSPITAL COSTS TO PHARMACY  
EDUCATION COST STUDY 1966

- (a) Salaries - general ledger balance.
- (b) Supplies - general ledger balance.
- (c) Repairs - general ledger balance.
- (d) Miscellaneous - general ledger balance.
- (e) Super-annuation, C.P.P. - payroll statistics.
- (f) Super-annuation, Group Plan - payroll statistics.
- (g) Group Life Insurance - payroll statistics.
- (h) Workmen's Compensation - payroll statistics.
- (i) Telephone and Telegraph - based on number of telephones and an analysis of long distance charges by department.
- (j) Fuel - based on estimates supplies by Maintenance Department and studies conducted by University of Saskatchewan Engineering Department.
- (k) Electricity - based on estimates supplied by Maintenance Department and studies conducted by University of Saskatchewan Engineering Department.
- (l) Water - based on estimates supplied by Maintenance Department and studies conducted by University of Saskatchewan Engineering Department.
- (m) Building Depreciation - includes the footage (bathrooms, halls, and so forth) assigned to the area gaining greatest use out of them.
- (n) Equipment Depreciation - based on 31 December 1964 department plant ledger list.
- (o) Personnel and Health Office - based on number of staff per department.
- (p) Purchasing and Stores - based on dollar amount of supplies used by department. Drugs have been excluded from this calculation because pharmacy purchases all drugs out of their offices.
- (q) Physical Plant - based on departmental breakdown of repair requisitions for 1964. Study conducted in 1965.

- (r) Laundry and Linen - based on number of pounds and type of laundry and linen used by each department. Information gathered from actual weight test checks and laundry statistics.
- (s) Housekeeping - based on actual number of hours spent and supplies used by housekeeping departmentally. Part of information was gathered by actual recording of time and supplies on a test check basis and partly from Housekeeping statistics.
- (t) Administration and General - based on percentage of total hospital costs previously allocated to department.

APPENDIX B

PHARMACY EFFORT ANALYSIS - RECORD FORM

UNIVERSITY HOSPITAL  
Saskatoon, Saskatchewan

DRUG DISTRIBUTION SYSTEMS STUDY

PHARMACY DEPARTMENT

NAME \_\_\_\_\_

POSITION \_\_\_\_\_

WEEK OF \_\_\_\_\_

Please record to the nearest 15 minutes the time you spend each morning and afternoon on the following activities. If you do not spend any time on an activity, please place a zero (0) in the appropriate space. The sum of the times spent on the various activities should equal the total hours worked each day. Your record will be kept confidential and will be used only to calculate the total amount of time devoted to drug distribution activities in the hospital.

| Activity                   | Mon. |      | Tues. |      | Wed. |      | Thurs. |      | Fri. |      | Sat. |      | Sun. |      |
|----------------------------|------|------|-------|------|------|------|--------|------|------|------|------|------|------|------|
|                            | A.M. | P.M. | A.M.  | P.M. | A.M. | P.M. | A.M.   | P.M. | A.M. | P.M. | A.M. | P.M. | A.M. | P.M. |
| 1. Inpatient Prescriptions |      |      |       |      |      |      |        |      |      |      |      |      |      |      |
| 2. Ward Stock              |      |      |       |      |      |      |        |      |      |      |      |      |      |      |
| 3. Satellite Pharmacy      |      |      |       |      |      |      |        |      |      |      |      |      |      |      |
| 4. Outpatients             |      |      |       |      |      |      |        |      |      |      |      |      |      |      |
| 5. Teaching and Research   |      |      |       |      |      |      |        |      |      |      |      |      |      |      |
| 6. Administration          |      |      |       |      |      |      |        |      |      |      |      |      |      |      |
| TOTAL HOURS WORKED         |      |      |       |      |      |      |        |      |      |      |      |      |      |      |

October 1970

Form 1

APPENDIX C

PHARMACY EFFORT ANALYSIS - DESCRIPTION OF PHARMACY  
ACTIVITIES

UNIVERSITY HOSPITAL  
Saskatoon, Saskatchewan

DRUG DISTRIBUTION SYSTEMS STUDY

1. Inpatient Prescriptions includes time spent receiving, dispensing, pricing and filing inpatient prescription orders, processing, credits, and providing information related to the care of inpatients.
2. Ward Stocks includes time spent collecting baskets, filling, pricing, and delivering ward stocks including narcotics and controlled drug ward stocks, and providing information about ward stocks.
3. Satellite Pharmacy includes time devoted to any activity associated with the operation of the satellite pharmacy and the unit-dose project.
4. Outpatients includes time spent receiving, dispensing, pricing, delivering or mailing, and filing outpatient orders, and providing information related to the care of outpatients.
5. Teaching & Research includes time spent at the hospital and University of Saskatchewan on all educational or research programs except time spent educating your own staff or pharmacy students in routines and methods in the operation of your area or department.
6. Administration includes time devoted to preparing monthly reports, formulary, reading, and other administrative activities. It will, in effect, include all time that cannot be allocated to other activities.

TOTAL HOURS WORKED includes regular hours plus time spent in the hospital on call backs.

If you have difficulty in allocating your time or questions about this study, please contact B.R. Schnell at the College of Pharmacy. Phone 343-4775.

Thank you for your assistance.

October 1970

Form 2

APPENDIX D

NURSING EFFORT ANALYSIS - RECORD FORM

UNIVERSITY HOSPITAL  
Saskatoon, Saskatchewan

DRUG DISTRIBUTION SYSTEMS STUDY

WARD \_\_\_\_\_ NAME \_\_\_\_\_  
 POSITION \_\_\_\_\_ WEEK OF \_\_\_\_\_

Please record to the nearest minute the time you spend each morning and afternoon on the following activities. If you do not spend any time at an activity, please place a zero (0) in the appropriate space. Your record will be kept confidential and will be used to calculate the total amount of time devoted to drug distribution activities in the hospital.

| Activity  | Mon. |      | Tues. |      | Wed. |      | Thurs. |      | Fri. |      | Sat. |      | Sun. |      |
|---|------|------|-------|------|------|------|--------|------|------|------|------|------|------|------|
|   | A.M. | P.M. | A.M.  | P.M. | A.M. | P.M. | A.M.   | P.M. | A.M. | P.M. | A.M. | P.M. | A.M. | P.M. |
| 1. Check Order Book for Drug Orders             |      |      |       |      |      |      |        |      |      |      |      |      |      |      |
| 2. Transcribe Orders to Kardex                  |      |      |       |      |      |      |        |      |      |      |      |      |      |      |
| 3. Order Drugs                                  |      |      |       |      |      |      |        |      |      |      |      |      |      |      |
| 4. Prepare and Check Medication Tickets         |      |      |       |      |      |      |        |      |      |      |      |      |      |      |
| 5. Prepare Medications (including intravenous)  |      |      |       |      |      |      |        |      |      |      |      |      |      |      |
| 6. Give Medications (including intravenous)     |      |      |       |      |      |      |        |      |      |      |      |      |      |      |
| 7. Chart Medications (including intravenous)    |      |      |       |      |      |      |        |      |      |      |      |      |      |      |
| 8. Check Narcotic and Controlled Drug Inventory |      |      |       |      |      |      |        |      |      |      |      |      |      |      |
| 9. Other Drug Activity                          |      |      |       |      |      |      |        |      |      |      |      |      |      |      |
| HOURS WORKED (e.g. 7 a.m.-3:30 p.m.)            |      |      |       |      |      |      |        |      |      |      |      |      |      |      |

APPENDIX E

NURSING EFFORT ANALYSIS - DESCRIPTION  
OF NURSING MEDICATION ACTIVITIES

UNIVERSITY HOSPITAL  
Saskatoon, Saskatchewan

DRUG DISTRIBUTION SYSTEMS STUDY

1. Check Order Book includes time spent in checking the order book for medication orders only. It does not include use of the order book when transcribing orders.
2. Transcribe Orders includes all transcription of medication orders, including intravenous orders, from the order book except preparation of the drug requisition and placing it in the tube system.
3. Order Drugs includes time spent in preparation of the medication requisition, sending it to pharmacy, receiving drugs from pharmacy, and putting them away. Ordering of ward stocks is included.
4. Prepare and Check Medication Tickets includes time spent in preparing medication tickets, checking medication tickets with the Kardex, and sorting tickets prior to preparation for administration.
5. Prepare Medications includes time devoted to the preparation of all medications, including intravenous, for administration.
6. Give Medications includes time from leaving the nursing station to administer medications until return to nursing station with administration completed. Delays not related to drug administration should be excluded.
7. Chart Medications includes time spent in pulling patient charts, entering drugs administered, replacing charts and medication tickets. Sorting tickets for the next shift is included in category 4.
8. Check Narcotic and Controlled Drug Inventory includes time spent in receiving narcotics and controlled drugs, and in physical counts of these items at each shift change.
9. Other Drug Activity includes time spent in telephone calls to pharmacy or satellite, consultation with pharmacist, or looking for drug information. It will, in effect, include any time spent in medication activities which cannot be allocated to other categories.

If you have difficulty in allocating your time or questions about this study please contact either:

B.R. Schnell, College of Pharmacy, 343-4775  
OR O. Buchko, Pharmacy Department, 343-2366

Thank you for your assistance.

October 1970

Form 4

APPENDIX F

TIME SPENT BY PHARMACY PERSONNEL ON PHARMACY ACTIVITIES  
DURING STUDY PERIOD, ALLOCATION OF ADMINISTRATION TIME, AND  
ACTIVITY TIME AS A PERCENTAGE OF TOTAL TIME

## Pharmacist A

| Activity                | Recorded Time<br>In Hours | Allocation<br>of Admin.<br>Time | Total<br>Activity<br>Time | Percent<br>of Total<br>Time |
|-------------------------|---------------------------|---------------------------------|---------------------------|-----------------------------|
| Inpatient Prescriptions | 1.50                      | 53.34                           | 54.84                     | 31.38%                      |
| Floor Stock             | --                        | 32.11                           | 32.11                     | 18.38                       |
| Satellite Pharmacy      | --                        | 51.97                           | 51.97                     | 29.74                       |
| Outpatients             | --                        | 12.78                           | 12.78                     | 7.31                        |
| Teaching and Research   | 5.50                      | 17.55                           | 23.05                     | 13.19                       |
| Administration          | 167.75                    | --                              | --                        | --                          |
| Totals                  | 174.75                    | 167.75                          | 174.75                    | 100.00%                     |

## Pharmacist B

| Activity                | Recorded Time<br>In Hours | Allocation<br>of Admin.<br>Time | Total<br>Activity<br>Time | Percent<br>of Total<br>Time |
|-------------------------|---------------------------|---------------------------------|---------------------------|-----------------------------|
| Inpatient Prescriptions | 17.25                     | 38.64                           | 55.89                     | 27.98%                      |
| Floor Stock             | 3.00                      | 23.25                           | 26.25                     | 13.14                       |
| Satellite Pharmacy      | --                        | 37.64                           | 37.64                     | 18.84                       |
| Outpatients             | 10.25                     | 9.26                            | 19.51                     | 9.77                        |
| Teaching and Research   | 47.75                     | 12.71                           | 60.46                     | 30.27                       |
| Administration          | 121.50                    | --                              | --                        | --                          |
| Totals                  | 199.75                    | 121.50                          | 199.75                    | 100.00%                     |

## Pharmacist C

| Activity                | Recorded Time<br>In Hours | Allocation<br>of Admin.<br>Time | Total<br>Activity<br>Time | Percent<br>of Total<br>Time |
|-------------------------|---------------------------|---------------------------------|---------------------------|-----------------------------|
| Inpatient Prescriptions | 44.75                     | 3.50                            | 48.25                     | 39.31%                      |
| Floor Stock             | 41.25                     | 2.10                            | 43.35                     | 35.32                       |
| Satellite Pharmacy      | 1.00                      | 3.41                            | 4.41                      | 3.59                        |
| Outpatients             | 8.25                      | .84                             | 9.09                      | 7.40                        |
| Teaching and Research   | 16.50                     | 1.15                            | 17.65                     | 14.38                       |
| Administration          | 11.00                     | --                              | --                        | --                          |
| Totals                  | 122.75                    | 11.00                           | 122.75                    | 100.00%                     |

## Pharmacist D

| Activity                | Recorded Time<br>In Hours | Allocation<br>of Admin.<br>Time | Total<br>Activity<br>Time | Percent<br>of Total<br>Time |
|-------------------------|---------------------------|---------------------------------|---------------------------|-----------------------------|
| Inpatient Prescriptions | 65.75                     | .87                             | 66.62                     | 40.93%                      |
| Floor Stock             | 38.25                     | .53                             | 38.78                     | 23.83                       |
| Satellite Pharmacy      | --                        | .85                             | .85                       | .52                         |
| Outpatients             | 56.00                     | .21                             | 56.21                     | 34.54                       |
| Teaching and Research   | --                        | .29                             | .29                       | .18                         |
| Administration          | 2.75                      | --                              | --                        | --                          |
| Totals                  | 162.75                    | 2.75                            | 162.75                    | 100.00%                     |

## Pharmacist E

| Activity                | Recorded Time<br>In Hours | Allocation<br>of Admin.<br>Time | Total<br>Activity<br>Time | Percent<br>of Total<br>Time |
|-------------------------|---------------------------|---------------------------------|---------------------------|-----------------------------|
| Inpatient Prescriptions | 89.00                     | 1.51                            | 90.51                     | 69.76%                      |
| Floor Stock             | 23.50                     | .91                             | 24.41                     | 18.81                       |
| Satellite Pharmacy      | --                        | 1.47                            | 1.47                      | 1.13                        |
| Outpatients             | 12.50                     | .36                             | 12.86                     | 9.91                        |
| Teaching and Research   | --                        | .50                             | .50                       | .39                         |
| Administration          | 4.75                      | --                              | --                        | --                          |
| Totals                  | 129.75                    | 4.75                            | 129.75                    | 100.00%                     |

## Pharmacist F

| Activity                | Recorded Time<br>In Hours | Allocation<br>of Admin.<br>Time | Total<br>Activity<br>Time | Percent<br>of Total<br>Time |
|-------------------------|---------------------------|---------------------------------|---------------------------|-----------------------------|
| Inpatient Prescriptions | 120.25                    | 1.43                            | 121.68                    | 88.98%                      |
| Floor Stock             | 1.25                      | .86                             | 2.11                      | 1.55                        |
| Satellite Pharmacy      | --                        | 1.40                            | 1.40                      | 1.02                        |
| Outpatients             | 6.50                      | .34                             | 6.84                      | 5.00                        |
| Teaching and Research   | 4.25                      | .47                             | 4.72                      | 3.45                        |
| Administration          | 4.50                      | --                              | --                        | --                          |
| Totals                  | 136.75                    | 4.50                            | 136.75                    | 100.00%                     |

## Pharmacist G

| Activity                | Recorded Time<br>In Hours | Allocation<br>of Admin.<br>Time | Total<br>Activity<br>Time | Percent<br>of Total<br>Time |
|-------------------------|---------------------------|---------------------------------|---------------------------|-----------------------------|
| Inpatient Prescriptions | 4.25                      | .32                             | 4.57                      | 3.06%                       |
| Floor Stock             | .25                       | .19                             | .44                       | .30                         |
| Satellite Pharmacy      | 104.00                    | .31                             | 104.31                    | 69.77                       |
| Outpatients             | --                        | .08                             | .08                       | .05                         |
| Teaching and Research   | 40.00                     | .10                             | 40.10                     | 26.82                       |
| Administration          | 1.00                      | --                              | --                        | --                          |
| Totals                  | 149.50                    | 1.00                            | 149.50                    | 100.00%                     |

## Pharmacist H

| Activity                | Recorded Time<br>In Hours | Allocation<br>of Admin.<br>Time | Total<br>Activity<br>Time | Percent<br>of Total<br>Time |
|-------------------------|---------------------------|---------------------------------|---------------------------|-----------------------------|
| Inpatient Prescriptions | 10.50                     | 18.20                           | 28.70                     | 16.76%                      |
| Floor Stock             | .25                       | 10.96                           | 11.21                     | 6.55                        |
| Satellite Pharmacy      | 75.75                     | 17.74                           | 93.49                     | 54.59                       |
| Outpatients             | --                        | 4.36                            | 4.36                      | 2.54                        |
| Teaching and Research   | 27.50                     | 5.99                            | 33.49                     | 19.56                       |
| Administration          | 57.25                     | --                              | --                        | --                          |
| Totals                  | 171.25                    | 57.25                           | 171.25                    | 100.00%                     |

## Pharmacist I

| Activity                | Recorded Time<br>In Hours | Allocation<br>of Admin.<br>Time | Total<br>Activity<br>Time | Percent<br>of Total<br>Time |
|-------------------------|---------------------------|---------------------------------|---------------------------|-----------------------------|
| Inpatient Prescriptions | 9.25                      | .32                             | 9.57                      | 6.51%                       |
| Floor Stock             | --                        | .19                             | .19                       | .13                         |
| Satellite Pharmacy      | 129.25                    | .31                             | 129.56                    | 88.14                       |
| Outpatients             | --                        | .08                             | .08                       | .05                         |
| Teaching and Research   | 7.50                      | .10                             | 7.60                      | 5.17                        |
| Administration          | 1.00                      | --                              | --                        | --                          |
| Totals                  | 147.00                    | 1.00                            | 147.00                    | 100.00%                     |

## Pharmacist J

| Activity                | Recorded Time<br>In Hours | Allocation<br>of Admin.<br>Time | Total<br>Activity<br>Time | Percent<br>of Total<br>Time |
|-------------------------|---------------------------|---------------------------------|---------------------------|-----------------------------|
| Inpatient Prescriptions | 7.00                      | --                              | 7.00                      | 5.36%                       |
| Floor Stock             | --                        | --                              | --                        | --                          |
| Satellite Pharmacy      | 122.50                    | --                              | 122.50                    | 93.87                       |
| Outpatients             | --                        | --                              | --                        | --                          |
| Teaching and Research   | 1.00                      | --                              | 1.00                      | .77                         |
| Administration          | --                        | --                              | --                        | --                          |
| Totals                  | 130.50                    | --                              | 130.50                    | 100.00%                     |

## Pharmacist K

| Activity                | Recorded Time<br>In Hours | Allocation<br>of Admin.<br>Time | Total<br>Activity<br>Time | Percent<br>of Total<br>Time |
|-------------------------|---------------------------|---------------------------------|---------------------------|-----------------------------|
| Inpatient Prescriptions | 46.75                     | .96                             | 47.71                     | 35.02%                      |
| Floor Stock             | 19.50                     | .57                             | 20.07                     | 14.73                       |
| Satellite Pharmacy      | --                        | .93                             | .93                       | .68                         |
| Outpatients             | 62.00                     | .23                             | 62.23                     | 45.67                       |
| Teaching and Research   | 5.00                      | .31                             | 5.31                      | 3.90                        |
| Administration          | 3.00                      | --                              | --                        | --                          |
| Totals                  | 136.25                    | 3.00                            | 136.25                    | 100.00%                     |

## Resident A

| Activity                | Recorded Time<br>In Hours | Allocation<br>of Admin.<br>Time | Total<br>Activity<br>Time | Percent<br>of Total<br>Time |
|-------------------------|---------------------------|---------------------------------|---------------------------|-----------------------------|
| Inpatient Prescriptions | 74.00                     | 9.78                            | 83.78                     | 56.99%                      |
| Floor Stock             | 3.75                      | 5.88                            | 9.63                      | 6.55                        |
| Satellite Pharmacy      | 4.00                      | 9.53                            | 13.53                     | 9.21                        |
| Outpatients             | 5.75                      | 2.34                            | 8.09                      | 5.50                        |
| Teaching and Research   | 28.75                     | 3.22                            | 31.97                     | 21.75                       |
| Administration          | 30.75                     | --                              | --                        | --                          |
| Totals                  | 147.00                    | 30.75                           | 147.00                    | 100.00%                     |

## Resident B

| Activity                | Recorded Time<br>In Hours | Allocation<br>of Admin.<br>Time | Total<br>Activity<br>Time | Percent<br>of Total<br>Time |
|-------------------------|---------------------------|---------------------------------|---------------------------|-----------------------------|
| Inpatient Prescriptions | 44.00                     | .87                             | 44.87                     | 49.04%                      |
| Floor Stock             | 7.50                      | .53                             | 8.03                      | 8.78                        |
| Satellite Pharmacy      | --                        | .85                             | .85                       | .93                         |
| Outpatients             | .50                       | .21                             | .71                       | .77                         |
| Teaching and Research   | 36.75                     | .29                             | 37.04                     | 40.48                       |
| Administration          | 2.75                      | --                              | --                        | --                          |
| Totals                  | 91.50                     | 2.75                            | 91.50                     | 100.00%                     |

## Resident C

| Activity                | Recorded Time<br>In Hours | Allocation<br>of Admin.<br>Time | Total<br>Activity<br>Time | Percent<br>of Total<br>Time |
|-------------------------|---------------------------|---------------------------------|---------------------------|-----------------------------|
| Inpatient Prescriptions | 43.00                     | 3.18                            | 46.18                     | 31.85%                      |
| Floor Stock             | 18.00                     | 1.91                            | 19.91                     | 13.73                       |
| Satellite Pharmacy      | --                        | 3.10                            | 3.10                      | 2.14                        |
| Outpatients             | 9.00                      | .76                             | 9.76                      | 6.73                        |
| Teaching and Research   | 65.00                     | 1.05                            | 66.05                     | 45.55                       |
| Administration          | 10.00                     | --                              | --                        | --                          |
| Totals                  | 145.00                    | 10.00                           | 145.00                    | 100.00%                     |

## Secretary

| Activity                | Recorded Time<br>In Hours | Allocation<br>of Admin.<br>Time | Total<br>Activity<br>Time | Percent<br>of Total<br>Time |
|-------------------------|---------------------------|---------------------------------|---------------------------|-----------------------------|
| Inpatient Prescriptions | 2.50                      | 48.18                           | 50.68                     | 32.91                       |
| Floor Stock             | --                        | 29.00                           | 29.00                     | 18.83                       |
| Satellite Pharmacy      | --                        | 46.93                           | 46.93                     | 30.48                       |
| Outpatients             | --                        | 11.54                           | 11.54                     | 7.49                        |
| Teaching and Research   | --                        | 15.85                           | 15.85                     | 10.29                       |
| Administration          | 151.50                    | --                              | --                        | --                          |
| Totals                  | 154.00                    | 151.50                          | 154.00                    | 100.00%                     |

## Pharmacy Aide

| Activity                | Recorded Time<br>In Hours | Allocation<br>of Admin.<br>Time | Total<br>Activity<br>Time | Percent<br>of Total<br>Time |
|-------------------------|---------------------------|---------------------------------|---------------------------|-----------------------------|
| Inpatient Prescriptions | 75.00                     | .32                             | 75.32                     | 49.55%                      |
| Floor Stock             | 58.00                     | .19                             | 58.19                     | 38.28                       |
| Satellite Pharmacy      | .50                       | .31                             | .81                       | .53                         |
| Outpatients             | 17.50                     | .08                             | 17.58                     | 11.57                       |
| Teaching and Research   | --                        | .10                             | .10                       | .07                         |
| Administration          | 1.00                      | --                              | --                        | --                          |
| Totals                  | 152.00                    | 1.00                            | 152.00                    | 100.00%                     |

## Pharmacy Clerk

| Activity                | Recorded Time<br>In Hours | Allocation<br>of Admin.<br>Time | Total<br>Activity<br>Time | Percent<br>of Total<br>Time |
|-------------------------|---------------------------|---------------------------------|---------------------------|-----------------------------|
| Inpatient Prescriptions | 85.00                     | 13.60                           | 98.60                     | 65.51%                      |
| Floor Stock             | 4.25                      | 8.18                            | 12.43                     | 8.26                        |
| Satellite Pharmacy      | --                        | 13.24                           | 13.24                     | 8.80                        |
| Outpatients             | 18.50                     | 3.26                            | 21.76                     | 14.46                       |
| Teaching and Research   | --                        | 4.47                            | 4.47                      | 2.97                        |
| Administration          | 42.75                     | --                              | --                        | --                          |
| Totals                  | 150.50                    | 42.75                           | 150.50                    | 100.00%                     |

## Technician A

| Activity                | Recorded Time<br>In Hours | Allocation<br>of Admin.<br>Time | Total<br>Activity<br>Time | Percent<br>of Total<br>Time |
|-------------------------|---------------------------|---------------------------------|---------------------------|-----------------------------|
| Inpatient Prescriptions | 8.50                      | --                              | 8.50                      | 5.59%                       |
| Floor Stock             | --                        | --                              | --                        | --                          |
| Satellite Pharmacy      | 142.50                    | --                              | 142.50                    | 93.75                       |
| Outpatients             | --                        | --                              | --                        | --                          |
| Teaching and Research   | 1.00                      | --                              | 1.00                      | .66                         |
| Administration          | --                        | --                              | --                        | --                          |
| Totals                  | 152.00                    | --                              | 152.00                    | 100.00%                     |

## Technician B

| Activity                             | Recorded Time In Hours | Allocation of Admin. Time | Total Activity Time | Percent of Total Time |
|--------------------------------------|------------------------|---------------------------|---------------------|-----------------------|
| Inpatient Prescriptions              | 11.50                  | .48                       | 11.98               | 8.29%                 |
| Floor Stock                          | --                     | .29                       | .29                 | .20                   |
| Satellite Pharmacy                   | 131.50                 | .46                       | 131.96              | 91.32                 |
| Outpatients                          | --                     | .11                       | .11                 | .08                   |
| Teaching and Research Administration | --                     | .16                       | .16                 | .11                   |
|                                      | 1.50                   | --                        | --                  | --                    |
| Totals                               | 144.50                 | 1.50                      | 144.50              | 100.00                |

## Technician C

| Activity                             | Recorded Time In Hours | Allocation of Admin. Time | Total Activity Time | Percent of Total Time |
|--------------------------------------|------------------------|---------------------------|---------------------|-----------------------|
| Inpatient Prescriptions              | 6.50                   | --                        | 6.50                | 4.51%                 |
| Floor Stock                          | --                     | --                        | --                  | --                    |
| Satellite Pharmacy                   | 137.50                 | --                        | 137.50              | 95.49                 |
| Outpatients                          | --                     | --                        | --                  | --                    |
| Teaching and Research Administration | --                     | --                        | --                  | --                    |
|                                      | --                     | --                        | --                  | --                    |
| Totals                               | 144.00                 | --                        | 144.00              | 100.00%               |

## Storeman

| Activity                             | Recorded Time In Hours | Allocation of Admin. Time | Total Activity Time | Percent of Total Time |
|--------------------------------------|------------------------|---------------------------|---------------------|-----------------------|
| Inpatient Prescriptions              | --                     | 38.00                     | 38.00               | 25.21%                |
| Floor Stock                          | 31.25                  | 22.87                     | 54.12               | 35.90                 |
| Satellite Pharmacy                   | --                     | 37.02                     | 37.02               | 24.56                 |
| Outpatients                          | --                     | 9.11                      | 9.11                | 6.04                  |
| Teaching and Research Administration | --                     | 12.50                     | 12.50               | 8.29                  |
|                                      | 119.50                 | --                        | --                  | --                    |
| Totals                               | 150.75                 | 119.50                    | 150.75              | 100.00%               |

## Porter A

| Activity                | Recorded Time<br>In Hours | Allocation<br>of Admin.<br>Time | Total<br>Activity<br>Time | Percent<br>of Total<br>Time |
|-------------------------|---------------------------|---------------------------------|---------------------------|-----------------------------|
| Inpatient Prescriptions | --                        | 12.40                           | 12.40                     | 8.16%                       |
| Floor Stock             | 113.00                    | 7.47                            | 120.47                    | 79.26                       |
| Satellite Pharmacy      | --                        | 12.08                           | 12.08                     | 7.95                        |
| Outpatients             | --                        | 2.97                            | 2.97                      | 1.95                        |
| Teaching and Research   | --                        | 4.08                            | 4.08                      | 2.68                        |
| Administration          | 39.00                     | --                              | --                        | --                          |
| Totals                  | 152.00                    | 39.00                           | 152.00                    | 100.00%                     |

## Porter B

| Activity                | Recorded Time<br>In Hours | Allocation<br>of Admin.<br>Time | Total<br>Activity<br>Time | Percent<br>of Total<br>Time |
|-------------------------|---------------------------|---------------------------------|---------------------------|-----------------------------|
| Inpatient Prescriptions | --                        | --                              | --                        | --                          |
| Floor Stock             | 149.75                    | --                              | 149.75                    | 98.68%                      |
| Satellite Pharmacy      | --                        | --                              | --                        | --                          |
| Outpatients             | 2.00                      | --                              | 2.00                      | 1.32                        |
| Teaching and Research   | --                        | --                              | --                        | --                          |
| Administration          | --                        | --                              | --                        | --                          |
| Totals                  | 151.75                    | --                              | 151.75                    | 100.00%                     |

## Student Helper A

| Activity                | Recorded Time<br>In Hours | Allocation<br>of Admin.<br>Time | Total<br>Activity<br>Time | Percent<br>of Total<br>Time |
|-------------------------|---------------------------|---------------------------------|---------------------------|-----------------------------|
| Inpatient Prescriptions | 23.50                     | --                              | 23.50                     | 90.38%                      |
| Floor Stock             | 2.50                      | --                              | 2.50                      | 9.62                        |
| Satellite Pharmacy      | --                        | --                              | --                        | --                          |
| Outpatients             | --                        | --                              | --                        | --                          |
| Teaching and Research   | --                        | --                              | --                        | --                          |
| Administration          | --                        | --                              | --                        | --                          |
| Totals                  | 26.00                     | --                              | 26.00                     | 100.00%                     |

## Student Helper B

| Activity                | Recorded Time<br>In Hours | Allocation<br>of Admin.<br>Time | Total<br>Activity<br>Time | Percent<br>of Total<br>Time |
|-------------------------|---------------------------|---------------------------------|---------------------------|-----------------------------|
| Inpatient Prescriptions | 26.00                     | --                              | 26.00                     | 74.29%                      |
| Floor Stock             | 9.00                      | --                              | 9.00                      | 25.71                       |
| Satellite Pharmacy      | --                        | --                              | --                        | --                          |
| Outpatients             | --                        | --                              | --                        | --                          |
| Teaching and Research   | --                        | --                              | --                        | --                          |
| Administration          | --                        | --                              | --                        | --                          |
| Totals                  | 35.00                     | --                              | 35.00                     | 100.00%                     |

## Student Helper C

| Activity                | Recorded Time<br>In Hours | Allocation<br>of Admin.<br>Time | Total<br>Activity<br>Time | Percent<br>of Total<br>Time |
|-------------------------|---------------------------|---------------------------------|---------------------------|-----------------------------|
| Inpatient Prescriptions | 55.00                     | .32                             | 55.32                     | 98.79%                      |
| Floor Stock             | --                        | .19                             | .19                       | .34                         |
| Satellite Pharmacy      | --                        | .31                             | .31                       | .55                         |
| Outpatients             | --                        | .08                             | .08                       | .14                         |
| Teaching and Research   | --                        | .10                             | .10                       | .18                         |
| Administration          | 1.00                      | --                              | --                        | --                          |
| Totals                  | 56.00                     | 1.00                            | 56.00                     | 100.00%                     |

## Total Pharmacy Staff

| Activity                | Recorded Time<br>In Hours | Allocation<br>of Admin.<br>Time | Total<br>Activity<br>Time | Percent<br>of Total<br>Time |
|-------------------------|---------------------------|---------------------------------|---------------------------|-----------------------------|
| Inpatient Prescriptions | 870.75                    | 246.21                          | 1,116.96                  | 31.80%                      |
| Floor Stock             | 524.25                    | 148.19                          | 672.44                    | 19.14                       |
| Satellite Pharmacy      | 848.50                    | 239.86                          | 1,088.36                  | 30.98                       |
| Outpatients             | 208.75                    | 59.00                           | 267.75                    | 7.62                        |
| Teaching and Research   | 286.50                    | 80.99                           | 367.49                    | 10.46                       |
| Administration          | 774.25                    | --                              | --                        | --                          |
| Totals                  | 3,513.00                  | 774.25                          | 3,513.00                  | 100.00%                     |

APPENDIX G

TIME SPENT BY NURSING PERSONNEL ON DRUG DISTRIBUTION ACTIVITIES  
UNDER VARIOUS DRUG DISTRIBUTION SYSTEMS AND AS A PERCENTAGE  
OF AVAILABLE TIME

TIME SPENT BY REGISTERED NURSES ON DRUG DISTRIBUTION ACTIVITIES UNDER THE UNIT-DOSE WITH UNIT ASSIGNMENT NURSING SYSTEM<sup>1</sup> DURING STUDY PERIOD<sup>2</sup> AND AS A PERCENTAGE OF AVAILABLE TIME.

| Activity   | Distribution of Time in Minutes |           |           | Total Minutes | Distribution of Time as a Percentage of Available Time |          |           |              |
|--|---------------------------------|-----------|-----------|---------------|--|----------|-----------|--------------|
|  | 12-8 a.m.                       | 8-4 p.m.  | 4-12 p.m. |               | 12-8 a.m.  | 8-4 p.m. | 4-12 p.m. | Study Period |
|  |                                 |           |           |               |  |          |           |              |
| Check Order Book for Drug Orders                   | 133.25                          | 414.75    | 136.75    | 684.75        | .49%   | .55%     | .33%      | .48%         |
| Transcribe Orders to Kardex                        | .50                             | 184.00    | 174.25    | 358.75        | --   | .24      | .43       | .26          |
| Order Drugs  | --                              | 3.75      | 4.00      | 7.75          | --   | .01      | .01       | .01          |
| Check Administration List                          | 116.00                          | 196.50    | 198.25    | 510.75        | .42  | .26      | .49       | .36          |
| Prepare Medications                                | 166.75                          | 323.00    | 246.25    | 736.00        | .61  | .43      | .60       | .51          |
| Give Medications                                   | 424.50                          | 798.75    | 999.25    | 2,222.50      | 1.55   | 1.06     | 2.45      | 1.55         |
| Chart Medications                                  | 262.00                          | 393.50    | 462.25    | 1,117.75      | .95  | .52      | 1.13      | .77          |
| Check Narcotic and Other Controlled Drug Inventory | 249.25                          | 267.25    | 191.75    | 708.25        | .91  | .36      | .47       | .49          |
| Other Drug Activity                                | 43.00                           | 144.00    | 53.75     | 240.75        | .15  | .19      | .13       | .16          |
| Totals   | 1,395.25                        | 2,725.50  | 2,466.50  | 6,587.25      | 5.08%  | 3.62%    | 6.04%     | 4.59%        |
| Minutes Available                                  | 27,450.00                       | 75,120.00 | 40,800.00 | 143,370.00    |  |          |           |              |

<sup>1</sup>Ward 4DE

<sup>2</sup>26 October - 22 November 1970

TIME SPENT BY REGISTERED NURSES ON DRUG DISTRIBUTION ACTIVITIES UNDER THE UNIT-DOSE WITH TEAM NURSING SYSTEM<sup>1</sup> DURING STUDY PERIOD<sup>2</sup> AS A PERCENTAGE OF AVAILABLE TIME

| Activity   | Distribution of Time in Minutes |           |           | Total Minutes | Distribution of Time as a Percentage of Available Time |          |           |              |
|--|---------------------------------|-----------|-----------|---------------|--|----------|-----------|--------------|
|  | 12-8 a.m.                       | 8-4 p.m.  | 4-12 p.m. |               | 12-8 a.m.  | 8-4 p.m. | 4-12 p.m. | Study Period |
|  |                                 |           |           |               |  |          |           |              |
| Check Order Book for Drug Orders                   | 29.00                           | 71.00     | 43.50     | 143.50        | .24%   | .11%     | .24%      | .15%         |
| Transcribe Orders to Kardex                        | 1.00                            | 251.00    | 50.00     | 302.00        | .01  | .38      | .27       | .31          |
| Order Drugs  | --                              | 2.00      | --        | 2.00          | --   | --       | --        | --           |
| Check Administration List                          | 111.50                          | 223.25    | 146.00    | 480.75        | .91  | .34      | .80       | .50          |
| Prepare Medications                                | 193.00                          | 247.75    | 149.00    | 589.75        | 1.59   | .38      | .82       | .61          |
| Give Medications                                   | 617.25                          | 741.00    | 862.00    | 2,220.25      | 5.08   | 1.13     | 4.72      | 2.31         |
| Chart Medications                                  | 178.50                          | 353.25    | 254.25    | 786.00        | 1.47   | .54      | 1.39      | .82          |
| Check Narcotic and Other Controlled Drug Inventory | 126.75                          | 90.00     | 116.50    | 333.25        | 1.04   | .13      | .64       | .35          |
| Other Drug Activity                                | --                              | 53.50     | 3.50      | 57.00         | --   | .08      | .02       | .06          |
| Totals   | 1,257.00                        | 2,032.75  | 1,624.75  | 4,914.50      | 10.34%   | 3.09%    | 8.90%     | 5.11%        |
| Minutes Available                                  | 12,150.00                       | 65,760.00 | 18,240.00 | 96,150.00     |  |          |           |              |

<sup>1</sup>Ward 4AB

<sup>2</sup>26 October - 22 November 1970

TIME SPENT BY REGISTERED NURSES ON DRUG DISTRIBUTION ACTIVITIES UNDER THE FLOOR STOCK-PRESCRIPTION ORDER WITH UNIT ASSIGNMENT NURSING SYSTEM<sup>1</sup> DURING STUDY PERIOD<sup>2</sup> AS A PERCENTAGE OF AVAILABLE TIME

| Activity   | Distribution of Time in Minutes |           |           | Total Minutes | Distribution of Time as a Percentage of Available Time |          |           |              |
|--|---------------------------------|-----------|-----------|---------------|--|----------|-----------|--------------|
|  | Distribution of Time in Minutes |           |           |               | Distribution of Time as a Percentage of Available Time |          |           |              |
|  | 12-8 a.m.                       | 8-4 p.m.  | 4-12 p.m. |               | 12-8 a.m.  | 8-4 p.m. | 4-12 p.m. | Study Period |
| Check Order Book for Drug Orders                   | 30.00                           | 286.00    | 133.00    | 449.00        | .24%   | .85%     | .68%      | .68%         |
| Transcribe Orders to Kardex                        | 8.00                            | 199.50    | 99.50     | 307.00        | .06  | .59      | .51       | .46          |
| Order Drugs  | 295.00                          | 125.25    | 57.75     | 478.00        | 2.34   | .37      | .29       | .72          |
| Prepare and Check Medication Tickets               | 128.00                          | 375.50    | 345.50    | 849.00        | 1.02   | 1.12     | 1.76      | 1.29         |
| Prepare Medications                                | 233.50                          | 681.50    | 579.00    | 1,494.00      | 1.85   | 2.03     | 2.94      | 2.27         |
| Give Medications                                   | 191.00                          | 1,019.00  | 760.50    | 1,970.50      | 1.52   | 3.03     | 3.86      | 2.99         |
| Chart Medications                                  | 103.50                          | 476.75    | 414.00    | 994.25        | .82  | 1.42     | 2.10      | 1.51         |
| Check Narcotic and Other Controlled Drug Inventory | 70.50                           | 143.00    | 200.00    | 413.50        | .56  | .43      | 1.01      | .63          |
| Other Drug Activity                                | 17.00                           | 234.00    | 37.00     | 288.00        | .13  | .70      | .19       | .44          |
| Totals   | 1,076.50                        | 3,540.50  | 2,626.25  | 7,243.25      | 8.54%  | 10.54%   | 13.34%    | 10.99%       |
| Minutes Available                                  | 12,600.00                       | 33,600.00 | 19,680.00 | 65,880.00     |  |          |           |              |

<sup>1</sup>Ward 3DE

<sup>2</sup>7 December - 20 December 1970

TIME SPENT BY SERVICE COORDINATOR ON DRUG DISTRIBUTION ACTIVITIES UNDER THE FLOOR STOCK-PRESCRIPTION ORDER WITH UNIT ASSIGNMENT NURSING SYSTEM<sup>1</sup> DURING STUDY PERIOD<sup>2</sup> AS A PERCENTAGE OF AVAILABLE TIME

| Activity   | Distribution of Time in Minutes |          |           | Total Minutes | Distribution of Time as a Percentage of Available Time |          |           |              |
|--|---------------------------------|----------|-----------|---------------|--|----------|-----------|--------------|
|  | Distribution of Time in Minutes |          |           |               | 12-8 a.m.  | 8-4 p.m. | 4-12 p.m. | Study Period |
|  | 12-8 a.m.                       | 8-4 p.m. | 4-12 p.m. |               |  |          |           |              |
| Check Order Book for Drug Orders                   | --                              | --       | --        | --            | --   | --       | --        | --           |
| Transcribe Orders to Kardex                        | --                              | --       | --        | --            | --   | --       | --        | --           |
| Order Drugs  | --                              | 133.00   | --        | 133.00        | --   | 3.08%    | --        | 3.08%        |
| Prepare and Check Medication Tickets               | --                              | --       | --        | --            | --   | --       | --        | --           |
| Prepare Medications                                | --                              | --       | --        | --            | --   | --       | --        | --           |
| Give Medications                                   | --                              | --       | --        | --            | --   | --       | --        | --           |
| Chart Medications                                  | --                              | --       | --        | --            | --   | --       | --        | --           |
| Check Narcotic and Other Controlled Drug Inventory | --                              | --       | --        | --            | --   | --       | --        | --           |
| Other Drug Activity                                | --                              | 35.00    | --        | 35.00         | --   | .81      | --        | .81          |
| Totals   | --                              | 168.00   | --        | 168.00        | --   | 3.89%    | --        | 3.89%        |
| Minutes Available                                  | --                              | 4,320.00 | --        | 4,320.00      | --   | --       | --        | --           |

<sup>1</sup>Ward 3DE

<sup>2</sup>7 December - 20 December 1970

TIME SPENT BY WARD AIDES ON DRUG DISTRIBUTION ACTIVITIES UNDER THE FLOOR STOCK-PRESCRIPTION ORDER WITH UNIT ASSIGNMENT NURSING SYSTEM<sup>1</sup> DURING STUDY PERIOD<sup>2</sup> AS A PERCENTAGE OF AVAILABLE TIME.

| Activity   | Distribution of Time in Minutes |          |           | Total Minutes | Distribution of Time as a Percentage of Available Time |          |           |              |
|--|---------------------------------|----------|-----------|---------------|--|----------|-----------|--------------|
|  | Distribution of Time in Minutes |          |           |               | 12-8 a.m.  | 8-4 p.m. | 4-12 p.m. | Study Period |
|  | 12-8 a.m.                       | 8-4 p.m. | 4-12 p.m. |               |  |          |           |              |
| Check Order Book for Drug Orders                   | --                              | --       | --        | --            | --   | --       | --        | --           |
| Transcribe Orders to Kardex                        | --                              | --       | --        | --            | --   | --       | --        | --           |
| Order Drugs  | --                              | 114.00   | 34.50     | 148.50        | --   | 2.37%    | .60%      | 1.41%        |
| Prepare and Check Medication Tickets               | --                              | --       | --        | --            | --   | --       | --        | --           |
| Prepare Medications                                | --                              | --       | --        | --            | --   | --       | --        | --           |
| Give Medications                                   | --                              | --       | --        | --            | --   | --       | --        | --           |
| Chart Medications                                  | --                              | --       | --        | --            | --   | --       | --        | --           |
| Check Narcotic and Other Controlled Drug Inventory | --                              | --       | --        | --            | --   | --       | --        | --           |
| Other Drug Activity                                | --                              | --       | --        | --            | --   | --       | --        | --           |
| Totals   | --                              | 114.00   | 34.50     | 148.50        | --   | 2.37%    | .60%      | 1.41%        |
| Minutes Available                                  | --                              | 4,800.00 | 5,760.00  | 10,560.00     |  |          |           |              |

<sup>1</sup>Ward 3DE

<sup>2</sup>7 December - 20 December 1970

TIME SPENT BY WARD CLERKS ON DRUG DISTRIBUTION ACTIVITIES UNDER THE FLOOR STOCK-PRESCRIPTION ORDER WITH UNIT ASSIGNMENT NURSING SYSTEM<sup>1</sup> DURING STUDY PERIOD<sup>2</sup> AS A PERCENTAGE OF AVAILABLE TIME

| Activity   | Distribution of Time in Minutes |          |           | Total Minutes | Distribution of Time as a Percentage of Available Time |          |           |              |
|--|---------------------------------|----------|-----------|---------------|--|----------|-----------|--------------|
|  | 12-8 a.m.                       |          | 4-12 p.m. |               | 12-8 a.m.  | 8-4 p.m. | 4-12 p.m. | Study Period |
|  | 12-8 a.m.                       | 8-4 p.m. | 4-12 p.m. |               | 12-8 a.m.  | 8-4 p.m. | 4-12 p.m. |              |
| Check Order Book for Drug Orders                   | --                              | --       | --        | --            | --   | --       | --        |              |
| Transcribe Orders to Kardex                        | --                              | --       | --        | --            | --   | --       | --        |              |
| Order Drugs  | --                              | --       | 5.00      | 5.00          | --   | .19%     | .06%      |              |
| Prepare and Check Medication Tickets               | --                              | --       | --        | --            | --   | --       | --        |              |
| Prepare Medications                                | --                              | --       | --        | --            | --   | --       | --        |              |
| Give Medications                                   | --                              | --       | --        | --            | --   | --       | --        |              |
| Chart Medications                                  | --                              | --       | --        | --            | --   | --       | --        |              |
| Check Narcotic and Other Controlled Drug Inventory | --                              | --       | --        | --            | --   | --       | --        |              |
| Other Drug Activity                                | --                              | 98.00    | .50       | 98.50         | --   | 1.70%    | 1.17      |              |
| Totals   | --                              | 98.00    | 5.50      | 103.50        | --   | 1.70%    | 1.23%     |              |
| Minutes Available                                  | --                              | 5,760.00 | 2,640.00  | 8,400.00      | --   | --       | --        |              |

<sup>1</sup>Ward 3DE

<sup>2</sup>7 December - 20 December 1970

TIME SPENT BY REGISTERED NURSES ON DRUG DISTRIBUTION ACTIVITIES UNDER THE FLOOR STOCK-PRESCRIPTION ORDER WITH TEAM NURSING SYSTEM<sup>1</sup> DURING STUDY PERIOD<sup>2</sup> AS A PERCENTAGE OF AVAILABLE TIME

| Activity   | Distribution of Time in Minutes |              |              | Total Minutes | Distribution of Time as a Percentage of Available Time |              |              |       |
|--|---------------------------------|--------------|--------------|---------------|--|--------------|--------------|-------|
|  | 12-8 a.m.                       | 8-4 p.m.     | 4-12 p.m.    |               | 12-8 a.m.  | 8-4 p.m.     | 4-12 p.m.    |       |
|  | Study Period                    | Study Period | Study Period |               | Study Period   | Study Period | Study Period |       |
| Check Order Book for Drug Orders                   | 69.00                           | 82.50        | 17.00        | 168.50        | .55%   | .16%         | .06%         | .18%  |
| Transcribe Orders to Kardex                        | 15.00                           | 108.25       | 53.50        | 176.75        | .12  | .21          | .19          | .19   |
| Order Drugs  | 523.00                          | 108.50       | 25.50        | 657.00        | 4.15   | .21          | .09          | .71   |
| Prepare and Check Medication Tickets               | 160.00                          | 458.25       | 442.50       | 1,060.75      | 1.27   | .87          | 1.59         | 1.15  |
| Prepare Medications                                | 197.00                          | 742.00       | 807.00       | 1,746.00      | 1.56   | 1.42         | 2.90         | 1.88  |
| Give Medications                                   | 317.00                          | 893.00       | 768.50       | 1,978.50      | 2.52   | 1.70         | 2.76         | 2.13  |
| Chart Medications                                  | 162.50                          | 607.00       | 501.50       | 1,271.00      | 1.29   | 1.16         | 1.80         | 1.37  |
| Check Narcotic and Other Controlled Drug Inventory | 77.00                           | 65.00        | 136.50       | 278.50        | .61  | .12          | .49          | .30   |
| Other Drug Activity                                | 10.00                           | 73.50        | 47.00        | 130.50        | .07  | .14          | .17          | .14   |
| Totals   | 1,530.50                        | 3,138.00     | 2,799.00     | 7,467.50      | 12.14%   | 5.99%        | 10.05%       | 8.05% |
| Minutes Available                                  | 12,600.00                       | 52,320.00    | 27,840.00    | 92,760.00     |  |              |              |       |

<sup>1</sup>Ward 3CF

<sup>2</sup>26 October - 22 November 1970

TIME SPENT BY WARD AIDES ON DRUG DISTRIBUTION ACTIVITIES UNDER THE FLOOR STOCK-PRESCRIPTION ORDER WITH TEAM NURSING SYSTEM<sup>1</sup> DURING STUDY PERIOD<sup>2</sup> AS A PERCENTAGE OF AVAILABLE TIME

| Activity   | Distribution of Time in Minutes |          |           | Total Minutes | Distribution of Time as a Percentage of Available Time |          |           |              |
|--|---------------------------------|----------|-----------|---------------|--|----------|-----------|--------------|
|  | 12-8 a.m.                       |          | 4-12 p.m. |               | 12-8 a.m.  | 8-4 p.m. | 4-12 p.m. | Study Period |
|  | 12-8 a.m.                       | 8-4 p.m. | 4-12 p.m. |               | 12-8 a.m.  | 8-4 p.m. | 4-12 p.m. | Study Period |
| Check Order Book for Drug Orders                   | --                              | --       | --        | --            | --   | --       | --        | --           |
| Transcribe Orders to Kardex                        | --                              | --       | --        | --            | --   | --       | --        | --           |
| Order Drugs  | --                              | 45.75    | --        | 45.75         | --   | .50%     | --        | .50%         |
| Prepare and Check Medication Tickets               | --                              | --       | --        | --            | --   | --       | --        | --           |
| Prepare Medications                                | --                              | --       | --        | --            | --   | --       | --        | --           |
| Give Medications                                   | --                              | --       | --        | --            | --   | --       | --        | --           |
| Chart Medications                                  | --                              | --       | --        | --            | --   | --       | --        | --           |
| Check Narcotic and Other Controlled Drug Inventory | --                              | --       | --        | --            | --   | --       | --        | --           |
| Other Drug Activity                                | --                              | --       | --        | --            | --   | --       | --        | --           |
| Totals   | --                              | 45.75    | --        | 45.75         | --   | .50%     | --        | .50%         |
| Minutes Available                                  | --                              | 9,120.00 | --        | 9,120.00      | --   | --       | --        | --           |

<sup>1</sup>Ward 3CF

<sup>2</sup>26 October - 22 November 1970

TIME SPENT BY WARD CLERKS ON DRUG DISTRIBUTION ACTIVITIES UNDER THE FLOOR STOCK-PRESCRIPTION ORDER WITH TEAM NURSING SYSTEM<sup>1</sup> DURING STUDY PERIOD<sup>2</sup> AS A PERCENTAGE OF AVAILABLE TIME

| Activity   | Distribution of Time in Minutes |           |           | Total Minutes | Distribution of Time as a Percentage of Available Time |          |           |              |
|--|---------------------------------|-----------|-----------|---------------|--|----------|-----------|--------------|
|  | 12-8 a.m.                       | 8-4 p.m.  | 4-12 p.m. |               | 12-8 a.m.  | 8-4 p.m. | 4-12 p.m. | Study Period |
| Check Order Book for Drug Orders                   | --                              | --        | --        | --            | --   | --       | --        | --           |
| Transcribe Orders to Kardex                        | --                              | --        | --        | --            | --   | --       | --        | --           |
| Order Drugs  | --                              | 99.00     | 63.25     | 162.25        | --   | .73%     | .82%      | .76%         |
| Prepare and Check Medication Tickets               | --                              | --        | --        | --            | --   | --       | --        | --           |
| Prepare Medications                                | --                              | --        | --        | --            | --   | --       | --        | --           |
| Give Medications                                   | --                              | --        | --        | --            | --   | --       | --        | --           |
| Chart Medications                                  | --                              | --        | --        | --            | --   | --       | --        | --           |
| Check Narcotic and Other Controlled Drug Inventory | --                              | --        | --        | --            | --   | --       | --        | --           |
| Other Drug Activity                                | --                              | --        | --        | --            | --   | --       | --        | --           |
| Totals   | --                              | 99.00     | 63.25     | 162.25        | --   | .73%     | .82%      | .76%         |
| Minutes Available                                  | --                              | 13,440.00 | 7,680.00  | 21,120.00     |  |          |           |              |

<sup>1</sup>Ward 3CF

<sup>2</sup>26 October - 22 November 1970

TIME SPENT BY CERTIFIED NURSING ASSISTANTS ON DRUG DISTRIBUTION ACTIVITIES UNDER THE FLOOR STOCK-  
 PRESCRIPTION ORDER WITH TEAM NURSING SYSTEM<sup>1</sup> DURING STUDY PERIOD<sup>2</sup> AS A PERCENTAGE OF AVAILABLE TIME

| Activity   | Distribution of Time in Minutes |           |           | Total<br>Minutes | Distribution of Time as a Percent-<br>age of Available Time |          |           |                 |
|--|---------------------------------|-----------|-----------|------------------|---|----------|-----------|-----------------|
|  | 12-8 a.m.                       |           | 4-12 p.m. |                  | 12-8 a.m.   | 8-4 p.m. | 4-12 p.m. | Study<br>Period |
|  | 12-8 a.m.                       | 8-4 p.m.  | 4-12 p.m. |                  | 12-8 a.m.   | 8-4 p.m. | 4-12 p.m. | Study<br>Period |
| Check Order Book for<br>Drug Orders                      | --                              | --        | --        | --               | --  | --       | --        | --              |
| Transcribe Orders to<br>Kardex                           | --                              | --        | --        | --               | --  | --       | --        | --              |
| Order Drugs  | 79.00                           | 4.00      | --        | 83.00            | .63%  | .02%     | --        | .16%            |
| Prepare and Check Medic-<br>ation Tickets                | --                              | --        | --        | --               | --  | --       | --        | --              |
| Prepare Medications                                      | --                              | --        | --        | --               | --  | --       | --        | --              |
| Give Medications   | --                              | --        | --        | --               | --  | --       | --        | --              |
| Chart Medications  | --                              | --        | --        | --               | --  | --       | --        | --              |
| Check Narcotic and<br>Other Controlled<br>Drug Inventory | 3.00                            | --        | --        | 3.00             | .02   | --       | --        | .01             |
| Other Drug Activity                                      | 10.00                           | --        | 12.00     | 22.00            | .08   | --       | .09%      | .04             |
| Totals   | 92.00                           | 4.00      | 12.00     | 108.00           | .73%  | .02%     | .09%      | .21%            |
| Minutes Available  | 12,600.00                       | 25,440.00 | 13,440.00 | 51,480.00        |   |          |           |                 |

<sup>1</sup>Ward 3CF

<sup>2</sup>26 October - 22 November 1970

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A COMPARISON OF UNIT-DOSE COSTS UNDER VARIOUS HOSPITAL  
DRUG DISTRIBUTION SYSTEMS

Bruce Robert Schnell

(Under the supervision of Professor Robert W. Hammel)

During the past 10 years numerous Unit-Dose systems for drug distribution in hospitals have been developed. Each has been designed in an attempt to provide a more professional and effective service to improve patient care. Cost often has been a secondary consideration. However, in view of the rapidly rising costs of hospital care, new systems should be established only after careful cost analysis so the benefits of the innovation can be weighed against the economic effect.

At University Hospital, Saskatoon, Saskatchewan, a unique Computer-Assisted, Unit-Dose, Satellite System of drug distribution has been developed and implemented on several nursing wards. In addition, the hospital is evaluating a new system of nursing service -- the Unit Assignment System. With the development of the Unit-Dose system of drug distribution and the unit assignment system of nursing service, there are four systems in operation through which drugs are made available and administered to patients: (a) Floor Stock-Prescription Order with Team Nursing System; (b) Floor Stock-Prescription Order with Unit Assignment Nursing System; (c) Unit-Dose with Team Nursing System; and (d) Unit-Dose with Unit Assignment Nursing System. Each of these systems varies in the type and amount of hospital resources utilized.

The primary objective of this study was to determine the difference,

if any, in the cost of producing and administering a unit-dose of medication under each of the four drug distribution systems. This was accomplished using cost analysis and work study techniques in the following manner:

1. Accumulation of all pharmacy costs, both direct and indirect during a study period.
2. Apportionment of the accumulated costs to the various pharmacy activities: (a) Inpatient Prescriptions; (b) Floor Stock; (c) Unit-Dose Project; (d) Outpatient Services; and (e) Teaching and Research.
3. Selection of four nursing wards, each operating with a different drug distribution system.
4. Apportionment of accumulated pharmacy inpatient costs to each of the experimental wards.
5. Accumulation of nursing drug distribution costs on each of the experimental wards during the study period.
6. Determination of the number of unit-doses administered on each of the experimental wards during the study period.
7. Calculation of the unit-dose cost on each of the experimental wards.

Data on each system were collected simultaneously during a three-month study period - 1 October 1970 through 31 December 1970. All costs involved in operating the four drug distribution systems during the study period were included. Data were obtained from business office records, personnel department records, pharmacy department records, computer printouts, patient charts, and work studies.

The cost per unit-dose under each of the drug distribution systems was:

|  |          |
|--|----------|
| Floor Stock-Prescription Order with Team Nursing System            | \$0.5083 |
| Floor Stock-Prescription Order with Unit Assignment Nursing System | \$0.5261 |
| Unit-Dose with Unit Assignment Nursing System                      | \$0.5861 |
| Unit-Dose with Team Nursing System                                 | \$0.6048 |

Hence, the Floor Stock-Prescription Order with Team Nursing System was found to be the least expensive system of drug distribution at University Hospital and the Unit-Dose with Team Nursing System, the most expensive system. The difference in cost per unit-dose between these two systems was \$0.0965.

The difference in cost per unit-dose between the two floor stock-prescription order systems was \$0.0178, and between the two Unit-Dose systems, \$0.0187. Because of these small variations, it was concluded the system of nursing service had little effect on the cost per unit-dose.

The higher cost of the Unit-Dose systems resulted primarily from increased pharmacy personnel costs, data processing costs, and packaging costs. These increases were partially offset by lower nursing personnel costs and reduced drug cost.

APPROVED \_\_\_\_\_

Professor R. W. Hammel

DATE \_\_\_\_\_